

EDULEARN₂₁

13TH INTERNATIONAL CONFERENCE
ON EDUCATION AND NEW LEARNING
TECHNOLOGIES



CONFERENCE
PROCEEDINGS



EDULEARN₂₁

**13TH INTERNATIONAL CONFERENCE
ON EDUCATION AND NEW LEARNING
TECHNOLOGIES**

**CONFERENCE
PROCEEDINGS**

Published by
IATED Academy
iated.org

EDULEARN21 Proceedings
13th International Conference on Education and New Learning Technologies
July 5th-6th, 2021

Edited by
L. Gómez Chova, A. López Martínez, I. Candel Torres
IATED Academy

ISBN: 978-84-09-31267-2
ISSN: 2340-1117
DL: V-1707-2021

Book cover designed by
J.L. Bernat

All rights reserved. Copyright © 2021, IATED Academy

The papers published in these proceedings reflect the views only of the authors. The publisher cannot be held responsible for the validity or use of the information therein contained.

EDULEARN21 COMMITTEE AND ADVISORY BOARD

<i>Agustín López</i>	SPAIN	<i>Jose F. Cabeza</i>	SPAIN
<i>Alexander Mikroyannidis</i>	UNITED KINGDOM	<i>Jose Luis Bernat</i>	SPAIN
<i>Aline Grunewald Nichele</i>	BRAZIL	<i>Kathleen O'Sullivan</i>	IRELAND
<i>Amparo Girós</i>	SPAIN	<i>Laura Zizka</i>	SWITZERLAND
<i>Ana Lucas</i>	PORTUGAL	<i>Leonor Silva de Mattos</i>	UNITED KINGDOM
<i>Ana Paula Lopes</i>	PORTUGAL	<i>Lorena López</i>	SPAIN
<i>Ana Tomás</i>	SPAIN	<i>Louise Robson</i>	UNITED KINGDOM
<i>Anamarija Štefić</i>	CROATIA	<i>Luis Gómez Chova</i>	SPAIN
<i>Andrew Youde</i>	UNITED KINGDOM	<i>M^a Jesús Suesta</i>	SPAIN
<i>Anemona Peres</i>	POLAND	<i>Manuel Gericota</i>	PORTUGAL
<i>Antonio García</i>	SPAIN	<i>Maria Luisa Spreafico</i>	ITALY
<i>Asako Ohno</i>	JAPAN	<i>Maria Porcel</i>	SPAIN
<i>Bob Barrett</i>	UNITED STATES	<i>Maria Susy Rogers</i>	UNITED KINGDOM
<i>Boza Tasic</i>	CANADA	<i>Marion Milton</i>	AUSTRALIA
<i>Bozena Mannova</i>	CZECH REPUBLIC	<i>Martina Bode</i>	UNITED STATES
<i>Chang-Tik Chan</i>	MALAYSIA	<i>Michelle Flood</i>	IRELAND
<i>Chelo González</i>	SPAIN	<i>Miguel Peiró</i>	SPAIN
<i>Chiew Hong Ng</i>	SINGAPORE	<i>Monika Jakubiak</i>	POLAND
<i>David Martí</i>	SPAIN	<i>Nathalie Wessseling</i>	NETHERLANDS
<i>Eladio Duque</i>	SPAIN	<i>Norma Barrachina</i>	SPAIN
<i>Elena Savova</i>	BULGARIA	<i>Polona Gradišek</i>	SLOVENIA
<i>Eulalia Tramuns</i>	SPAIN	<i>Rebecca Allen</i>	UNITED STATES
<i>Fausto Brevi</i>	ITALY	<i>Sandra Gomes</i>	PORTUGAL
<i>Filomena Soares</i>	PORTUGAL	<i>Sean Lancaster</i>	UNITED KINGDOM
<i>Hanna-Riitta Kymäläinen</i>	FINLAND	<i>Sergio Pérez</i>	SPAIN
<i>Helen Reddy</i>	UNITED KINGDOM	<i>Siobhan O'Sullivan</i>	UNITED ARAB EMIRATES
<i>Ignacio Ballester</i>	SPAIN	<i>Suzy Connor</i>	JAPAN
<i>Ignacio Candel</i>	SPAIN	<i>Teemu Patala</i>	FINLAND
<i>Iolie Nicolaidou</i>	CYPRUS	<i>Teresa Cardoso</i>	PORTUGAL
<i>Iván Martínez</i>	SPAIN	<i>Thomas Rachfall</i>	GERMANY
<i>Jacqueline Baxter</i>	UNITED KINGDOM	<i>Tunde Szecsi</i>	UNITED STATES
<i>Jana Bérešová</i>	SLOVAKIA	<i>Victor Fester</i>	NEW ZEALAND
<i>Jane Davies</i>	MALAYSIA	<i>Victoria Brennan</i>	UNITED KINGDOM
<i>Javier Domenech</i>	SPAIN	<i>Wayne Bailey</i>	UNITED KINGDOM
<i>Javier Martí</i>	SPAIN	<i>Wendy Gorton</i>	UNITED STATES
<i>Joanna Lees</i>	FRANCE	<i>Xavier Lefranc</i>	FRANCE

CONFERENCE TRACKS & SESSIONS

DIGITAL TRANSFORMATION OF EDUCATION

Data Science & AI in Education
Learning Analytics & Educational Data Mining
Digital Transformation
Digital Technologies and Resources for Learning under Lockdown
21st Century Skills
Educational Programming & Robotics

DIGITAL & DISTANCE LEARNING

Distance Education in COVID-19 Times
Challenges and Practices during the Pandemic
Blended & Mobile Learning
MOOCs & Open Educational Resources
Learning Management Systems & Virtual Learning Environments

INNOVATIVE EDUCATIONAL TECHNOLOGIES

AI, Chatbots & Robots
Virtual & Augmented Reality
Social Media in Education
Technology Enhanced Learning

TEACHER TRAINING & ED. MANAGEMENT

ICT & Digital Skills
Professional Development of Teachers
Educational Management

ACTIVE & STUDENT-CENTERED LEARNING

Gamification & Game-based Learning
Experiential Learning
Problem & Project-Based Learning
Soft Skills Development
Pedagogical Innovations
Non-Formal Learning

ASSESSMENT, MENTORING & STUDENT SUPPORT

Assessment & Evaluation
Rethinking Assessment in COVID-19 Times
Feedback for Learning
Tutoring & Coaching
Student Support & Motivation

EDUCATIONAL STAGES & LIFE-LONG LEARNING

From Pre-school to Secondary Education
Vocational Training
Transition to the Job Market
Developing Entrepreneurship in Education
Life-Long & Workplace Learning

QUALITY & IMPACT OF EDUCATION

Quality in Education
Experiences and Challenges in Curriculum Design
Sustainability & Social Impact of Education
Education and Research
University-Industry Collaboration
Mobility & International Projects

MULTICULTURALITY & INCLUSION

Multicultural Education
Diversity Issues
Special Educational Needs
Inclusion in Education

STEM EDUCATION

Maths & Statistics
Engineering Education
STEM Experiences

LANGUAGE LEARNING AND TEACHING

Foreign Languages
Language Learning & Translation Studies
Teaching Foreign Languages during the Lockdown

DISCIPLINE-ORIENTED SESSIONS

Architecture & Interior Design
Health Sciences Education
Computer Science
Business & Tourism Education

ABOUT EDULEARN21 Proceedings

HTML Interface: Navigating with the Web browser

This USB Flash drive includes all presented papers at EDULEARN21 conference. It has been formatted similarly to the conference Web site in order to keep a familiar environment and to provide access to the papers through your default Web browser (open the file named "EDULEARN21_Proceedings.html").

An Author Index, a Session Index, and the Technical Program are included in HTML format to aid you in finding conference papers. Using these HTML files as a starting point, you can access other useful information related to the conference.

The links in the Session List jump to the corresponding location in the Technical Program. The links in the Technical Program and the Author Index open the selected paper in a new window. These links are located on the titles of the papers and the Technical Program or Author Index window remains open.

Full Text Search: Searching EDULEARN21 index file of cataloged PDFs

If you have Adobe Acrobat Reader version 6 or later (www.adobe.com), you can perform a full-text search for terms found in EDULEARN21 proceedings papers.

Important: To search the PDF index, you must open Acrobat as a stand-alone application, not within your web browser, i.e. you should open directly the file "EDULEARN21_FrontMatter.pdf" with your Adobe Acrobat or Acrobat Reader application.

This PDF file is attached to an Adobe PDF index that allows text search in all PDF papers by using the Acrobat search tool (not the same as the find tool). The full-text index is an alphabetized list of all the words used in the collection of conference papers. Searching an index is much faster than searching all the text in the documents.

To search the EDULEARN21 Proceedings index:

1. Open the Search PDF pane through the menu "Edit > Advanced Search" or click in the PDF bookmark titled "SEARCH PAPERS CONTENT".
2. The "EDULEARN21_index.pdx" should be the currently selected index in the Search window (if the index is not listed, click Add, locate the index file .pdx, and then click Open).
3. Type the search text, click Search button, and then proceed with your query.

For Acrobat 9 and later:

1. In the "Edit" menu, choose "Search". You may receive a message from Acrobat asking if it is safe to load the Catalog Index. Click "Load".
2. A new window will appear with search options. Enter your search terms and proceed with your search as usual.

For Acrobat 8:

1. Open the Search window, type the words you want to find, and then click Use Advanced Search Options (near the bottom of the window).
2. For Look In, choose Select Index.
3. In the Index Selection dialog box, select an index, if the one you want to search is available, or click Add and then locate and select the index to be searched, and click Open. Repeat as needed until all the indexes you want to search are selected.
4. Click OK to close the Index Selection dialog box, and then choose Currently Selected Indexes on the Look In pop-up menu.
5. Proceed with your search as usual, selecting other options you want to apply, and click Search.

For Acrobat 7 and earlier:

1. In the "Edit" menu, choose "Full Text Search".
2. A new window will appear with search options. Enter your search terms and proceed with your search as usual.

RENATURING MALTA: DEVELOPING A CAPACITY-BUILDING STRATEGY FOR THE MAINSTREAMING OF NATURE-BASED SOLUTIONS

J. Tomaskinova¹, D. Geneletti², M. Grace³, L.V. Dicks³, M. Collier⁴,
A. Sapundzhieva⁵, P. Stoev⁵, A.F. Alcantara Valero⁶, D. Longato², J. Kato
Huerta², M.S. Orta Ortiz², L. De Santis¹, M.V. Balzan¹

¹*Institute of Applied Sciences, Malta College of Arts, Science and Technology (MALTA)*

²*Department of Civil, Environmental and Mechanical Engineering, University of Trento
(ITALY)*

³*Department of Zoology, University of Cambridge (UNITED KINGDOM)*

⁴*School of Natural Sciences, Trinity College Dublin (IRELAND)*

⁵*Pensoft Publishers (BULGARIA)*

⁶*Corporate Development Department, IUCN Center for Mediterranean Cooperation (SPAIN)*

Abstract

Nature based solutions (NbS) have the potential to build climate resilience and tackle key societal challenges while also providing multiple co-benefits to biodiversity and human well-being. The demand for nature-based innovation is strongly felt in Malta – a small island state, with the highest population density in the European Union. Learning and training play a pivotal role in the endeavour to create sustainable societies. Current environmental, social and economic challenges to meet the balance of the four dimensions of sustainable development (social, environmental, economic and governance) require new ways of thinking and acting. The ReNature project helps to facilitate international knowledge exchange for the mainstreaming of NbS, via holistic and interdisciplinary stakeholder education. This will be demonstrated through increasing outstanding research initiatives in NbS for innovation, sustainable economic growth and human well-being in Malta. The ReNature consortium is working towards increasing the range of appropriate learning opportunities and sharing experiences about NbS implementation around the Mediterranean basin. The outcomes of this project will foster capacity building and enhance research excellence in the field of NbS through a number of strategically designed training activities and project outputs in topics related to the key areas of this concept. This article is aimed at presenting the ReNature capacity-building framework and learning model. We believe that these tools are setting a direction for learning that is based on values, principles and practices which are indispensable to respond effectively to current and future challenges.

Keywords: Nature-based solutions, capacity-building framework, learning model, stakeholder education, sustainable development.

1 INTRODUCTION

The current COVID-19 crisis has caused global distress, but it has also taught us valuable lessons. From an ecological perspective, chief among them must surely be the extent of interdependence between all living organisms, and the need to account for this when formulating policies that will significantly impact the environment. This is true not only of the various types of natural habitats but also of largely anthropogenic environments and spaces such as towns and cities.

Today, cities face growing environmental, social, and economic challenges that together threaten the resilience of urban areas [1]. Resilient cities are those that can effectively operate and offer services even under conditions of multiple shocks and stresses, including climate change [2]. Such stresses may include rapid population growth, challenges in job creation, the provision of basic services, and in waste management. Often, economic factors and unstable political situations, as well as the occurrence of natural disasters, further aggravate this condition of vulnerability.

As socio-ecological systems, resilient cities are characterised by increased self-sufficiency and their ability to deal with crises and return to normalcy after periods of shocks and stress. As pointed out in the OECD 2018 Report [3], “*resilient cities are those which have the ability to absorb, recover and prepare for future shocks (environmental, economic, social and institutional)*”, whilst encouraging sustainable development, prosperity, and comprehensive growth.

This is where nature-based solutions (NbS) may contribute. NbS are defined by IUCN 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*” [4]. Examples of NbS include different forms of green and blue infrastructure, such as green roofs and walls, rain gardens, sustainable urban drainage systems, natural water retention measures, hedgerows, salt marshes and dunes, floodplains, and urban green spaces, among others. A central idea in the use of NbS is that of addressing the societal challenges of innovation, job creation and community development but at the same time creating net positive effects on the environment by making sustainable use of biodiversity and natural resources, in order to improve human wellbeing [5]. Thus, NbS present landscape and urban planners with new opportunities to improve the quality of life of citizens, for example through enhanced air and water quality, the regulation of the local climate, flood protection, ecotourism and recreation, and food provisioning. The NbS concept covers a whole range of ecosystem-related approaches such as landscape scale considerations and policy integration. Focussing on resilience, as opposed to vulnerability, emphasises the possible contributions of the city or community itself, building upon its natural, social, political, human, financial and physical capital, while strengthening its capabilities. NbS can contribute to the urgent transformations needed to meet global goals and targets, such as the UN Sustainable Development Goals [6], and are considered by a wide range of stakeholders as an essential mechanism for achieving sustainable development [7]. Taking into consideration worldwide trends, “*global goals for 2030 and beyond may only be achieved through transformative changes across economic, social, political and technological factors*” [8]. To date, NbS (primarily through the expansion of green and blue infrastructures) have made significant contributions to climate resilience, the conservation and promotion of urban biodiversity; and the improvement of human well-being in the Mediterranean [7]. Progress has been registered as regards policy responses and actions for more sustainable management of the Mediterranean, particularly in contrast to ‘no intervention’ scenarios. However, NbS remain complex to implement as there are still potential physical, ecological, cultural, political and economic barriers to the mainstreaming of these solutions into policy, landscape design and urban planning.

The demand for nature-based innovation is strongly felt in Malta, a small island state with the highest population density in the European Union. Over the past few years, Malta has experienced strong tourism and economic growth, but is increasingly vulnerable to climate change and to growing pressures on its limited natural resources. [9] Socio-economic inequalities in life expectancy and health status have been identified as a persistent concern [10-11] and Maltese citizens had the highest rate of exposure to pollution, grime or other environmental problems in the EU in 2017 [11-12]. The region is also characterised by an increased risk to human life driven by a strong rise in the frequency and intensity of heat waves towards the south of Europe and an upsurge in drought conditions, as a consequence of climate change [11,13]. The implementation of NbS therefore creates an opportunity to improve resilience and to foster adaptation to climate and environmental changes, the latter including rapid urbanisation and the steep growth in demand for energy and water resources [9].

In order to tackle these challenging phenomena with some measure of success, it will be increasingly necessary to rely on NbS. Such solutions should constitute an important pillar within the framework of any general strategy aimed at the pursuit of economic growth. Strengthening the provision of ecosystem services to address societal challenges through NbS is one of the major challenges of scientists in the 21st century. NbS can be implemented separately or integrated with other solutions [14] and many solutions offer co-benefits. Urgent and collective efforts for mainstreaming NbS into policy, planning and practice are required for environmental protection, while simultaneously fostering sustainable development in the region.

Within this context, it is important to foster transdisciplinary, bottom-up processes and the creation of a continuous, creative dialogue between and within key stakeholders and communities. This dialogue can lead to the collaborative production (co-production) of knowledge and the collaborative creation (co-creation) of ideas and solutions to develop and implement NbS as part of a strategy for the attainment of sustainable development. The NbS standard from IUCN [15] can help in this process.

Against this background, the aim of the capacity-building activities carried out within the Horizon 2020 project ReNature (promoting Research excellence in Nature-based solutions for innovation, economic growth and human well-being in Malta) was to enhance the institutional research capacity and to develop stronger links between research, policy, and the business and stakeholder community. As such, the project is in line with ongoing efforts to raise Malta's profile in the field of research and innovation and the generation of novel NbS that tackle environmental challenges faced by modern societies. The ReNature consortium, and the research community within which it is anchored, seek to promote capacity building and have identified a number of learning outcomes that are considered as being important in the field of NbS. This training is delivered through specific modules in topics related to the key areas of this concept. This article is aimed at presenting the ReNature capacity-building framework and learning model.

2 METHODOLOGY

2.1 Conceptual approach

The long-term goal of the ReNature project is to establish and implement a Strategic Research Agenda and a National Research and Innovation Cluster to stimulate scientific excellence and innovation capacity in the area of NbS for sustainable development at the Institute of Applied Sciences of the Malta College of Arts, Science and Technology (MCAST) in Malta. MCAST is the leading further and higher education institution in Malta for the provision of vocational qualifications and the implementation of applied research in science and engineering.

ReNature brings together knowledge holders, i.e. people and organisations possessing relevant knowledge in various areas of expertise, in order to become knowledge providers through networking and clustering to co-create knowledge that develops new solutions. Networks are defined as a 'specific type of relation linking individuals or events' [16], and clusters as 'geographic concentrations of interconnected companies and institutions in a particular field, linked by commonalities and complementarities' [17]. Clusters have a better chance of being competitive at a national and global level, whilst promoting stronger local collaboration and links to the market at the same time. Clustering at a local/regional level enables participants to exploit their synergies and complementarity, leading to benefits such as knowledge transfer, preservation of community values and lifestyle improvement [16,18]. The strong interest in clusters for research and innovation has been influenced by a perceived failure of past policies focused on hard measures such as infrastructure development, and the need to shift support towards institutional development and intangible elements such as networking and social capital via the use of 'soft' measures such as clusters [19]. A justification for fostering clustering for research and innovation arises from the need to address market, systemic and public failures. Market failures may be associated with underinvestment in knowledge and technology; systemic failures arise when connections between actors are poor and insufficiently conducive to knowledge generation, whilst public failures may result from institutional lag and poor performance in current programs. Clustering is therefore seen as a way to address these failures, whilst promoting research and innovation, growth, productivity, and competitiveness [19].

The ReNature project promotes the development of an interconnected cluster of researchers, with key links to city councils, policy-makers and businesses, and fostering peer-to-peer learning, multi-disciplinarity, and capacity-building. The ReNature consortium is working towards increasing the range of appropriate learning opportunities and sharing experiences about NbS implementation around the Mediterranean basin. This includes establishment of twinning between MCAST and leading research-intensive international institutions within this rapidly developing field, the raising of stakeholders' awareness and development of networking.

Strategically designed training activities were delivered during the project period (2018-2021), based on the ReNature capacity-building framework for the mainstreaming of NbS (Fig. 1).

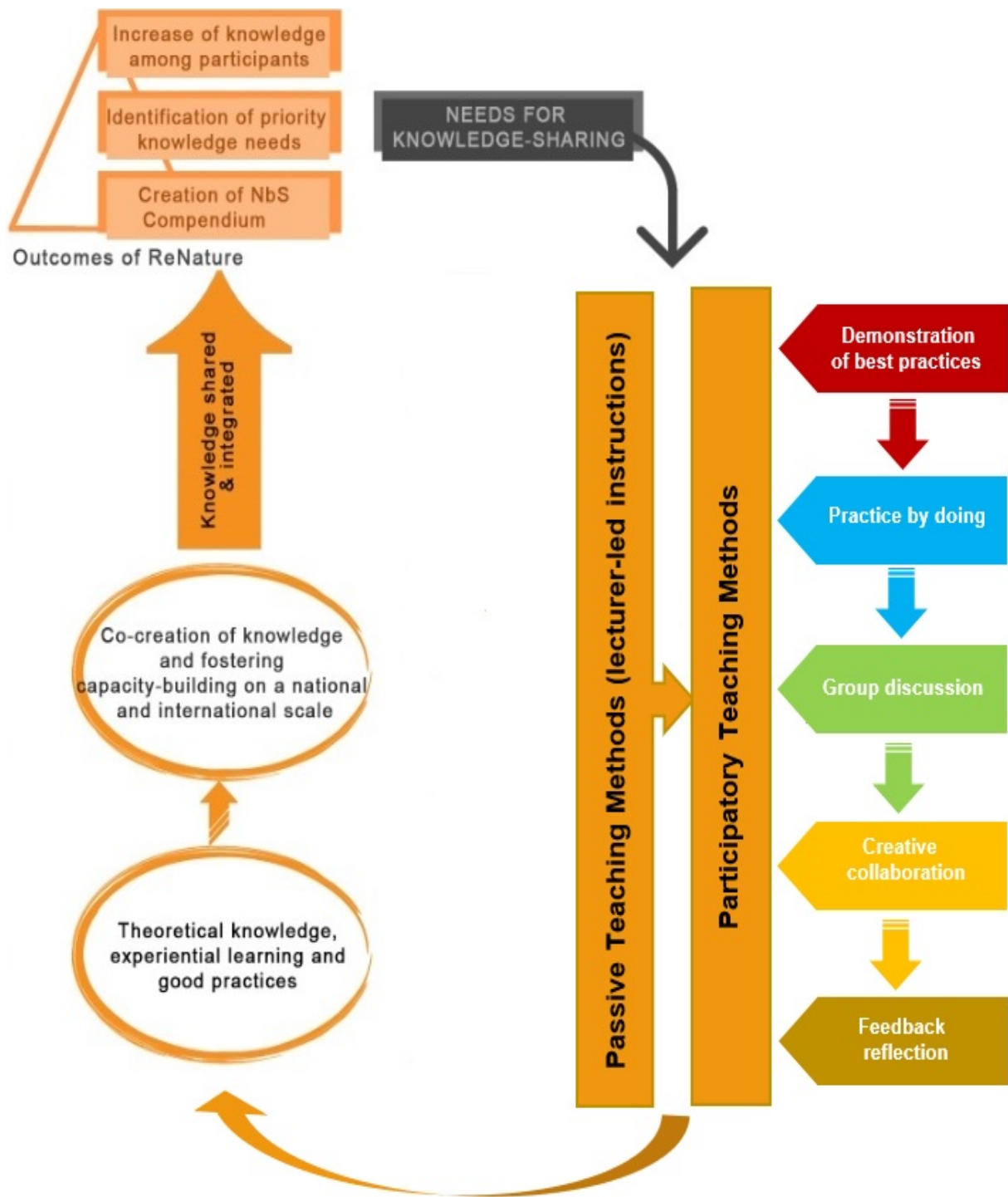


Figure 1. ReNature capacity-building framework for the mainstreaming of nature-based solutions.

The training activities were led by a total of 35 trainers and keynote speakers from 16 countries (Fig. 2), during the whole project period. Italian and Irish trainers were predominant with 20% representation each, followed by Maltese trainers (11.43%).

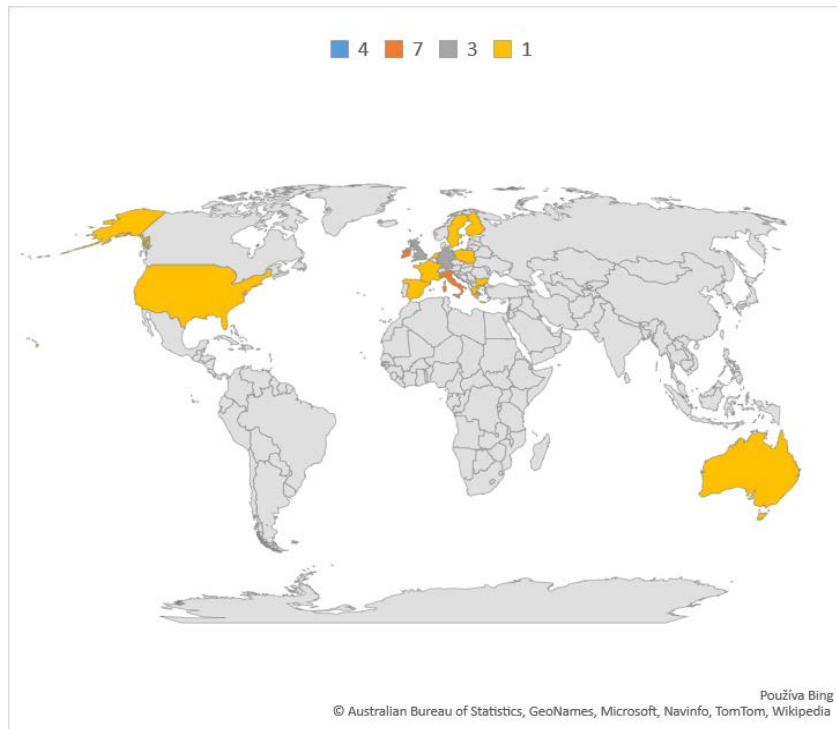


Figure 2. Trainers and keynote speakers - Country of Affiliation.

Training activities were carried out with a total of 174 participants from 43 countries (Fig. 2) who participated in 8 training activities (5 training courses, 1 thematic workshop, 2 interdisciplinary training schools), of which 2 were held online via Zoom (the fifth training course and the second interdisciplinary training school), due to COVID-19 restrictions. Maltese participants were predominant (43.86%).

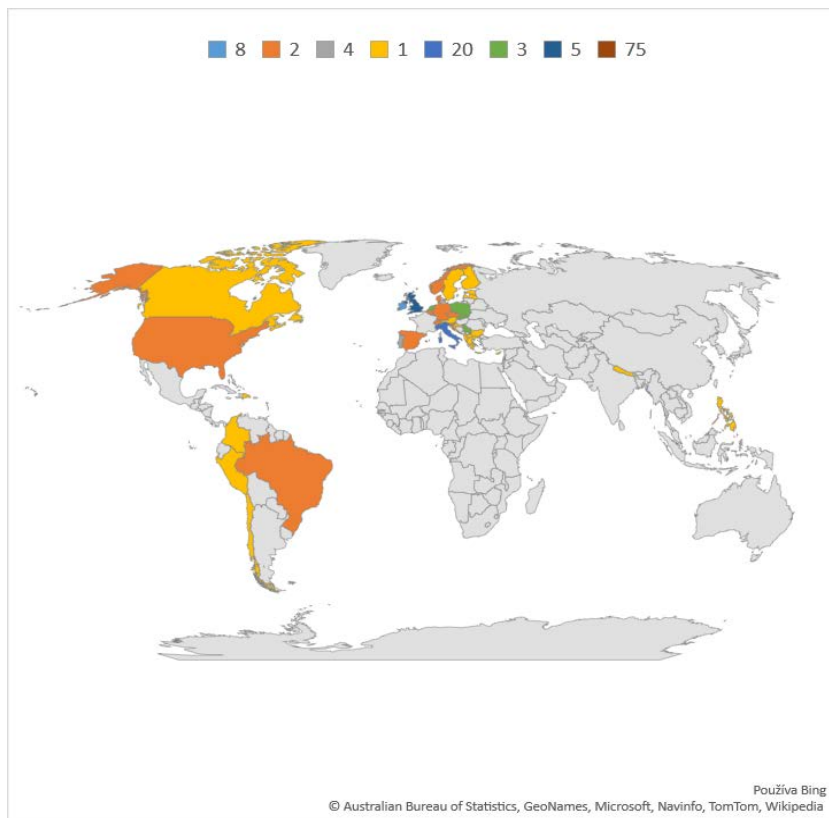


Figure 3. Participants (8 training activities) - Country of Affiliation.

The fifth ReNature Training Course showed great potential in widening participation through the online format of delivery. As well as being held online via Zoom, it was livestreamed on YouTube. In all, there were a total of 314 registrations, and up to 131 unique viewers on the same day (the maximum number allowed was 100 attendees) whilst the YouTube livestream was watched >300 times until the last day of the training course. Our audience hailed from Malta (34%), the EU and the UK (52%) and the rest of the world (14%, including the USA, Australia, and others) during the first day of this capacity-building event (Fig. 4).

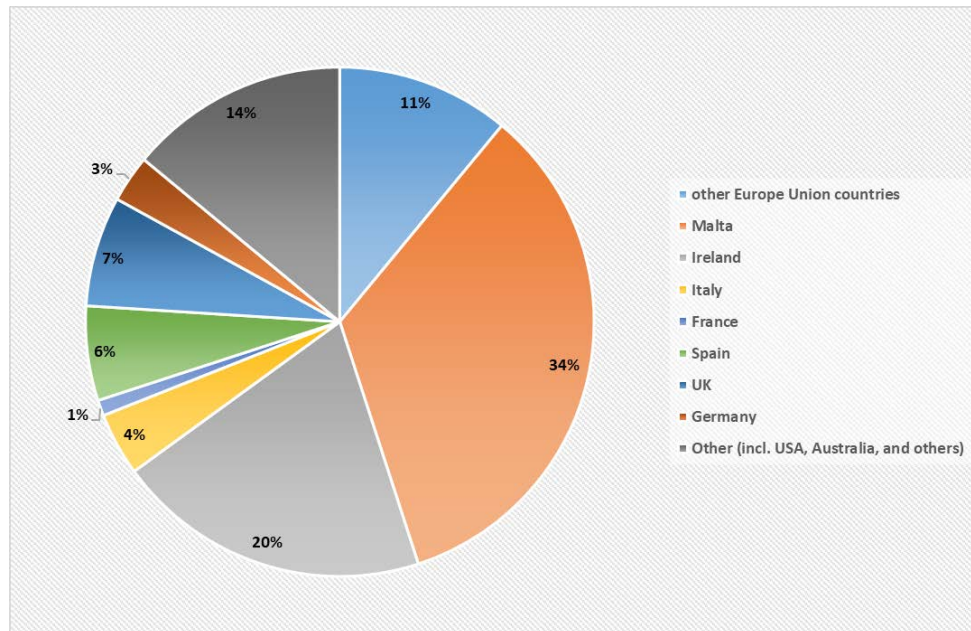


Figure 4. Fifth training course attendees - Country of Affiliation during the first day.

3 RESULTS AND DISCUSSION

Knowledge exchange plays a pivotal role in the endeavour to create sustainable societies. Current environmental, social, and economic challenges to meet the balance of the four dimensions of sustainable development (social, environmental, economic and governance) require new ways of thinking and acting. Improving NbS implementation is one approach to this, and mainstreaming the use of NbS necessitates developing routes to improving societal awareness, through a range of appropriate interdisciplinary knowledge exchange opportunities and sharing good practice. Open science is one of the key pillars of the ReNature project (<http://renature-project.eu/>), which has already openly shared access to developed training material and scientific outcomes. Similarly, the ReNature Nature-based Solutions Compendium (<http://renature-project.eu/compendium>) has collated information about NbS in Malta and shared data openly with all interested users and practitioners [11,20]. The compendium is growing to include submissions from across the Mediterranean climatosphere. The development of an open-source compendium plays an essential role in the co-creation of knowledge and fostering capacity-building at a national and international level: some of the key objectives of ReNature. By sharing existing successful examples of NbS implementation, the platform is extending this knowledge to practitioners and the research community [21]. ReNature has produced a number of significant outputs in topics related to the key areas of the NbS concept, in the form of a multi-stakeholder consultation exercise to identify priority knowledge needs and barriers preventing wider implementation of NbS in Mediterranean islands [22]; an open-source compendium [20]; a blueprint for socially and economically viable NbS [23], and an NbS impacts toolbox. These tools are expected to shape an approach for knowledge transition and knowledge co-creation that is based on values, principles and practices essential to respond effectively to current and future challenges. Notwithstanding the current high degree of focus on policy, the mainstreaming of NbS into policy, planning and practice has remained at a relatively low level, and often vitiated by limited knowledge of their potential effects [22, 24]. Greater uptake relies on the identification of appropriate means of implementation as well as on identifying and tackling any knowledge gaps impeding implementation within the applicable spheres, including government, business and environmental NGOs [22].

The outcomes of this project also foster capacity building and enhance research excellence in the field of NbS through a number of strategically designed training activities related to the key areas of this concept, based on the ReNature learning model for knowledge-sharing (Fig. 5). These trainings have focused on the complex problems that are present in human-dominated environments, including the effects and impacts of urbanisation, such as rapidly emerging and changing landscapes in the areas of the rural-urban interface. Cultural landscapes and the related complex social and environmental issues call for a rethinking of traditional landscape planning and management approaches in the twenty-first century. Training modules were aimed at providing trainees with an understanding of the potential of NbS in cultural landscapes, in the context of the holistic approach towards achieving the UN SDGs. The trainees acquired the necessary skills and knowledge to identify and apply NbS in different contexts. The training courses focused on “problem-based” learning sessions, boosting their professional development (i.e. professional reasoning, integration of scientific/professional knowledge, and consensual decision-making skills, dialogue/discussion skills, team maintenance skills, etc.) and cooperation among participants. Another valuable learning opportunity was provided by lectures and discussion sessions, which allowed attendees to interact and share experiences and activities with experts from the research and practitioners’ community (Fig. 1-2), as well as generating opportunities for future networking and collaboration. We believe that the ReNature capacity-building framework and learning model are setting a direction for learning that is based on values, principles and practices which are crucial in enabling an effective response to current and future challenges.



Figure 5. ReNature learning model for knowledge-sharing (pie chart is not indicative of size of segments).

ReNature has provided an opportunity to develop strong links between the project partners. Through this collaboration, the focus shifts to ensuring transdisciplinarity through knowledge co-creation and co-production, the engagement of communities of interest and communities of influence, and the development of new technological and NbS to sustainability challenges. Through a transdisciplinary approach, which involves the co-production of knowledge and the co-creation of ideas and solutions and which draws strengths of different academic and non-academic disciplines to address a complex issue [25], ReNature has brought together communities-of-interest (i.e. from academia, government

organisations, public bodies, NGOs) that are continually seeking active engagement in decision-making and positive control in city making by creating a National Research and Innovation Cluster. This cluster contributes to nature-based innovation in Malta and Europe by providing a context with a strong demand for this type of innovation, adopting research-to-practice approaches through an already existing but further-developed strong collaboration with stakeholders.

Capacity building and the development of a self-sustaining national research and innovation cluster that promotes knowledge sharing and develops and implements policy-oriented tools and methodologies are two main outcomes of ReNature. Through collaborative work with research-intensive institutions, and as part of the ReNature training activities, MCAST researchers and students have benefitted from training opportunities that stimulate scientific excellence within the NbS sectors. In addition, the creation of a national research and innovation cluster is a way of increasing adaptability of research and training to the industry and policy needs, thus ensuring an improved long-term capability to actively engage with, and participate in, applied research focusing on the development of implementation-oriented tools and methodologies. In particular, this approach allowed MCAST to expand the engagement of the research group through interaction with successful consortia in the field of NbS. ReNature has also increased the international exposure of MCAST, given that research-intensive partners have shared opportunities to participate within their networks. In addition, ReNature has created opportunities for cross-agency and cross-departmental engagement of local authorities through a collaborative, multi-stakeholder exercise to identify priority knowledge needs that could enhance the uptake of NbS in Mediterranean islands. Innovation processes such as knowledge co-creation have helped establish collaborations that engage with stakeholders in a trustworthy environment, raising awareness and catalysing sustainable transformation, particularly in cities. This brings us to a unique opportunity to establish MCAST as a knowledge hub, which constitutes an excellent overview of up-to-date tools, models and methods for implementing NbS. As a hub, it can combine multidisciplinary approaches and expand shared knowledge among researchers, professionals, decision-makers, and civil society, and develop and implement new solutions to environmental and sustainability challenges.

4 CONCLUSIONS

ReNature activities have created an opportunity to facilitate a policy knowledge exchange in the Mediterranean region and its islands on upscaling the NbS process. In-depth knowledge synthesis has been identified as an appropriate next step to addressing the majority of the priority knowledge needs identified by Grace *et al.* [22]. However, knowledge synthesis is a resource intensive activity that is not currently prioritised by environmental funding bodies. It will therefore be necessary to source funding for knowledge synthesis to address the outstanding knowledge needs. The opportunity here is to create a mechanism for engaging with the wider global NbS community and facilitate information-sharing across the Mediterranean region, and in turn benefitting similar regions around the world. This was established with the completion of the first published version of the ReNature Nature-based Solutions Compendium database consisting of entries from Malta, which will be expanded upon in the future. This will be a Mediterranean-specific compendium aimed at providing assistance to practitioners, planners, designers and policymakers.

Through the stimulation of networking (i.e. workshops and meetings), knowledge transfer (i.e. training and collaborative work) and sharing of best practices (a form of benchmarking of specific practices), ReNature should succeed in creating a self-sustaining cluster that promotes knowledge co-production, co-creation, and sharing, thus developing the links to decision-making whilst promoting the mainstreaming of NbS across all the policy-relevant sectors.

ACKNOWLEDGEMENTS

This work was supported by the ReNature project. This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 809988.

REFERENCES

- [1] J. Bush, A. Doyon, Building urban resilience with nature-based solutions: How can urban planning contribute? *Cities*, vol. 95, 102483, 2019. Retrieved from <https://doi.org/10.1016/j.cities.2019.102483>.
- [2] A. Galderisi, G. Limongi, K.D. Salata, Strengths and weaknesses of the 100 Resilient Cities Initiative in Southern Europe: Rome and Athens' experiences. *City, Territory and Architecture*, vol. 7, no. 16, 2020. Retrieved from <https://doi.org/10.1186/s40410-020-00123-w>.
- [3] Organisation for Economic Co-operation and Development (OECD). *Resilient cities*, 2018. Retrieved from <http://www.oecd.org/cfe/regional-policy/resilient-cities.htm>
- [4] IUCN, Commission on Ecosystem Management, *Nature-based Solutions*, 2021. Retrieved from <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions#:~:text=Nature-based%20Solutions%20%28NbS%29%20are%20defined%20by%20IUCN%20as,benefits%E2%80%9D.%20Photo%3A%20copyright.%20Photo%3A%20Marco%20Quesada.%20Prev%20Next>.
- [5] J. Maes, S. Jacobs, Nature-Based Solutions for Europe's Sustainable Development. *Conservation Letters*, vol. 10, 121–124, 2019.
- [6] J.G.C. Martin, A. Scolobig, J. Linnerooth-Bayer, W. Liu, J. Balsiger, Catalyzing Innovation: Governance Enablers of Nature-Based Solutions. *Sustainability*, vol. 19, no. 4, 1971, 2021. Retrieved from <https://doi.org/10.3390/su13041971>.
- [7] IUCN, Nature-based Solutions in Mediterranean cities. Rapid assessment report and compilation of urban interventions (2017-2018). Malaga/Spain: IUCN, 2019.
- [8] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), *The global assessment report on biodiversity and ecosystem services: Summary for policymakers*. [Díaz, S., Settele, J., Brondízio, E.S., Ngo, H.T., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K.A., Butchart, S.H.M., Chan, K.M.A., Garibaldi, L.A., Ichii, K., Liu, J., Subramanian, S.M., Midgley, G.F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S., Purvis, A., Razaque, J., Reyers, B., Chowdhury, R., Shin, Y.J., VisserenHamakers, I.J., Willis, K.J. and Zayas, C.N. (eds.)]. Bonn/Germany: IPBES secretariat, 2019. Retrieved from https://ipbes.net/sites/default/files/202002/ipbes_global_assessment_report_summary_for_policymakers_en.pdf.
- [9] J. Tomaskinova, L. Dicks, M. Collier, D. Geneletti, M. Grace, D. Longato, R. Sadula, P. Stoev, A. Sapundzhieva, M.V. Balzan, Capacity-building and networking events for nature-based solutions and re-naturing in Malta. *Research Ideas and Outcomes* 6: e60893, 2020. Retrieved from <https://doi.org/10.3897/rio.6.e60893>.
- [10] OECD/European Observatory on Health Systems and Policies. *State of health in the EU. Malta Country Health Profile 2019*. Brussels/Belgium: OECD Publishing, 2019.
- [11] M.V. Balzan, J. Tomaskinova, M.J. Collier, L. Dicks, D. Geneletti, M. Grace, D. Longato, R. Sadula, P. Stoev, A. Sapundzhieva, Building capacity for mainstreaming nature-based solutions into environmental policy and landscape planning. *Research Ideas and Outcomes* 6: e58970, 2020. Retrieved from <https://doi.org/10.3897/rio.6.e58970>.
- [12] Eurostat, Exposure to pollution, grime and other environmental problems. 2017.
- [13] G. Forzieri, A. Cescatti, A., F.B. e Silva, L. Feyen, Increasing risk over time of weather-related hazards to the European population: a data-driven prognostic study. *The Lancet Planetary Health*, vol. 1, no. 5, e200–e208, 2017. Retrieved from [https://doi:10.1016/s2542-5196\(17\)30082-7](https://doi:10.1016/s2542-5196(17)30082-7).
- [14] G. Walters, E. Cohen-Shacham, S. Maginnis, P. Lamarque, What are Nature-based Solutions? In Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.): *Nature-based Solutions to address global societal challenges*. Gland/Switzerland: IUCN, 2-4, 2016.
- [15] IUCN (2020). Guidance for using the IUCN Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of Nature-based Solutions. Gland/Switzerland: IUCN, 2020.
- [16] M. Novelli, B. Schmitz, T. Spencer, Networks, clusters and innovation in tourism: A UK experience. *Tourism Management*, no. 27, 1141–1152, 2006.

- [17] M.E. Porter, Clusters and the New Economics of Competition *Harvard Business Review*. *Harvard Business Review*, 77–90, 1998.
- [18] T.J. Roelandt, P. den Hertog, P. Summary Report of the Focus Group on Clusters. 1998.
- [19] E. Uyarra, R. Ramlogan, The Effects of Cluster Policy on Innovation. *NESTA Compendium of Evidence on Innovation Policy Intervention*, 1–48, 2012.
- [20] J. Williams, A. Sapundzhieva, M. Collier, I. Kuzmova. *Open-source compendium*. Deliverable 5.1, 2019.
- [21] A. Sapundzhieva, M.V. Balzan, J. Tomaskinova, L. De Santis, M.J. Collier, J. Williams, L. Dicks, M. Grace, D. Geneletti, I. Demirova, ReNature: creating the first nature-based solutions compendium in the Mediterranean. *Research Ideas and Outcomes* 6: e59646, 2020. Retrieved from <https://doi.org/10.3897/rio.6.e59646>.
- [22] M. Grace, M. Balzan, M. Collier, D. Geneletti, J. Tomaskinova, R. Abela, D. Borg, G. Buhagiar, L. Camilleri, M. Cardona, N. Cassar, R. Cassar, I. Cattafi, D. Gauchi, C. Galea, D. La Rosa, E. Malekkidou, M. Masini, P. Portelli, G. Pungetti, M. Spagnol, J. Zahra, A. Zammit, L.V. Dicks, Priority knowledge needs for implementing nature-based solutions in the Mediterranean islands. In *Environmental Science and Policy*, no. 116, 56-68, 2021. Retrieved from <https://doi.org/10.1016/j.envsci.2020.10.003>.
- [23] M. Collier, H. Reddington, M.V. Balzan, J. Tomaskinova, L. De Santis, D. Geneletti, D. Longato, M. Grace, L.V. Dicks, A. Sapundzhieva, *Blueprint for socially & economically viable nature-based solutions*. Deliverable 5.2, 2021.
- [24] C. Cortinovis, D. Geneletti, Ecosystem services in urban plans: what is there, and what is still needed for better decisions. *Land Use Policy*, no. 70, 298–312, 2018. Retrieved from <https://doi.org/10.1016/j.landusepol.2017.10.017>.
- [25] M.J. Collier, S. Connop, K. Foley, Z. Nedović-Budić, D. Newport, A. Corcoran, P. Crowe, L. Dunne, H. de Moel, S. Kampelmann, S. McQuaid, H.G. Schwarz von Raumer, A. Slaev, E.M. Stumpp, P. Van den Abeele, P. Vandergert, Urban transformation with TURAS open innovations; opportunities for transitioning through transdisciplinarity. *Current Opinion in Environmental Sustainability*, 22, 57-62, 2017. Retrieved from <https://doi.org/10.1016/j.cosust.2017.04.005>.