ENHANCING CIRCULAR ECONOMY THROUGH NATURE-BASED SOLUTIONS IN HIGHER EDUCATION

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Abstract
Circular economy entails core sustainability concepts, such as reducing waste, preserving the environment and recycling goods in order to promote sustainable development. Nature-based Solutions (NBS) have been identified as tools for protecting biodiversity and natural resources, thus supporting healthier ecosystems and leading to sustainable development. NBS includes the concept of circular economy, as by protecting and sustainably managing natural resources, natural cycles are enhanced and promoted. Both concepts lie in the heart of the European Commission's efforts to strengthen environmental protection and economic development at the European and global level. Higher Education Institutions (HEIs) as primary agencies of education and training, which are to deliver and promote Sustainable Development Goals (SDGs), are called to integrate those concepts not only into their everyday campus practices but in their courses and academic curricula as well.

This paper aims to explore the level of integration of those concepts in the Greek HEIs by examining and analyzing policies, strategies and initiatives at the campus level as well as by exploring relevant university curricula. It highlights the importance of interdisciplinary cooperation and innovative learning methods in order to leverage the integration of circular economy by implementing NBS in HEIs.

Key words: *Circular Economy, Nature-based Solutions, Higher Education Institutions, sustainable development*

Introduction

Our societies need to take urgent action to address current environmental concerns, with climate change and biodiversity loss being the most pressing ones. International community's efforts have led to the adoption of the Sustainable Development Goals (SDGs), as tools to achieve the overarching goal of sustainable development (UNGA, 2015).

SDGs include inter alia the target of "Quality Education" (SDG 4) "that will allow many other Sustainable Development Goals (SDGs) to be achieved" (UNGA, 2015). Quality education is crucial for achieving sustainable development (Laurie R. et al., 2016) and current research focuses especially on the role of higher education institutes in promoting sustainable development and transforming their curricula towards sustainability and eco-citizenship (Lozano R. et al., 2013, Filho W. et al. 2019, Serafini et al. 2022). This transformation requires several reforms and integration of new concepts in academic teaching, such as the concepts of circular economy, nature-based solutions (NBS) and eco-citizenship, as well as new pedagogical approaches (Lozano R. et al. 2017, Martín-Garin A., 2021).

This article explores the integration of the concept of circular economy into higher education institutions (HEIs) programs, especially through other environmental concepts and particularly nature-based solutions (NBS). It aims at highlighting NBS and circular economy education programs in Greece and discussing the integration of these concepts in higher

education institutions' curricula and campus policies. It emphasizes the need for state and institutional support for promoting innovative teaching programmes as well as the significance of interdisciplinary cooperation towards a greener and more inclusive higher education.

The paper is structured as follows: after the introductory part, the second part clarifies the research question and explains the methodology. Presentation of the research findings follows regarding the integration of NBS and circular economy in Greek universities' curricula and courses. Finally, conclusions and recommendations for future research are presented.

Research Question and Methodology of Research

The concepts of Nature-Based Solutions (NBS) and circular economy have gained a lot of leverage in the last few years because of their significant potential to address environmental (as well as social) challenges and their dynamic in fostering global efforts towards biodiversity conservation and restoration and adapting to climate change.

According to the European Commission's definition, NBS are 'solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience; such solutions bring more, and additional diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions' (European Commission: European Research Executive Agency 2024). In literature, NBS have been identified as means of natural solutions which may address both environmental protection and social challenges (Viti M., 2022). Nature-based Solutions (NBS) are critical tools for restoring biodiversity and protecting natural resources, thus fostering healthier ecosystems and a green transition.

The United Nations Environmental Assembly (UNEP 2019) has attempted a definition of circular economy, or maybe "a shared understanding of some of its basic principles" (United Nations Economist Network, 2022). The United Nations Environmental Assembly has defined circular economy as "one of the current sustainable economic models, in which products and materials are designed in such a way that they can be reused, remanufactured, recycled or recovered (4-R) and thus maintained in the economy for as long as possible, along with the resources of which they are made, and the generation of waste, especially hazardous waste, is avoided or minimized, and greenhouse gas emissions are prevented or reduced" (UNEP 2019).

Circular economy entails sustainability concepts such as reducing waste, preserving the environment and recycling goods, as well as "sustainable management of natural resources, the closing of material loops, the preservation of natural capital, and circular consumption and production behaviours in the economy in order to promote sustainable development" (United Nations Economist Network, 2022). Nature-based Solutions (NBS) include the concept of circular economy, as by protecting and sustainably managing natural resources, natural cycles are enhanced and promoted.

Both concepts lie in the heart of the European Commission's efforts to strengthen environmental protection and economic development at the European and global level. The economic benefits of nature-based solutions (NBS) and a nature-based economic approach can act in a complementary way to achieving circular economy (European Commission Knowledge Centre for Biodiversity, 2023).

Following these new targets and goals at the global as well as the EU level, and as Higher Education Institutions (HEIs) are considered primary agencies of education and training, they are expected to deliver and promote Sustainable Development Goals (SDGs) and SDG 4 in particular (Chankseliani, M., McCowan, T. 2021, McCowan T., 2023). Thus, higher

education institutions are called to integrate circular economy, nature-based solutions and other sustainability concepts not only into their everyday campus practices (Nunes, B. T. et al., 2018) but in their courses and academic curricula as well (Stefanakis, A. I. et al., 2021). Integrating nature-based solutions and circular economy (Renfors, S.-M., 2024) into higher education institutions is a critical parameter towards sustainable transition (Salas, D. A. et al., 2021, Vergani F., 2024).

Therefore, the research question of this article is formulated in order to explore the current projects, programmes and initiatives which foster integration of NBS and circular economy in Greek universities and the possible barriers, challenges and obstacles which could impede educators in higher education institutions to integrate nature-based solutions and circular economy concepts in their courses and university curricula.

In order to explore the level of integration of NBS in Greek universities, the author of this article has elaborated previous desk research and field work in the framework of the Erasmus Plus Project "Integrating Nature-Based Solutions into Higher Education towards exploiting the transformative potential of Social Economy for a green and inclusive future" (acronym: "SEgoesGreen"), funded by the European Union (2022-1-PL01-KA220-HED-000087149) along with the rest of the partners of the project, aiming at identifying different best practices on nature-based solutions in different EU countries. The goal of the project was to support university faculties to integrate sustainability teaching within their courses and curricula with a specific focus on exploiting the educational potential of Nature-Based Solutions. SEgoesGreen aimed at a) offering flexible training tools and resources to HEIs educators, b) exploring the state of the art in NBS education, c) identifying any barriers against the integration of NBS in HEIs, d) promoting students' interest in green education and eco-citizenship.

The research conducted in the framework of the project has explored the integration of NBS in universities and academic institutions in five European counties, namely Poland, Croatia, Greece, Cyprus and Portugal (Murzyn, D., et al. 2024). Desk research aimed at identifying the best practices in integrating NBS in the abovementioned countries and a combination of research methods has been used, such as best practices analysis, interviews with stakeholders and constructed discussions in small groups of professionals, educators, and other stakeholders. The author has built upon the research on nature-based solutions by adding the parameter of circular economy and focusing explicitly on the Greek higher education institutions.

Research Findings

The first part of the research in the framework of the SEgoesGreen project identified a set of best practices in Greece by using specific parameters such as "the country and city of implementation, the field of study, the educational institution, the level of study, course(s), NBS category, topic of the best practice, its specific objectives, the results or impact achieved, stakeholders involved, pedagogical approaches utilised and any significant considerations pertinent to the best practice" ((Murzyn, D., et al. 2024).

Building upon the research conducted on Nature-based Solutions within the SEgoesGreen project, this article explored the level of integration of the concept of circular economy in Greek higher education institutions' courses and curricula and focused particularly on the synergy creation between nature-based solutions and circular economy.

The first findings of this research on the integration of circular economy in Greek higher education institutions demonstrate that circular economy isgradually being integrated into Greek universities. However, the level of implementation varies across institutions, programmes and levels of tertiary education (master programmes, undergraduate programmes

etc.).The integration of circular economy principles in Greek universities may be identified in courses and curriculum development, in research projects and initiatives, as well as in other sustainability projects, and collaborations with external stakeholders.

The most important methods and tools for integrating circular economy in Greek higher education institutions are first of all, through curriculum and academic programmes. During desk research it was found that Greek universities have started including the concept of circular economy, and the principles related to it, into their academic courses and programmes. Thus, one may find a number of specialized courses, modules, and entire degree programs, which focus on sustainability, environmental management, circular economy and sustainable consumption. For instance, the University of West Attica[1] and the Aristotle University of Thessaloniki[2] are currently offering courses related to sustainability and circular economy as part of their environmental sciences, engineering or business programs. Similarly, the Technical University of Crete (TUC), offers a master's program for students on the topics of Circular Economy and Bioeconomy[3] and generally it is a university very much involved in sustainability research, trying to integrate the concept of circular economy into courses that examine sustainability and resource management.

Apart from the specialized programmed and courses, the Greek higher education institutions foster circular economy through research and collaborations with other universities and research centers abroad. They participate in and/or lead research projects that focus on circular economy (i.e. funded projects[4] or international partnerships and collaborations[5]). Greek universities have also been very active in initiating or supporting respective research initiatives on relevant topics. Areas of focus include waste management, renewable resources, sustainable production processes, and others. The Athens University of Economics and Business[6] and NTUA[7] (National Technical University of Athens), actively participate in European and international research initiatives related to the circular economy, addressing issues like recycling, eco-design, and green technology. Greek HEIs also cooperate with research centers: for instance the Centre for Renewable Energy Sources[8] (CRES) in Greece focuses on developing sustainable energy solutions, which is closely tied to circular economy principles.

In addition, the Greek HEIs have developed and/or are developing collaboration schemes with the private sector and relevant government agencies. Almost all Greek universities are working closely with local businesses, municipalities, and governmental organizations to pilot circular economy practices. By developing such collaboration schemes, higher education institutions in Greece can offer their students real-world application of circular economy principles in various sectors of the economy, such as waste management, agriculture, and manufacturing. An example of this process is the collaboration of the Harokopio University of Athens with the Hellenic Recycling Agency[9] in the integrated LIFE project LIFE-IP CEI-Greece which aims to contribute towards the implementation of the National Waste

[1] MSc "Circular Economy and Sustainability Strategies", https://msc-circular.uniwa.gr/
[2] Elective course on "Waste treatment and circular economy (sustainability management and circular economy), https://qa.auth.gr/en/class/1/600216145
[3]https://www.tuc.gr/en/university/in-the-spotlight/item/tuc-participates-in-masters-program-on-circular-economy-and-bioeconomy
[4] For example: BIOREGIO Interreg at https://fodsakm.gr/en/projects/other-programs/bioregio/
[5] COST Action CA21103 Implementation of Circular Economy in the Built Environment at https://circularb.eu/ , CA22124 – EU Circular Economy Network for All: Consumer Protection through reducing, reusing, repairing (ECO4ALL) at https://eco4all.org/
[6] For example: https://www.dept.aueb.gr/en/ReSEES/content/circular-economy-balkan-countries
[7] For example: https://unescochair.simor.ntua.gr/,
[8]Centre for Renewable Energy Sources at http://www.cres.gr/kape/index_eng.htm
[9]https://circulargreece.gr/partners/

Management Plan, the National Waste Prevention Plan and the National Strategy for Circular Economy. Other university departments work with local waste management organizations and municipal authorities in pilot projects that explore sustainable waste processing and resource management.

Another aspect of the Greek HEIs' engagement in circular economy and Nature-based Solutions are the initiatives developed for promoting sustainability and "greening" the universities' campuses. For instance the University of Patras[10] has established the Sustainable-Green University Committee which promoted a combination of nature-based solutions and circular economy practices, such as adopting circular economy solutions by promoting resource reuse practices, redesigning of the campus map to include new green zones planting and transplanting of trees, green routes for pedestrians and cyclists, procurement of electric and conventional bicycles, creation of a parking base and photovoltaic charging system, etc., with the aim to provide quality living, sports and recreation to all members of the community and others. The higher education institutions in Greece are trying to develop and adopt circular economy principles in their everyday operations, through initiatives such as:

- Waste minimization: The Greek universities have recycling programs in place for paper, plastic, and electronic waste. Some of them also encourage cycling within campus grounds.
- Energy efficiency: Universities are investing in green energy and energy-saving systems, which align with the goals of circular economy and sustainability by reducing consumption and minimizing their environmental footprint.
- Green infrastructure: Campuses also embrace circular economy practices through nature-based solutions by integrating sustainable infrastructure, such as green roofs, rainwater harvesting systems, and energy-efficient buildings.

Last but not least, the Greek HEIs are promoting and taking measures to enhance student and community engagement. The main vehicle towards student and local communities' engagement is the uptaking of initiatives which raise awareness both within the academic community and beyond it. These efforts include organizing conferences, workshops, and seminars on sustainability, nature-based solutions and circular economy, such as hackathons and innovation challenges related to circular solutions, student-led sustainability projects, i.e. organizing zero-waste events or supporting the use of shared mobility (bike-sharing programs) on campuses.

Conclusions and Future Research

This article provided a study on the emerging field of promoting circular economy through nature-based solutions (NBS) in higher education institutions focusing on the Greek universities. It offered insights into the ways in which Higher Education Institutions develop and support effective ways for integrating circular economy and NBS in their settings. The data and information collected have been synthesized in a study that elaborated on how circular economy concepts and practices may be further strengthened through the adoption of NBS solutions in Greek universities.

The study conducted was based on desk research and data collection from Greek higher education institutions and can be further developed to include surveys and interviews with the academic community (researchers, educators, students, management) and other stakeholders which may foster the integration of circular economy through applying nature-based solutions in the Greek universities' curricula and in the campuses, as well.

[10] https://www.upatras.gr/en/university/sustainability/

There are certainly several barriers and obstacles that limit the adoption of nature-based solutions and circular economy learning in higher education. The most important challengesare the lack of appropriate state funding, the lack of knowledge and experience within the academic community, especially within educators who are not familiar with these concepts and sometimes the lack of time needed to familiarize and gain knowledge on these topics.

These challenges could be addressed by developing interdisciplinary and multisciplinary collaboration schemes/partnerships within the academic community and by involving other external stakeholders (including government agencies, the civil society and the private sector) in the whole process. It is crucial for the achievement of sustainable development to promote integration of circular economy principles across all disciplines and university policies and nature-based solutions offer a vehicle for facilitating this integration.

A few recommendations towards this goal could be first of all, to develop a curriculum that will be particularly designed to offer students hands-on project approach and research experience using nature-based solutions. Second, it is crucial to engage students by helping them to develop better awareness about environmental challenges, circular economy and the potential contribution of nature-based solutions. Furthermore, both educators and students need to be trained and build specific skills in order to take action towards sustainable transition and transformation of the Greek higher education institutions, by endorsing circular economy and NBS concepts. Eco-citizenship approaches in Greek academic institutions may only be promoted by fostering behavioural transformation of students, researchers, educators, professors, employees and the academic community in general. Engagingexperts and academics from different fields/disciplines shall offer a new dimension of the NBS/circular economy synergy.

In conclusion there is great potential for Greek universities to serve as key players in promoting circular economy strategies, given their research capabilities, innovation culture, and position in the broader European sustainability landscape. By integrating circular economy practices, such as reusing materials or designing products for longer life cycles, with nature-based solutions, new systems are created that have the potential to regenerate both human-made and natural environments. Universities can offer their students an advanced approach in sustainability transition by exploring real world problems and promoting the Sustainable Development Goals. The outcome of this process will be building resilience and sustainability and enhancing a harmonious relationship between human activities and nature.

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