

Introductory course on
**Species distributions models: concepts,
methods, applications, and challenges**

Évora (Portugal), 14th-21st September 2015



Course directors:
Prof. Miguel B. Araújo
Dr. Babak Naimi

Course administrator:
Natália Melo

Organised by:
Science Retreats, LDA

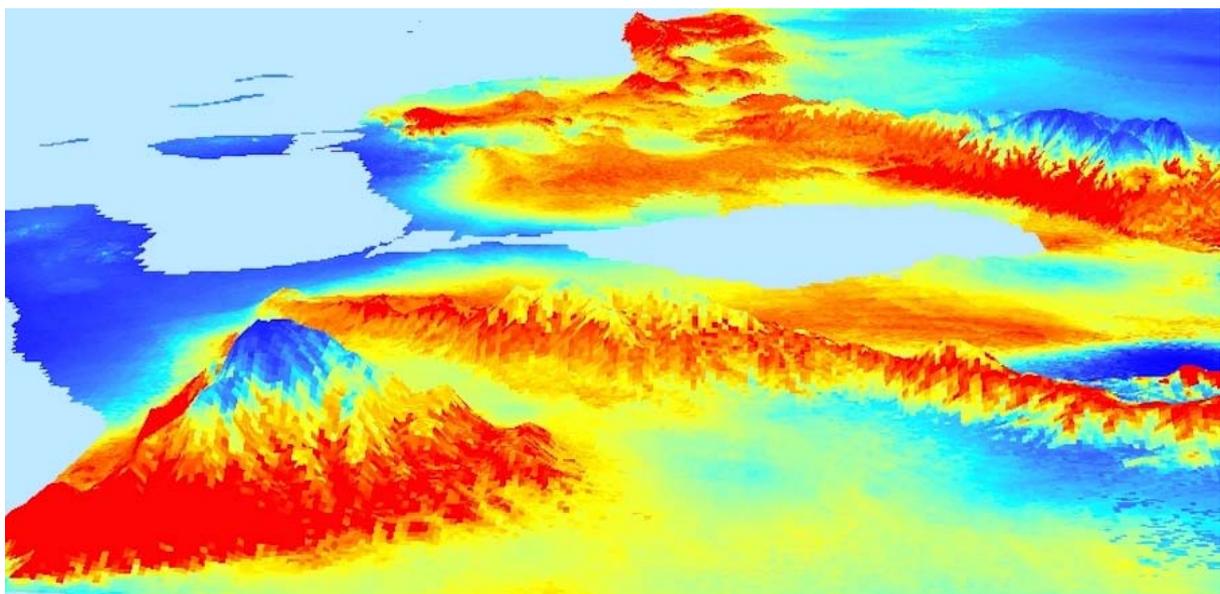
The concept

We are organising a new course on “Species distributions models: concepts, methods, applications, and challenges”, which aims to introduce the fundamental concepts underpinning ecological niche models (ENM), describe the methods currently in use, and discuss the strengths and limitations of these models for different applications. The course gives equal weight to theory and application. The students will have the opportunity to learn how to run ENM with the new SDM R platform programmed by one of the instructors and they will be asked to bring their own data (if such data are not available we can provide our own data). During two mornings over the weekend the students will analyse these data and prepare a small report for discussion in the class.

Introduction

Ecological niche models (ENM), also known as bioclimatic envelope models (BEM), habitat suitability models (HSM), and species distributions models (SDMs), are widely used to infer the ecological requirements of species and to predict their geographic distributions. Such models have been applied to a variety of questions in ecology and evolution, including discovery of new populations of known species, discovery of previously unknown species, spatial conservation prioritization, assessment of potential geographic ranges of invasive species, mapping risk of disease transmission, forecasting the effects of climate change on species distributions and on phylogenetic diversity, and identifying historical refugia for biodiversity.

The course “Species distributions models: concepts, methods, applications, and challenges” aims to introduce the fundamental concepts underpinning ENMs, describe the methods currently in use, and discuss the strengths and limitations of ENMs for different applications. We also plan to have specialized seminars introducing emerging concepts and next-generation approaches for modelling species distributions. The course gives equal weight to theory and application. The students will have the opportunity to learn how to run ENM with R and they will be asked to bring their own data (if such data are not available we can provide our own data). During two days the students will analyse these data and prepare a small report for discussion in the class.



SDM model for the Caribbean spiny pocket mouse

Source: Radosavljevic, A. and R. P. Anderson. 2014. J. Biogeogr 41:629-643

Course Objectives

In the end of the course, our aim is that students will be equipped to:

1. Understand the theoretical underpinnings of ecological niche models
2. Understand the strengths and limitations of ecological niche models in the context of different uses
3. Be able to correctly design an ecological niche modelling study for a variety of uses of interest
4. Get started with ecological niche modelling using R.

Course length and ECTS

4.6 hours on-site. This course is equivalent to 5 ECTS (European Credit Transfer System). Participants who have completed the course will receive a certificate at the end of it.

Requirements

Some experience in the computer language R is desirable, and experience with GIS is helpful. All participants must bring their own personal laptop.

Language

English.

Participation

The course accepts a minimum of 10 students and maximum of 30 students selected according to their track record and the relevance of the course for their research and/or work.

How to apply?

Send one PDF file including an explanation how the course will benefit your research and/or work, and a short CV to Natália Melo (cibioue@uevora.pt). Applications must be received no later than the 20th of June 2015. Although the main target of the course are postgraduate students doing their MSc or PhD degrees, we encourage applications from candidates who have already completed their PhD. Applications will be evaluated based on their relatedness to the course content. Successful candidates will be informed before the 10th of July 2015.

The course fee is €740 to be paid by the 20th of July, ideally by bank transfer. The fee covers the lectures, the course material, including the early release of the software SDM-R and its manual, and snacks over coffee breaks.

Accommodation

Accommodation during the course should be arranged privately. Évora is a touristic destination, so there is a wide range of options. Some nearby possibilities include:

Seminário Maior de Évora - 20€

Largo dos Colegiais, 6 | +351 266 758 320 or +351 963 897 674 – Email: seminarioevora@hotmail.com

Burgos Hostel – 35€

R. de Burgos, 2 | +351 266 703 428 - Fax: +351 266 709 157 – Email: burgoshostel@gmail.com

Évora Inn Chiado Design – 38€

Rua da República, 11 | +351 266 744 500 - Email: mail@evorainn.com

Ibis Hotel – 39€

Rua de Viana 18, Quinta da Tapada Urbanização da Muralha | +351 266760700 - Fax : +351 266760799 – Email: h1708@accor.com

StayInn Ale-Hop – 45€

Rua João de Deus, nº 86 | +351 910 852 255 – Email: stayinn.alehop@gmail.com

Hostel Namasté – 45€

Largo Doutor Manuel Alves Branco, 12 | +351 266 743 014 – Email: welcome@hostelnamasteevora.pt

Moov Hotel – 45€

Rua do Raimundo | +351 220 407 000 – Email: evora@hotelmoov.com

Hotel Solar de Monfalim – 50€

Largo da Misericórdia, 1 | +351 266 703 529 – Email: info@solarmonfalim.com

Best Western Plus Hotel Santa Clara – 58€

Travessa da Milheira, 19. 7000-545 Évora | +351 266 704 141 - Fax: +351 266 706 544 - Email: reservas@hotelsantaclara.pt

Hotel Riviera – 63€

Rua 5 de Outubro, 49 7000-854 Évora | +351 266 737 210 - Fax: +351 266 737 212 – Email: reservas@riviera-evora.com

M'Ar de Ar Muralhas – 102€

Travessa da Palmeira, 4/6 | + 351 266 739 300 - Fax: + 351 266 739 305 – Email: reservas@mardearhotels.com

Pousada dos Loios – 126€

Largo Conde Vila-Flor | +351 266 730 070/+351 266 707 248 – Email: guest@pousadas.pt

M'Ar de Ar Aqueduto – 153€

Rua Cândido dos Reis, 72 | + 351 266 740 700 - Fax: + 351 266 740 735 – Email: reservas@mardearhotels.com

Cancelation policy

If you wish to cancel your participation in this course, cancellations up to 20 days before the course start date will incur a 30% cancellation fee. For later cancellations, or non-attendance, the full course fee will be charged.

In the unlikely event that the course is cancelled due to unforeseen circumstances, accepted candidates will either be entitled to a full refund of the course fee, or the fee can be credited

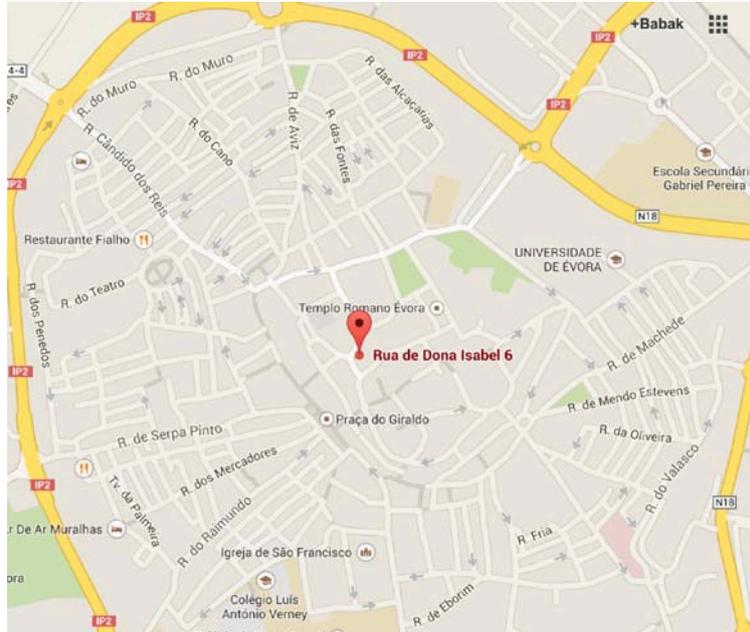
toward a future course. The organisation is not responsible for travel costs, or any other expenses incurred by the candidate as a result of such cancellation. Every effort will be made to avoid the cancellation of the planned course.

Funding

Unfortunately we do not provide internal grants for this course. However, 20% discounts are offered to students or researchers affiliated with the University of Évora, the CIBIO-InBIO, and the CSIC. If you would like to apply for such a discount please state the name of your organisation in your application (proof of affiliation will be requested). Unemployed scientists and self-funded Portuguese PhD students might also benefit from a 20% discount on the course fee, up to a maximum of two places.

Location

The course will take place in the Researcher's Residence ("Residência de Investigadores") in the old district of Évora (Rua Dona Isabel, No 6, corner with Travessa das Casas Pintadas, 7000-780 Évora, see map below but note that red tag should be moved northwards slightly – error from Google map!!). The Residence is set within a 15th century manor house next to what was then Vasco da Gama's home. The residence is *ca.* 100 m to the famous Roman Temple of Diana and about 2 minutes walk to Évora's main square "Praça do Giraldo".



Course Programme

14th of September (Monday)

- 09:00-09:30 – Introduction to the course
- 09:30-11:00 – Presentations by students (3 slides and 5 min each)
- 11:00-11:30 – Coffee break
- 11:30-12:00 – Presentations by students (continuation)
- 12:00-13:00 – Theory of niches and geographical distributions (lecture 1)
- 13:00-14:00 – Lunch
- 14:00-15:00 – Using models to predict the distributions of unknown species (lecture 2)
- 15:00-16:00 – Using models to predicting the distributions of invasive species (lecture 3)
- 16:00-16:30 – Coffee break
- 16:30-17:30 – Using models to forecast changes in species distributions (lecture 4)

15th of September (Tuesday)

- 09:00-10:00 – Using models in conservation planning (lecture 5)
- 10:00-11:00 – Ecological niche models in practice (lecture 6)
- 11:00-11:30 – Coffee break
- 11:30-12:30 – Data exploration and preparation for niche modelling (lecture 7)
- 12:30-13:30 – Lunch
- 13:30-15:30 – Modelling niches and geographical distributions with SDM R (practical)
- 15:30-16:00 – Coffee break
- 16:00-17:30 – Modelling niches and geographical distributions with SDM R (practical)

16th of September (Wednesday)

- 09:00-10:30 – Do niches evolve? (seminar 1)
- 10:30-11:00 – Coffee break
- 11:00-12:00 – Conceptual issues with data, validation and ensembles (lecture 8)
- 12:00-13:00 – Lunch
- 13:00-14:00 – Model evaluation and thresholds (lecture 9)
- 14:00-16:00 – Model evaluation with SDM R (practical)
- 16:00-16:30 – Coffee break
- 16:30-17:30 – Model evaluation with SDM R (practical)

17th of September (Thursday)

- 09:00-11:00 – Hybrid correlative-mechanistic SDMs (lecture 10)
- 11:00-11:30 – Coffee break
- 11:30-12:30 – Coupled niche-metapopulation models (lecture 11)
- 12:30-13:30 – Lunch
- 13:30-14:30 – Fitting coupled niche-metapopulation models with DemoNiche R (practical)
- 14:30-15:30 – Modelling niches and geographical distributions with SDM R (practical)
- 15:30-16:00 – Coffee break
- 16:00-17:30 – Modelling niches and geographical distributions with SDM R (practical)

18th of September (Friday)

- 09:00-10:00 – Alternative methods and software to develop niche models (lecture 12)
- 10:00-11:00 – Community-based models (lecture 13)
- 11:00-11:30 – Coffee break

11:30-12:30 – Community-based models with SDM R (practice)
12:30-13:30 – Lunch
13:30-15:00 – Community-based models with SDM R (practice)
15:00-15:30 – Coffee break
15:30-17:30 – Project development (discussion, project)

19th of September (Saturday)

09:00-13:00 – Project – Bring your own data (private work, project)

20th of September (Sunday)

09:00-13:00 – Project – Bring your own data (private work, project)

21st of September (Monday)

09:00-11:00 – Project (student presentations + discussion)
11:00-11:30 – Coffee break
11:30-12:30 – Project (student presentations + discussion)
12:30-13:30 – Lunch
13:30-15:00 – Project (student presentations + discussion)
15:00-15:30 – Coffee break
15:30-17:30 – Project (student presentations + discussion)

Key references

Text book for the course:

Peterson, A.T.P., Soberón, J., Pearson, R.G., Anderson, R.P., Martínez-Meyer, E., Nakamura, M. & Araújo, M.B. 2011. Ecological Niches and Geographical Distributions: A Modeling Perspective. Monographs in Population Biology. Princeton University Press.

Seminar

Araújo, M.B., Ferri-Yáñez, F., Bozinovic, F., Marquet, P., Valladares, F. & Chown, S.L. 2013. Heat freezes niche evolution. Ecology Letters. 16: 1206-1219.

Peterson, A. T. 2011. Ecological niche conservatism: a time-structured review of evidence. Journal of Biogeography 38: 817-827.

Broennimann, O., Treier, U.A., Müller-Schärer, H., Thuiller, W., Peterson, A.T., & Guisan, A. 2007. Evidence of climatic niche shift during biological invasion. Ecology Letters 10: 701-709.

Lecture 1

Araújo, M.B. & Peterson, A.T. 2012. Uses and misuses of bioclimatic envelope modelling. Ecology. 93: 1527-1539.

Soberón, J. & Nakamura, M. 2009. Niches and distributional areas: concepts, methods, and assumptions. Proceedings of the National Academy of Sciences USA 106(Supplement 2): 19644-19650.

Araújo, M.B. & Guisan, A. 2006. Five (or so) challenges for species distribution modelling. Journal of Biogeography 33: 1677-1688

Lecture 2

Raxworthy, C. J., E. Martínez-Meyer, N. Horning, R. A. Nussbaum, G. E. Schneider, M. A. Ortega-Huerta and A. T. Peterson (2003). "Predicting distributions of known and unknown reptile species in Madagascar." *Nature* 426: 837-841.

Lecture 3

Pearson, R.G., Phillips, S.J., Lorant, M.M., Beck, P.S.A., Damoulas, T., Knight, S.J., & Goetz, S.J. 2013. Shifts in Arctic vegetation and associated feedbacks under climate change. *Nature Climate Change* 3:673-677.

Lecture 4

Botkin, D., Saxe, H., Araújo, M.B., Betts, R., Bradshaw, R., Cedhagen, T., Chesson, P., Davis, M.B., Dawson, T., Etterson, J., Faith, D.P., Guisan, A., Ferrier, S., Hansen, A.S., Hilbert, D., Kareiva, P., Margules, C., New, M., Skov, F., Sobel, M.J. & Stockwell, D. 2007. Forecasting effects of global warming on biodiversity. *Bioscience* 57: 227-236.

Heikkinen, R.K., Luoto, M., Araújo, M.B., Virkkala, R., Thuiller, W. & Sykes, M. 2006. Methods and uncertainties in bioclimatic modelling under climate change. *Progress in Physical Geography* 30: 751-777.

Lecture 5

Araújo, M.B., Alagador, D., Cabeza, M., Nogués Bravo, D. & Thuiller, W. 2011. Climate change threatens European conservation areas. *Ecology Letters* 14: 484-492.

Williams, P., Hannah, L., Andelman, S., Midgley, G., Araújo, M.B., Hughes, G., Manne, L.L., Martínez-Meyer, E. & Pearson, R. 2005. Planning for climate change: Identifying minimum dispersal corridors for the Cape Proteaceae. *Conservation Biology*. 19: 1060-1073.

Araújo, M.B. & Williams, P.H. 2000. Selecting areas for species persistence using occurrence data. *Biological Conservation* 96: 331-45

Lecture 6

Guisan, A. & Zimmermann, N.E. 2000. Predictive habitat distribution models in ecology. *Ecological Modelling* 135: 147-186.

Lecture 7

Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G. & Jarvis, A. 2005. "Very high resolution interpolated climate surfaces for global land areas." *International Journal of Climatology* 25(15): 1965-1978.

Lecture 8

Araújo, M.B. & New, M. 2007. Ensemble forecasting of species distributions. *Trends in Ecology and Evolution* 22: 42-47.

Araújo, M.B., Pearson, R.G., Thuiller, W., & Erhard, M. 2005. Validation of species-climate impact models under climate change. *Global Change Biology* 11: 1504-1513.

Araújo, M.B., Whittaker, R.J., Ladle, R.J. & Erhard, M. 2005. Reducing uncertainty in extinction risk from climate change. *Global Ecology and Biogeography* 14: 529-538.

Oreskes, N., Shrader-Frechette, K.S. & Belitz, K. 1994. Verification, validation, and confirmation of numerical models in the earth sciences. *Science* 263: 641-646.

Lecture 9

Nenzén, H.K. & Araújo, M.B. 2011. Choice of threshold alters projections of species range shifts under climate change. *Ecological Modelling*. 222: 3346-3354.

Peterson, A.T., Papes, M. & Soberón, J. 2008. Rethinking receiver operating characteristic analysis applications in ecological niche modeling. *Ecological Modelling* 213: 63-72.

Liu, C., Berry, P.M., Dawson, T.P. & Pearson, R.G. 2005. Selecting thresholds of occurrence in the prediction of species distributions. *Ecography* 28: 385-393.

Fielding, A.H. & Bell, J.F. 1997. A review of methods for the assessment of prediction errors in conservation presence/absence models. *Environmental Conservation* 24: 38-49.

Naimi, B., N. a. S. Hamm, T. A. Groen, A. K. Skidmore & A. G. Toxopeus (2014). "Where Is Positional Uncertainty a Problem for Species Distribution Modelling?" *Ecography*, 37, 191-203.

Naimi, B., A. K. Skidmore, T. A. Groen & N. a. S. Hamm (2011). "Spatial Autocorrelation in Predictors Reduces the Impact of Positional Uncertainty in Occurrence Data on Species Distribution Modelling." *Journal of Biogeography*, 38, 1497-1509.

Lecture 10

Fordham, D.A., Akçakaya, H.R., Araújo, M.B., Keith, D. & Brook, B.W. 2013. Tools for integrating range change, extinction risk and climate change information into conservation management. *Ecography*. 36: 956–964.

Fordham, D.A., Akçakaya, H.R., Brook, B.W., Rodriguez, A., Alves, P.C., Civantos, E., Triviño, M., Watts, M.J. & Araújo, M.B. 2013. Adapted conservation measures are required to save the Iberian Lynx in a changing climate. *Nature Climate Change*. 3: 899–903.

Keith, D.A., Akçakaya, H.R., Thuiller, w., Midgley, G.F., Pearson, R.G., Phillips, S.J., Regan, H.M., Araújo, M.B. & Rebelo, T.G. 2008. Predicting extinction risks under climate change: coupling stochastic population models with dynamic bioclimatic habitat models. *Biology Letters*. doi:10.1098/rsbl.2008.0049.

Lecture 11

Nenzén, H.K., Keith, D.A., Swab, R. & Araújo, M.B. 2012. demoniche – An R package for simulating spatially-explicit population dynamics. *Ecography*. 35: 577-580.

Lecture 12

Diniz-Filho, J.A., Bini, L.M., Rangel, T.F.L.B., Loyola, R.D., Hof, C., Nogués-Bravo, D. & Araújo, M.B. 2009. Partitioning and mapping uncertainties in ensembles of forecasts of species turnover under climate changes. *Ecography* 32: 897-906.

Thuiller, W., Lafourcade, B., Engler, R., & Araújo, M.B. 2009. BIOMOD – A platform for ensemble forecasting of species distributions. *Ecography* 32: 369-373.

Lecture 13

Baselga, A. & Araújo, M.B. 2010. Do community-level models describe community variation effectively? *Journal of Biogeography* 37(10): 1842-1850.

Baselga, A. & Araújo, M.B. 2009. Individualistic vs. community modelling of species distributions under climate change. *Ecography* 32: 55-65.

Ferrier, S. & Guisan, A. 2006. Spatial modelling of biodiversity at the community level. *Journal of Applied Ecology* 43: 393–404.

Ferrier, S., Drielsma, M., Manion, G. & Watson, G. 2002. Extended statistical approaches to modelling spatial pattern in biodiversity in north-east New South Wales: II. Community-level modelling. *Biodiversity and Conservation* 11: 2309-2338.

About us



Miguel Araújo is a Research Professor of the Spanish National Research Council (CSIC) and visiting Professor at the Universities of Évora and Copenhagen. Previously, he held faculty or research positions at the Imperial College London, the University of Oxford, the CNRS, and the Natural History Museum in London. He was recently elected Editor-in-Chief of *Ecography*. Miguel Araújo has a wide range of interests in biogeography, conservation planning, global change biology, and macroecology. Earlier work included the development of reserve-selection techniques that minimise species extinctions within reserves. More recently, a variety of types of species distributions models have been used to investigate impacts of climate change on species distributions. The goal is to better understand the sources of uncertainty in models and to propose alternative approaches to reduce them. He was lead author for section on the biodiversity and climate change in Europe in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) for which the IPCC shared the Nobel Peace Prize. Miguel Araújo is a highly cited author and recipient of the Royal Society Wolfson Research Merit Award (2014). He received the IBS (International Biogeography Society) MacArthur & Wilson Award (2013), given to an individual ‘for notable, innovative contributions to biogeography at an early stage in their career’, and the GIBIF (Global Information Biodiversity Facility) 2013 Ebbe Nielsen Prize awarded to researchers that “combine biosystematics and biodiversity informatics in an exciting and novel way”.



Babak Naimi is a Research Associate at the University of Copenhagen’s Natural History Museum of Denmark within the Centre for Macroecology, Evolution and Climate. His research interests revolve around spatiotemporal statistics, environmental modelling, and the interface between geo-informatics and biogeography. He is currently working on developing new methods for species distribution modelling under climate change and land use change scenarios to improve their ability for understanding ecological processes associated with the patterns in species distributions as well as to deal with the challenges in the methods.

The introductory course on Species distributions models: Concepts, Methods, Applications, and Challenges is organised by Science Retreats LDA on behalf of the Évora branch of InBIO-CIBIO.

InBIO

InBIO (RESEARCH NETWORK IN BIODIVERSITY AND EVOLUTIONARY BIOLOGY) is an Associate Laboratory that results from a collaborative partnership between CIBIO – RESEARCH CENTER IN BIODIVERSITY AND GENETIC RESOURCES and CEABN - CENTRE FOR APPLIED ECOLOGY "PROF. BAETA NEVES" with the mission of conducting top-level basic and applied research on biodiversity and evolution. The Centre carries out scientific and educational activities for public and private institutions and the general public in the areas of biodiversity conservation and use of biological resources.

InBIO's general objectives are:

- Promote scientific advancement in the field of biodiversity and evolutionary biology, with a special emphasis on understanding the processes that lead to present-day patterns of biological diversity and the principles governing the spatial partitioning of genotypic and phenotypic variation;
- Improve and integrate ecologic, taxonomic, and biogeographic knowledge at different scales, particularly focusing in the Iberian and Mediterranean biological heritage;
- Apply scientific knowledge to help guiding the establishment of conservation priorities and management tools by national and international conservation authorities;
- Use scientific data from wild and domestic breeds to improve species management through collaborations with local authorities;
- Provide top level education programmes in evolutionary and conservation biology;
- Foster public awareness, understanding and appreciation of biodiversity by communicating scientific results and promoting outreach.

Science retreats, LDA

Is a SME (Small and Medium-sized Enterprise) established with the purpose of organising scientific meetings and workshops as well as promoting the dissemination of knowledge in sciences, humanities and arts. Its headquarters are in the historical district of Évora (Portugal), within a recently restored 15th century manor house originally owned by the 'Morgado do Esporão'.

Évora (Portugal)

Évora is the finest example of a city of the golden age of Portugal after the destruction of Lisbon by the earthquake of 1755. The cityscape of Évora demonstrates the influence exerted by Portuguese architecture in Brazil, in sites such as Salvador de Bahia.

It is the capital of Alentejo Province and one of the tourist attractions of the south. In spite of sharp population growth which has led to the construction of new quarters to the west, south and east, this museum city has retained all of its traditional charm inside the Vauban-style wall built in the 17th century according to the plans of Nicolas de Langres, a French engineer. The rural landscape to the north has remained virtually unchanged.

Évora has been shaped by some 20 centuries of history, going as far back as Celtic times. It fell under Roman domination, when it was called Liberalitas Julia and, among other ruins, still retains those of the Temple of Diana. During the Visigothic period, the Christian city occupied the surface area surrounded by the Roman wall, which was then reworked. Under Moorish domination, which came to an end in 1165, further improvements were made to the original defensive system as shown by a fortified gate and the remains of the ancient Kasbah. Moreover, the toponymy is indicative of the Maghreb population, which remained after the reconquest in the La Mouraria quarter of the north-east.



The Roman Temple of Diana

There are a number of buildings from the medieval period, the best known of which is unquestionably the cathedral, begun in 1186 and essentially completed in the 13th-14th centuries. It was in the 15th century, however, when the Portuguese kings began living there on an increasingly regular basis, that Évora 's golden age began. At that time, convents and royal palaces sprang up everywhere: St Claire Convent, the royal church and convent of São Francisco, not far from the royal palace of the same name, Os Lóios Convent with the São João Evangelista Church. These splendid monuments, which were either entirely new

buildings or else constructed within already existing establishments, are characterized by the Manueline style which survived in the major creations of the 16th century: Palace of the Counts of Basto, built on the site of the Alcazar, and the Church of the Knights of Calatrava, the convents of Carmo and da Graça, Santo Antão, Santa Helena do Monte Calvario, etc.



Bones chapel

The 16th century was a time of major urban planning as demonstrated by the ancient style: Agua da Prata aqueduct built in 1537 by Francisco de Arruda and the many fountains that remain (la Praça do Geraldo is the best known). It also marked the beginning of Évora's intellectual and religious influence. The University of the Holy Spirit, where the Jesuits taught from 1553, played a role in the south which was comparable to that of Coimbra in the north of the kingdom. Moreover, Évora began a rapid decline following the expulsion of the Company of Jesus by the Minister, Pombal, in 1759. Évora is also interesting for reasons other than its monumental heritage related to significant historic events and royal orders. This interest also goes beyond the many 16th-century patrician houses (Cordovil house, the house of Garcia de Resende). In fact, the unique quality of the city arises from the coherence of the minor architecture of the 16th, 17th and 18th centuries, which finds its overall expression in the form of myriad low whitewashed houses, covered with tile roofs or of terraces which line narrow streets whose layout is of medieval configuration in the old city centre and which in other areas bears witness to the concentric growth of the town until the 17th century.



University of Évora – Claustro do Espírito Santo

Wrought iron and azulejo decoration, which is splendid in the convents and palaces and very charming in the most humble dwellings, serves to strengthen the fundamental unity of a type of architecture which is perfectly adapted to the climate and the site.

Source: UNESCO/CLT/WHC