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Nature-based Solutions: evolution through time in the Mediterranean Basin

PANTERA A.[1*], PAPADOPOULOS A.[1], MACIEK W. LUBCZYNSKI[2], PISANI, B.[2], ANDREU A.[3], MENDES, M.P.[4], ROLO, V. [5], MORENO, G.[5], SALBITANO, F.[6], MOSQUERA-LOSADA, M.R.[7], SAMPER, J[2].

[1]AGRICULTURAL University of Athens, Karpenissi, Greece

[2]Interdisciplinary Center of Chemistry and Biology (CICA), Civil Engineering, Campus de Elviña, University of A Coruña, 15071-A Coruña,

[3]Fluvial Dynamics and Hydrology Research Group, Department of Agronomy, Unit of Excellence María de Maeztu (DAUCO), University of Córdoba,14071 Córdoba, Spain

[4]CERENA - Centro de Estudos em Recursos Naturais e Ambiente, IST-ID, Av. António José de Almeida 12, 1049-001, Lisbon, Portugal

[5]Forest Research Group, INDEHESA, University of Extremadura, Plasencia, Spain

[6]Department of Agricultural Sciences, University of Sassari, Italy

[7] University of Santiago de Compostela, Lugo, Spain

*corresponding author: pantera@aua.gr

Abstract The Mediterranean basin may be one of the few bioregions on earth where the steep environmental gradients and the biota are so tightly intermixed and interrelated within diverse ecological niches, ecosystems and landscapes. However, several natural or human-induced challenges threaten this unique ecosystem, such as climate change, exacerbating droughts, habitat and biodiversity losses. Nature-Based Solutions (NbS) represent a new concept, including old and new practices (i.e., green roofs), inspired by nature in harmony with humans to face contemporary societal and environmental challenges. EU-funded projects such as the DRYAD aim to bring upfront, upscale and highlight such practices in Mediterranean agroecosystems. This article presents a literature review on NbSs since 2000 with special emphasis on the Mediterranean basin.

Keywords: climate change, DRYAD, environment, water

1. Introduction

The Mediterranean basin may be one of the few bioregions on earth where the steep environmental gradients and the biota are so tightly intermixed and interrelated that so many diverse ecological niches, ecosystems and landscapes have been arisen. It has supported several of the world's greatest civilizations playing a leading role in human history by their contribution in culture, philosophy, science and natural resources use. However, this nature's hot spot faces a series of naturally or human caused threats, including climate change with exacerbating droughts and heatwaves, wildfires, floods, habitat and biodiversity losses, water pollution and overexploitation, soil erosion, compaction and secondary salinization, alien species invasions and overpopulation. Based on IUCN, Nature-based Solutions (NbS) could be a critical tool for improving the status of productive landscapes and defined them as "*actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits*" (IUCN Members Assembly, 2016). NbS have been developed over time with specific milestones, thoroughly described in a recent IUCN report (Demozzi et al., 2024). According to the same report, interventions must address one of the following societal challenges while not hindering the achievement of the others in order to be considered an NbS (IUCN, 2020a): 1. climate change adaptation and mitigation; 2. disaster risk reduction; 3. reversing ecosystem degradation and biodiversity loss; 4. human health; 5. socioeconomic development; 6. food security; and, 7. water security. The goals of this article were to investigate the adoption of: NbS, as presented in publications, the implementation of NbS in climate-prone regions such as the Mediterranean basin, and the evolution of NbS over time.

2. Methodology

A literature review was conducted to investigate the number of articles published dealing or mentioning NbS since 2000. Two major scientific web search engines were used, Google Scholar© and SCOPUS©. The search criteria/keywords were "Nature based Solutions", "Nature based Solutions and Mediterranean Basin". The

Google Scholar© was used to assess the usage of the term NbS in the scientific literature, including scientific articles, conference proceedings, books, etc. The SCOPUS© database was used to assess the geographical distribution in the usage of the term NbS. The results were screened to reflect only the Mediterranean Basin-related articles.

3. Results

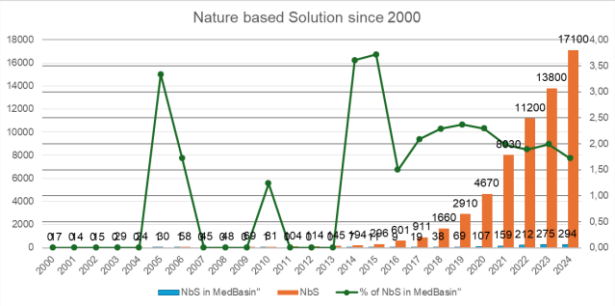

Figure 1. NbS related articles since 2000 in Google Scholar. The vertical right axis indicates percentages of NbS Med to total NbS, and the left one number of articles

Based on Google Scholar, approximately 100 articles were published before 2000, mentioning NbS. The number has been exponentially growing since 2010 with the highest peaks in the years of 2011, 2018 and 2022. NbS related arcticles specifically for the Mediterranean basin are generally low, ranging from 0 to 19 until 2017. However, their number has nearly doubled until 2024. The average percentage of Mediterranean (Med) NbS to NbS is 1.27%.

Figure 2. Word cloud generated by the titles of all articles mentioning NbS since 2000 in Google Scholar

As seen in Figure 2, the dominant word in articles mentioning NbS since 2000, is the word "Climate" followed by "change" and "management". "Water" and "urban" are also mentioned in most of the articles.

When the keywords "Nature based solutions" and Nature based solutions and Mediterranean basin" were searched in the Scopus© database (Table 1), the percentage of NbS articles focused on the Mediterranean basin, was higher than that of Google Scholar, reaching 9.33%. The country with the highest number of publications was Italy followed by Spain. In general, the Mediterranean countries had a high percentage of NbS oriented articles, ranging from 66.67% Cyprus followed by Greece (36.67%), with the lowest being France (9.80%).

Table 2. Number of articles per country (Scopus©)

Country	NbS	NbS in the Mediterranean
Italy	130	22
Spain	82	19
Portugal	49	12
Greece	30	11
France	51	5
Slovenia	20	3
Cyprus	3	2
Turkey	9	1
Total (more countries)	793	74

4. Discussion and conclusions

The natural environment of the Mediterranean basin faces several challenges, mainly attributed to climate change. This fact increases needs, concerns and uncertainties for food security and safety, biodiversity loss and water scarcity. The scientific community steped forward to address these challenges, as reflected by the inclusion of NbS actions in their research. An increase in NbS-oriented articles/research has been noticed since 2008, after the report of the World Bank (MacKinnon et al., 2008) the adoption of the term by IUCN, and EU defining NbS in 2015, further boosting their dissemination (Demozzi et al. 2024). Other milestone-events can be related to the growth of NbS-related articles, combined with the growing concern about climate change and its imperative effects.

EU-funded projects, such as the DRYAD, contribute to this knowledge, acknowledging, testing and disseminating NbS adoptable and adaptable to the Mediterranean Agrosilvopastoral Ecosystems (MAEs). DRYAD aims to enhance MAE resilience to climate change through locally adapted NbS designed in collaboration with farmers and other stakeholders. The DRYAD project is centered around the development, testing and demonstration of NbS in five Demonstration Regions (DRs). The most promising NbS will be transferred to the three Replication Regions (RR).

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