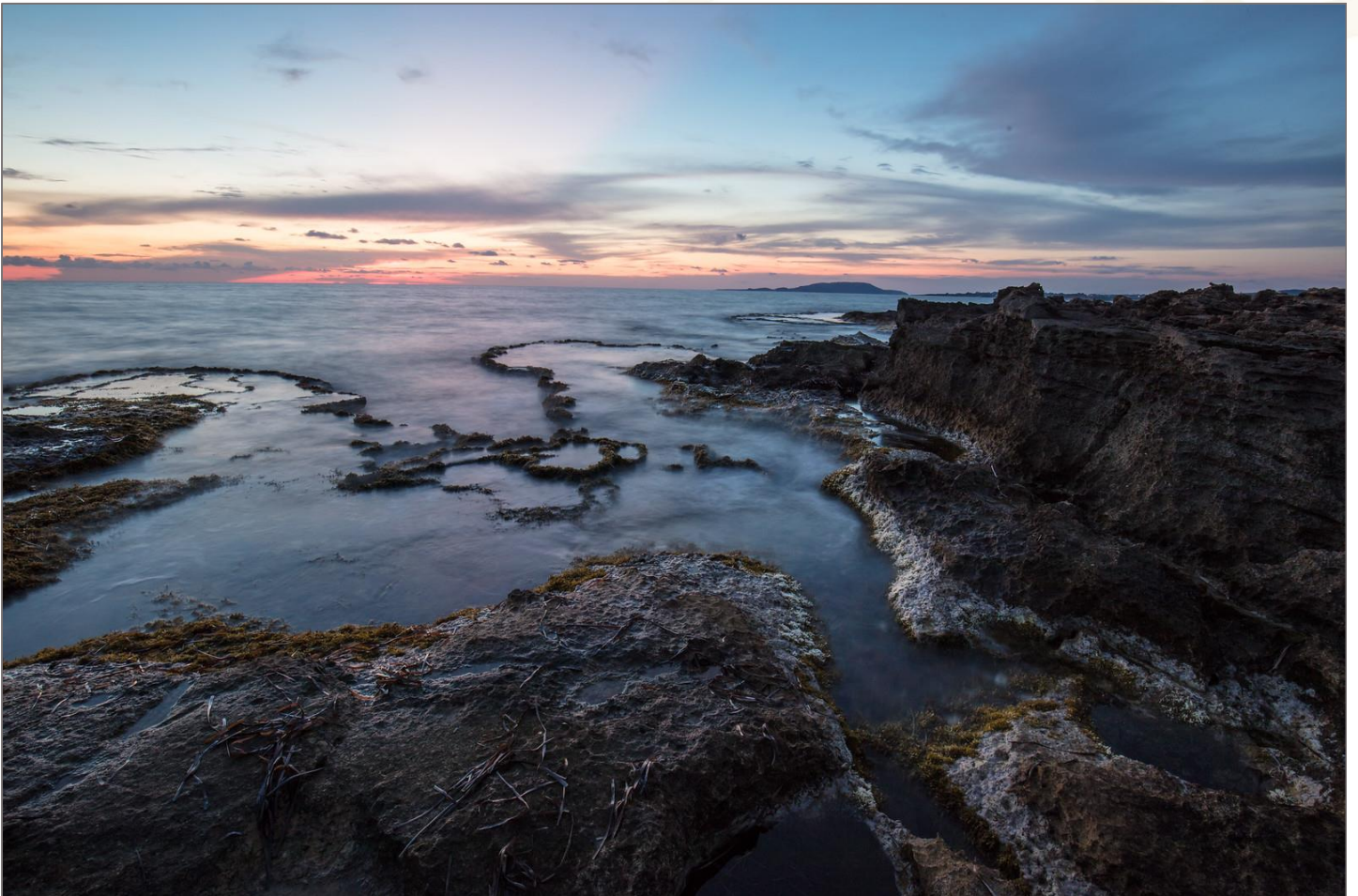


NAVARINO
ENVIRONMENTAL
OBSERVATORY

ANNUAL REPORT

2017



Navarino Dunes, Costa Navarino, 24 001 Messinia, Greece



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Foreword

The Navarino Environmental Observatory (NEO), located in Messinia, Greece, is a pioneering example of international partnership between the academic community and the private sector in the fields of climate change and environmental sciences in the Mediterranean region. By the end of 2017, more than 50 peer-reviewed articles related to NEO have been published. Five PhD and 12 MSc theses have been completed, and more are in progress. Workshops and events, such as café-NEO (scientific café), are organized to promote research communication and to bring together academics, corporates and policy-makers to discuss important environmental issues of local, regional and global interest.

The mission of NEO is to develop the understanding and sustainable use and management of our natural resources. By that NEO addresses several of the sustainable development goals of the United Nations Agenda as well as of the Paris Agreement. To push the boundaries of knowledge we need basic research. For society to benefit from our new insights we also need applied research. For research to lead to concrete actions, innovations and improvements in our use of the natural resources we need sound collaboration and dialogues between the academy, the business sector and the public sector. This is why NEO is such an important and stimulating partnership to be engaged in!

In 2017, the NEO related EU-proposal called COASTAL was approved. This is a new milestone in the history of NEO. The project is a rare collaboration of coastal and rural business entrepreneurs, administrations, stakeholders, and natural and social science experts, aiming at identifying problems and developing business road maps and strategic policy guidelines, for an improved land-sea synergy and sound coastal and rural development. I am looking forward to continue following the development of NEO in the years to come!



Karin Holmgren
Chairperson of the NEO Steering Committee

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Navarino Environmental Observatory (NEO), is an international cooperation between the academia and the private sector dedicated to research, education and science communication on the climate and environment of the Mediterranean region. Three partners constitute NEO: Stockholm University; Biomedical Research Foundation of the Academy of Athens; and TEMES S.A (Tourism Enterprises in Messina, SA). Located near Costa Navarino, Messinia, Greece, NEO is growing into a dynamic hub where scientists from all over the world conduct frontline research, develop new tools and methods, as well as meet to exchange knowledge and ideas.

NEO Structure

The *NEO Steering Committee* (NEO SC) consists of a chairperson and two delegates from Stockholm University, two delegates from Academy of Athens and two delegates from TEMES.

NEO management, consists of the NEO director (Håkan Berg, Assoc. Professor, Department of Physical Geography, Stockholm University) and the NEO Station Manager (Giorgos Maneas, PhD student at Department of Physical Geography, Stockholm University).



NEO Associated Members

Since its start, NEO has gained several associated members, academic colleagues with which we collaborate. Our aim is to welcome more associated members from the private sector.

Table 1: NEO Associated members	
Affiliation	Location
<i>National Observatory of Athens</i>	Athens, Greece
<i>Environmental Chemical Processes Laboratory (ECPL), Dep. of Chemistry - University of Crete</i>	Iraklion, Greece
<i>Laboratory of Atmospheric Physics (LAPUP), Dep. of Physics - University of Patras</i>	Patras, Greece
<i>Laboratory of Climatology, Climate Dynamics and Climate Change, Dep. of Geography - Justus Liebig University Giessen</i>	Giessen, Germany
<i>Laboratory of Archaeometry, Dep. of History, Archaeology and Cultural Resources Management - University of Peloponnese</i>	Kalamata, Greece
<i>Soil and Water Lab, Dep. of Biological and Environmental Engineering, Cornell University</i>	Ithaca-NY, USA
<i>Laboratory of Tree-Ring Research, University of Arizona</i>	Tucson, USA
<i>Department of Geography, Johannes Gutenberg University</i>	Mainz, Germany
<i>Department of Archaeology and Ancient History, Uppsala University</i>	Uppsala, Sweden

Activities during 2017

In 2017, NEO hosted 7 courses, a summer school, a workshop and several fieldwork visits. A total of 209 visitors stayed 1061 nights at the NEO Research Station. The follow up of the NEO workshop, “Achievements and future perspectives”, which was held at Stockholm University in November, 2016, resulted in the submission of several EU research proposals. All these proposals were joint initiatives between academy, NGOs, small-medium-size enterprises, farmer organizations etc., at local, regional and international levels (Table 1).

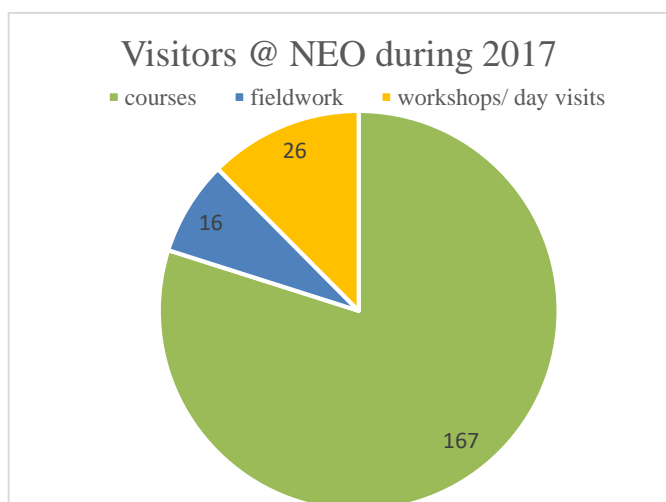


Table 1: Proposals submitted to EU

Proposals submitted to EU	Financial instrument	Work Programme Part	Project coordinator	Consortium	In collaboration with	Status
AENEO A bluEprint for open science in action: research-society-policy interface in sustainable tourism developed by the Navarino Environmental Observatory	EU, Research and Innovation Action H2020-SwafS-2016-17	Science with and for Society	Stockholm University (SU)	11 partners (including SU, AoA, TEMES, NOA)	Research institutions, policy makers, farmers, tech. SME:s, NGO:s	Submitted on August 30
COASTAL COllaborative lAnd-Sea inTegrAtion pLatform	EU, Research and Innovation Action H2020-RUR-2016-2017	Food security, sustainable agriculture, forestry, marine and inland water research and bio-economy	Flemish Inst. Techn. Res. (VITO), Belgium	29 partners (including SU and TEMES)	Policy makers, farmers' association, industry, private enterprises	Submitted on September 14
EVIDENS EVidence based Demonstrators for effective Nature based Solutions	EU, Research and Innovation Action H2020-SC5-2016-2017	Climate action, environment, resource efficiency and raw materials	Norwegian Inst. of Bioeconomy Res., Norway	28 partners (including SU and NOA)	NGO:s, SME:s, tech companies, public institutions	Submitted on September 5
The Messinia business model Enhancing biodiversity and ecosystems through engaging enterprises:	LIFE Nature and Biodiversity		Piraeus Bank SA, Greece	7 partners (including SU and TEMES)	Agriculture foundations, NGO:s, educational institution, SME:s	Submitted on September 14
LEAF LEarning from the past – Adapting to the Future	Erasmus +		Academy of Athens (AoA)	12 partners (including NEO)		Submitted on February 28

The EU-application **COASTAL - COllaborative lAnd-Sea inTegrAtion pLatform**, submitted to EU, Research and Innovation Action (H2020-RUR-2016-2017) **was approved**. The project is coordinated by the VITO-Flemish Institute for Technological Research in Belgium and is granted a total of € 5 million, with 29 partners. The project links NEO research for the South-Western Peloponnese coastal region to corresponding research for the Baltic Sea coast and other EU coastal areas within the project. The objective is to develop generic tools and performance indicators through combining a multi-actor approach with system dynamics modelling to understand the interactions with market, demographic, environmental and climate forecasts. A NEO-based collaboration between Stockholm University and the Hellenic Centre of Marine Research will co-ordinate the activities of the project at the Greek case study. TEMES, Captain Vassilis and Carmen Konstantakopoulos Foundation and Development Agency of Messinia are NEO-related actors in the project.

Education

Activities @NEO station

Starting from school level all the way to up to PhD level, subjects studied during this year included atmospheric composition, water resources, climate change, earth sciences, geography and interdisciplinary environmental management among others (Table 2). Most courses were organized by Stockholm University but we have also welcomed students from other Swedish universities, as well as German and Greek universities including the local university in Kalamata. Training of young researchers on state-of-the-art instruments for determining the key properties of atmospheric aerosols and tools for analyzing and interpreting the data, and putting those in the context of climate change was the objective of the 1st HAAR international summer school.

Table 2: Educational activities @NEO station during 2017.

Course in	Level	Affiliation
<i>Natural disasters form a natural- and social science perspective</i>	Upper secondary school	Värmdö Gymnasium, Stockholm
<i>Environmental sciences</i>		Hersby Gymnasium, Stockholm
<i>Physical Geography and Quaternary Geology</i>	Bachelor	Dep. of Physical Geography, Stockholm University
<i>Climate, Climate Change Impacts: Greece</i>		Dep. of Geography, Justus-Liebig University of Giessen
<i>Cultural Heritage Materials and Technologies</i>	Master	Dep. of History and Archaeology, University of Peloponnese
<i>Eco-hydrology: A Mediterranean perspective</i>		Dep. of Physical Geography, Stockholm University
<i>Humans, environments and climate on the Peloponnese during 5000 years – an integrated history</i>		University of Uppsala, Swedish Institute at Athens
<i>Theory and practice of aerosol chemistry and engineering for climate, air quality, emissions and health effects, by means of In-Situ and Remote Sensing Observations</i>	PhD Summer School	Hellenic Association of Aerosol Research (HAAR)

Master thesis/ Internships

Three interns from the Department of Physical Geography, SU, spent in total 12 weeks at NEO Station. Bojing Hu and Eirini Makopoulou focused their efforts in compiling data about the region, and producing maps from satellite images and aerial pictures. Gabriel Sainz was given the task to set up the spectro-radiometers sensors in Gialova area and conduct a basic water parameter monitoring (temperature, conductivity, turbidity) covering the whole area of the lagoon.

In total 6 MSc theses related to NEO have been completed and presented at Stockholm University in 2017 (Table 3). Three theses, from the MSc programme in *Quaternary Science and Climate*, were related to NEO relevant research on Past Climate and Societies in the Peloponnese, Greece. One thesis from the MSc programme in *Hydrology, Hydrogeology and Water Resources* and two from the MSc programme in *Environment and Health Protection* were related to NEO relevant research on Environmental monitoring and management of Gialova Lagoon.



Figure 1: Picture selection from educational activities @NEO station during 2017.

Table 3: Completed MSc thesis related to NEO in 2017.			
Title	By	Supervisor	Master Programme
<i>The Land and the Sea: Final Neolithic to Early Roman Socio-environmental Interactions in Southwestern Messenia, Peloponnese, Greece</i>	Taariq Sheik	Martina Hättestrand	Quaternary Science and Climate Dep. of Physical Geography, Stockholm University
<i>Reconstruction of past vegetational changes at Gialova lagoon – southern Peloponnese, Greece</i>	Erika Modig	Martina Hättestrand	Quaternary Science and Climate Dep. of Physical Geography, Stockholm University
<i>A first step towards a Holocene Tephrochronology for the Peloponnesus peninsula, SW Greece</i>	Helene Sunmark	Stefan Wastegård	Quaternary Science and Climate Dep. of Physical Geography, Stockholm University
<i>Seasonal salinity variations and hydrological conditions of the Gialova Lagoon</i>	Agnes Classon	Stefano Manzoni	Hydrology, Hydrogeology and Water Resources Dep. of Physical Geography, Stockholm University
<i>A comparison of conventional and organic olive farming in the catchment area of Gialova Lagoon, south-west Greece</i>	Amanda Salguero Engström	Håkan Berg, Giorgos Maneas	Environment and Health Protection Dep. of Physical Geography, Stockholm University
<i>An evaluation of Gialova lagoons importance as an stop-over area for spring migrating birds in relation to other wetlands along the west coast of Greece</i>	Viggo Norrby	Håkan Berg, Giorgos Maneas	Environment and Health Protection Dep. of Physical Geography, Stockholm University

Outreach

A *NEO seminar* entitled “**Bridging between science and business**” was held at the Residence of the Swedish Ambassador in Greece, on April 2017. The objective of the seminar, was to provide an opportunity for participants to discuss ways science can be brought closer to business and vice versa. Mr. Kevin Noone, Professor at Stockholm University, who was the main speaker of the seminar, elaborated on ways business and science are connecting and creating safe, authorized and repeated spaces for collaboration. In addition, two *café-NEO* meetings, the scientific café organized by NEO, were held in different coffee bars in Kalamata (Table 4).

Table 4: Open discussions				
Title	Type	Location	Date	NEO speaker
<i>Bridging between science and business</i>	Seminar	Athens, Residence of the Swedish Ambassador	April 27	Prof. Kevin Noone, Stockholm University/ Prof. Karin Holmgren, NEO Steering Committee Chairperson
<i>Atmosphere – Climate – Health: Invisible particles with visible impacts</i>	Café-NEO	Kalamata, Vino-banco Tapas bar	May 20	Prof. Nikos Mihalopoulos, National Observatory of Athens
<i>Climate change and societies: interactions during the past centuries</i>	Café-NEO	Kalamata, Baba-Yaga cafe bar	October 2	Dr. Elena Xoplaki, Justus-Liebig University of Giessen



Figure 2: Participants at café-NEO meetings in Kalamata.

Research

An atmospheric monitoring station operates at NEO (Methoni, SW Messinia, Greece), since 2011, to track climate change signals and air pollution (Table 5 and Figure 6). It is an important part of a European Network and fills the gap of missing data from this part of Europe. Physical, optical and chemical properties of aerosols and local-to-regional scale pollution and atmospheric composition are monitored and analysed in relation to observations on a wider scale of the Mediterranean region.

Table 5: Instruments at NEO atmospheric station at Methoni	
NEO instrumentation	Parameter
Nephelometer, M903, Radiance Research	Scattering coefficient at 530 nm,
Single wavelength aethalometer, AE-16, Magee Scientific	Absorption coefficient quantified as a function of Black Carbon (BC) at 880 nm
DMPS (custom made) and Aerodynamic Particle Sizer (APS)	Aerosol size distributions in the 0.4-20 μm aerodynamic diameter range
Gas analyzers	O ₃ and CO concentrations at five minute resolution
PM10 sampling, Derenda	Aerosols' chemical composition
Automated meteorological station	Air temperature (°C)/ Relative humidity (%)/ Air pressure (hPa) at station's height/ Atmospheric precipitation (rain, hail, snow) (mm)/ Wind Speed (m/sec) and Wind Direction (deg.)/ Total and Diffuse solar radiation on a horizontal plane (W/m ²)/ Sunshine Duration (minutes)
Automated rain sampler	Isotope analysis

Water research and monitoring are undertaken to understand hydrological processes and to develop suitable water resource management strategies for the region. NEO researchers have studied natural and human-driven changes in water availability and quality, and developed methods and tools for quantification and support of sustainable water resource management (Figure 3). For example, they have investigated and identified: i) tipping points for seawater intrusion into coastal groundwater under rising sea level and other hydro-climatic changes; ii) cost-efficient management of coastal aquifers via recharge with treated wastewater and desalination of brackish groundwater; and iii) water resource impacts of Mediterranean tourism, agricultural irrigation, and other land- and water-use developments in a changing climate.

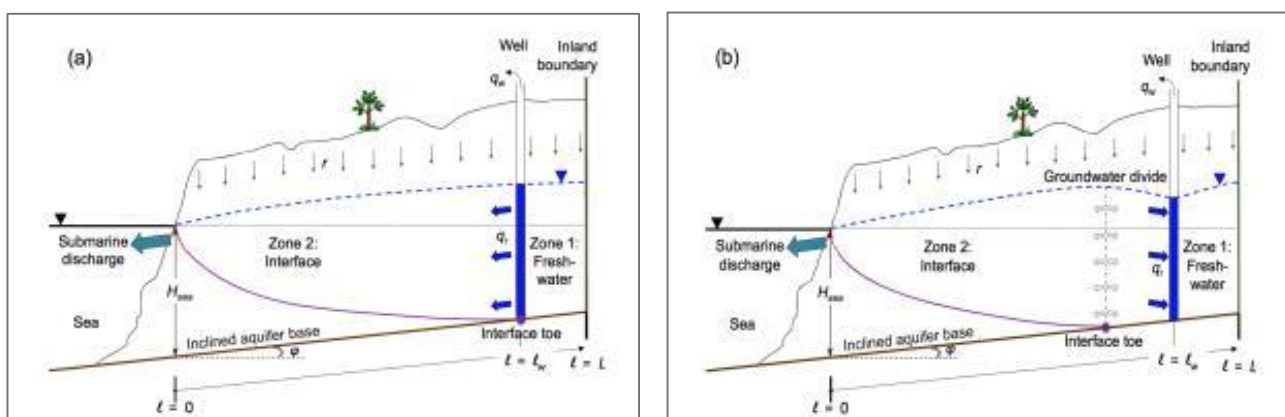


Figure 3: Schematic illustration of two main critical conditions for seawater intrusion in a coastal aquifer: (a) intrusion into water supply wells, with the toe of seawater-freshwater interface (purple line) reaching a key well location; (b) complete intrusion into the coastal aquifer, with the interface toe reaching the coastal groundwater divide (point of maximum resistance to intrusion), which may be located between key pumping well locations and the coast. *Source:* Mazi et al. (2016).

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Research done in close cooperation with different stakeholders aim to develop multifunctional landscapes that can help to enhance and diversify the local economy, while still sustaining critical ecosystems and associated ecosystem services. Monitoring and analyses of socio-ecological parameters in the nearby coastal lagoon (Gialova lagoon) and adjacent streams, rivers and cultivated land, aiming to provide viable alternatives for long-term sustainable tourism and agriculture were initiated in 2016 (Figure 4). The research takes into account resilience to future climate changes and minimization of the impact of tourism and agriculture on the Natura 2000 sites, exploiting the expertise and experience of local stakeholders.

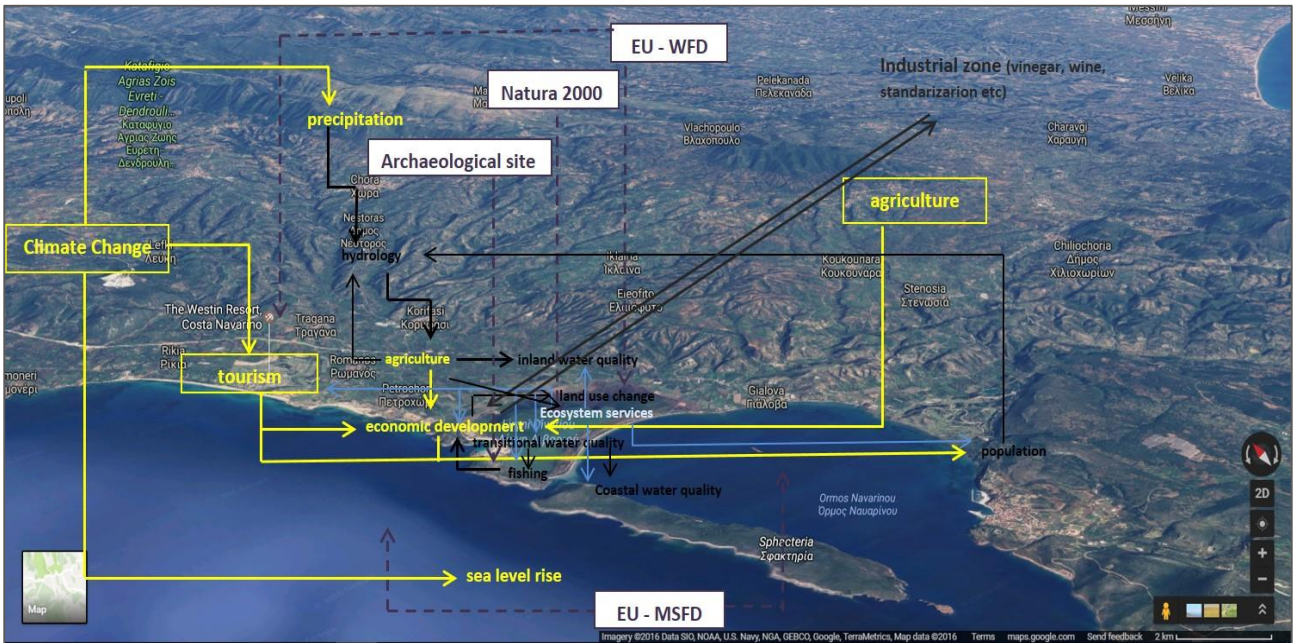


Figure 4: Different variables affecting the Gialova Lagoon wetland, located in SW Messinia (Peloponnese, Greece). *After Maneas et al. (in progress)*

NEO scientists have produced lake sediment-, tree-ring- and speleothem-based climate time series for Greece, covering the last 10000 years. The climate time series provide information on natural climate variability that improves our understanding of both natural and human-made processes governing our climate. For example, in 2017 a paper discussing the influence of climate on the destruction of the Palace of Nestor at Pylos was published. This stalagmite-based study shows that climate may be one of several factors behind the failure of the Mycenaean way of life at Pylos at the end of the Late Bronze Age and that severe aridity following the destruction of the Palace, made it difficult for social elites to re-form and for the palatial system to re-emerge. (Figure 5, 6).

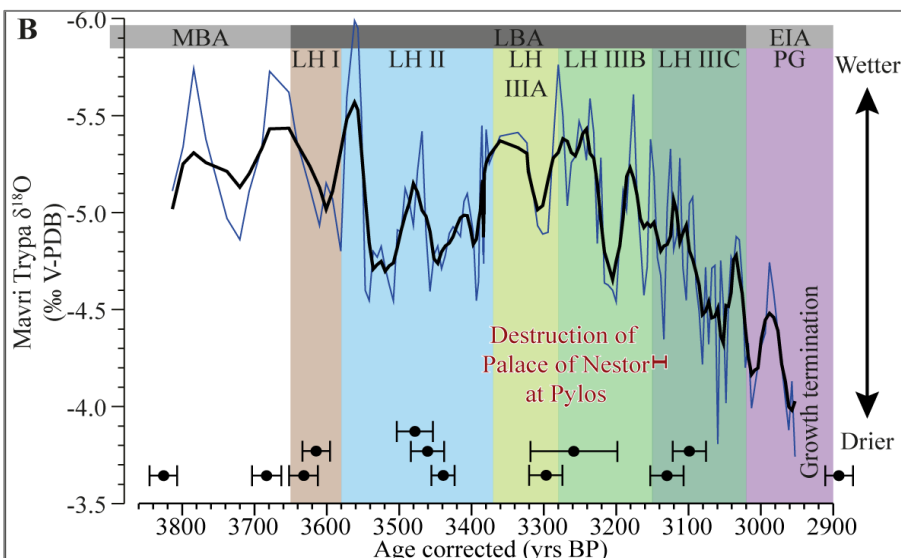


Figure 5: Stalagmite-based isotope results and its hydrological interpretation for the time period covering the Late Bronze Age (LBA) and Early Iron Age (EIA). The sub-periods of the LBA (Late Helladic (LH) I to LH IIIC) and the Protogeometric (PG) are shown together with the suggested period when the Palace of Nestor at Pylos was destroyed. The horizontal bars show the U-series-based age determinations. *After Finné et al. 2017*



Figure 6: From top to bottom: NEO Atmospheric Station at Methoni HNMS, Gialova Lagoon wetland premises and field work for paleoclimatic studies at Mavri Trypa Cave, Schiza Island.

Scientific Peer-review Publications

- Anchukaitis, K.J., et al. (includes P.J. Krusic) (2017). Last millennium northern hemisphere summer temperatures from tree rings: Part II, spatially resolved Reconstructions. QUATERNARY SCIENCE REVIEWS, 163, 1-22.
- Buntgen, U., Krusic, P. J., Verstege, A., et al. (2017). New Tree-Ring Evidence from the Pyrenees Reveals Western Mediterranean Climate Variability since Medieval Times. JOURNAL OF CLIMATE, 30 (14), 5295-5318.
- Finné, M., Holmgren, K., Shen, C.C., Hu, H.M., Boyd, M., Stocker, S. (2017). Late Bronze Age climate change and the destruction of the Mycenaean Palace of Nestor at Pylos. PLoS ONE 12(12), e0189447. <https://doi.org/10.1371/journal.pone.0189447>.
- Klingborg, P. and Finné, M. (2018). Modelling the freshwater supply of cisterns in ancient Greece. WATER HISTORY, 1-19, <https://doi.org/10.1007/s12685-017-0209-y>.
- Klippel, L., Krusic, P.J., Brandes, R., Hartl-Meier, C., Trouet, V., Meko, M., Esper, J. (2017). High-elevation inter-site differences in Mount Smolikas tree-ring width data. DENDROCHRONOLOGIA, 44, 164-173. <http://dx.doi.org/10.1016/j.dendro.2017.05.006>.
- Konter, O., Krusic, P.J., Trouet, V., Esper, J. (2017). Meet Adonis; Europe's oldest dendrochronologically dated tree. DENDROCHRONOLOGIA, 42, 12 .
- Norström, E., Katrantsiotis, C., Smittenberg, R., Kouli, K. (2017). Chemotaxonomy in some Mediterranean plants and implications for fossil biomarker records. GEOCHIMICA ET COSMOCHIMICA ACTA, 219, 96-110.
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- Thorslund, J., Jarsjö, J., Jaramillo, F., Jawitz, J.W., Manzoni, S., Basu, N.B., Chalov, S.R., Cohen, M.J., Creed, I.F., Goldenberg, R., Hylin, A., Kalantari, Z., Koussis, A.D., Lyon, S.W., Mazi, K., Mård, J., Persson, K., Pietroń, J., Prieto, C., Quin, A., Van Meter, K., Destouni, G. (2017). Wetlands as large-scale nature-based solutions: Status and challenges for research, engineering and management. ECOLOGICAL ENGINEERING, 108 Part B, 489-497, doi:10.1016/j.ecoleng.2017.07.012.

Acknowledgements

We would like to thank our colleagues at Costa Navarino, who offer valuable support and help us to keep NEO station up and running. Also we would like to thank the local community in the NEO area for their warm welcome to students and researchers visiting NEO annually. Especially, Nikos Lymberopoulos, who has provided part of his olive orchard for NEO equipment and Giorgos Kokkinos, from Nileas cooperative of farmers, for his valuable knowledge and support in engaging farmers in our research. Last, we would like to thank all the local stakeholders who engaged in the submission of several NEO related EU proposals. Without their contribution our efforts would not have been successful.

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Edited by NEO Management

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