

Enhancing Small-Medium Islands resilience by securing the sustainability of Ecosystem Services: the SMILES Cost Action

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Abstract

European islands are hotspots of biological and cultural diversity, which, compared to mainland, are more vulnerable to climate change, tourism development, uncontrolled land-use changes and the consequences of financial crisis. These drivers of change have increasingly resulted in severe impacts on socio-economic and environmental parameters. Projected climate, land-use and socio-economic change will impact on islands' biodiversity, ecosystem services and, in turn, on the quality of life of island inhabitants. Even if the existing methods can adequately predict the abovementioned changes of the larger islands, this is not the case for small and medium-

size islands, where there is a need for refinement. Although ecosystem services (ES) assessments have been carried out worldwide in different geographical areas, islands are still under-represented. Despite the recognised islands' importance and vulnerability, efforts to date have focused solely on the pressures they face. Still, we know little about ES supply, flow and demand and their spatio-temporal variability, whilst integrated approaches that consider ES cross-island realms (terrestrial, marine and their interface) remain scarce. Even more under-represented are studies that explore the telecoupled relationship amongst islands and their mainland counterparts. Moreover, the current conceptual approaches guiding ES mapping and assessment need further refinement to account for the complex manifestations of nature and culture arising from peoples' interaction with island spaces. This paper discusses the creation of a platform for coordinated interdisciplinary research on several aspects of mapping and assessment of ES in small and medium European islands in order to synthesise and strengthen the knowledge base for conservation of island realms and contribute to their sustainable development.

Keywords

Biodiversity conservation, climate change, European policy, land-use changes, landscapes, nature-based solutions, seascapes

1. Introduction

European islands (Fig. 1) are hotspots of biological and cultural diversity, which, compared to their mainland counterparts, are more vulnerable to climate change, intense human activities, uncontrolled land-use changes and financial crisis (Balzan et al. 2018, Pörtner 2019). Beyond Europe, the United Nations since 1992, acknowledged the social, economic and environmental vulnerabilities of all small islands (UN-OHRLLS 2018) and also the fact that they might face the consequences of the constantly emerging changes "with a limited coping capacity" (The World Bank 2017). These factors have increasingly resulted in severe impacts on social, economic and environmental services and, in turn, on sustainability. Island regions i.e. those entirely made up of islands, are recognised as Nomenclature of Territorial Units for Statistics (NUTS) 3 regions (small regions for specific diagnoses) as NUTS3 regions by EUROSTAT on the basis of surface, distance from mainland and population size. Small islands, in particular (those with an area < 10,000 km² and < 500,000 inhabitants), but even medium-sized sparsely populated ones, experience greater difficulty in achieving a comparable level of development and standard of living when compared to the European mainland (EESC 2003). Article 174 of the European Treaty has recognised that many of the European islands are suffering from structural handicaps, leading to limited economic activity due to their small size, population reduction and landscape degradation. Despite their importance and vulnerability, the management of biodiversity and ecosystem services on and adjacent to islands is challenging for both the administrators, who are usually based on the mainland and the islanders themselves (Mercer et al. 2012). The range of contributions delivered to

human societies by nature so-called “ecosystem services” (ES) have received increased attention during the last 15 years (Millennium Ecosystem Assessment 2005; The Economics of Ecosystems & Biodiversity 2008; Maes 2014; Díaz et al. 2015; Haines-Young and Potschin-Young 2018) Worldwide islands are dependent on ES provided by their terrestrial component (e.g. freshwater provisioning, pollination) or the adjacent marine and coastal areas (e.g. food provision through fisheries) and supply important services that benefit society beyond their boundaries (e.g. lifecycle maintenance, recreation and tourism) (Millennium Ecosystem Assessment 2005). Small physical size, limited natural resources i.e. freshwater, relative isolation and openness of their economies (highly sensitive to external shocks) limit the capacity of small islands to supply the required goods and services and meet domestic and external needs, thus the islands may become dependent on imports and exports. Space constraints impact not just agricultural production, but also housing, infrastructure, waste disposal, industrial development and, ultimately, biodiversity conservation. Although the presence of resources on islands is constrained by their physical setting, the use of these resources is significantly influenced by political decision-making. Therefore, it becomes increasingly important for islands to be aware of their natural capital and how it may be threatened by changes due to internal or external biophysical and socio-economic drivers. For decision-makers and islanders alike, tourism is often seen as the core activity capable of reviving and sustaining local economies (Dorta Antequera et al. 2021, Singh et al. 2020) This also appears to be reflected in the scientific literature (Mazzola et al. 2019) where most studies on island ecosystems and their services have focused on the management of island tourism or the environmental impacts of mass tourism and other human activities (Balzan et al. 2018) with limited attention to benefits which island spaces offer to society. However, the increasing sophistication of tourist demands requires access to non-material characteristics of the environment i.e. nature, archaeology, good water quality, fresh food and aesthetic environments, so-called cultural ES (CICES). Therefore, nature and/or cultural conservation is not an impediment to tourism development (Baldacchino 2016), but a means to promote an island identity. In addition, new technologies are opening up new possibilities and solutions for more sustainable lifestyles and land and sea management. This may result in improved preservation of environmental quality under proper planning and active management for which a prerequisite is the assessment of ES provided by islands to put an end to the dilemma faced by the communities, i.e. tourism or abandonment. The recent crises, such as the COVID-19 pandemic, extreme fires in Mediterranean islands or volcanic eruptions in the Canary Islands, have showcased the high social, economic and environmental vulnerabilities facing these regions. The ongoing global environmental change has revealed the fragility of all social-ecological assets of these regions related to food security, education, diversity, health and digital infrastructure (Veron et al. 2019). Conversely, the contribution of the island territories to the GDP of the countries they are part of, is important through the provision of ecosystem services, such as recreation and tourism, renewable energy, fisheries, agriculture and raw materials and, as such, an island is a resource in itself for a mainland state and, thus, needs to be safeguarded.

The now commonly accepted framework of ES assessment in Europe, Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin-Young 2018), may underpin economic, social and biophysical valuation of the Ecosystem Services provided by **Small and Medium IsLands** (SMILES). However, if a case is to be made for those islands, the drivers which affect ES supply should be addressed, since their demise might be closer than their assessment. Two of the most important drivers are land-use and climate change. On one hand, islands are faced with new demands for new uses of their land or sea areas (e.g. from energy or tourism) and, on the other hand, with abandonment which often leads to a polarisation effect in land uses i.e. tourism/urbanisation vs. rewilding (Tzanopoulos and Vogiatzakis 2011, García-Nieto et al. 2018). At the same time, climate change impacts on islands will be disproportionate to their size and their “contribution” to CO₂ emissions, as has been documented in various global scale assessments (Millennium Ecosystem Assessment 2005, Pörtner 2019). Extreme weather events, such as Medicanes (Mediterranean tropical-like cyclones), flooding and the increase in wildfires which have been intensified the past five years, will undoubtedly affect islanders and the use of resources, calling for an increased effort to increase island community resilience, given that infrastructures to enhance this resilience are usually less developed in island spaces. Already the documented shift in populations due to rural push and urban pull factors, results in island abandonment since traditional jobs, such as those linked with agriculture, are eschewed and, in turn, loss of associated cultural practices, a key to the maintenance of many species and habitats of conservation importance. Thus, there is a documented need towards a better-balanced national and regional development, which recognises the value of insular geographical areas and strengthens their economic, social and territorial cohesion (ESPON BRIDGES 2019).

This paper introduces a new European Cooperation in Science and Technology (COST). Action: ‘Enhancing Small-Medium IsLands resilience by securing the sustainability of Ecosystem Services (SMILES)’ which brings together researchers, policy-makers and other stakeholders to address the threats to the European islands’ ecosystem services.

2. The regulatory framework underlying island sustainability in Europe

Worldwide islands have evolved at the interface between land and sea. The size of the island determines the importance/dominance of the seascape over the landscape or vice versa. When the terrestrial component of an island is not sufficient to support human communities, recourse to coastal and/or sea resources becomes of paramount importance. The sea has a dual role as a conduit, but also as an obstacle in colonisation, settling, movement, communication and exchange to and from the wider world. However, islands are often examined in isolation from the sea which surrounds them (Vogiatzakis et al. 2017). This is also reflected in various key policies which usually adopt a sectorial approach treating separately the two main island realms (terrestrial vs. marine).

Following the establishment of the EU, the place of islands has changed from being “just” a part of individual nations to strategic fringes of the EU territory. The Treaty of Amsterdam (EU 1997) introduced a number of provisions to account for island specificities and constraints. Policies related to islands originate from mainlands. Therefore, the “continentality” of Europe’s policies results in political and financial neglect for islands. At the same time, an emerging issue in the last decade is the role of islands, particularly in the Mediterranean, as stepping-stones for immigration from Africa and Asia into Europe. Policies of the majority of economic and environment sectors are now dictated by EU directives and regulations incorporated in national policies. There are a number of EU policies affecting island development including the Cohesion Policy, the CAP, Common Fisheries Policy, the Integrated Maritime Policy and the Marine Strategy Framework Directive (MSFD). In addition, the EU support policies targeting Small Island Developing States (SIDS), as well as its Overseas Territories (OCT-EU). By far though, the most ambitious of these policies are the Green Deal and the EU Biodiversity Strategy for 2030 which set up concrete goals and binding targets for conservation at land and sea.

3. Scientific research needs to address challenges to biodiversity

SMILES will address gaps in knowledge sharing and promote concerted efforts on small-medium island protection and development. It will provide a platform for knowledge transfer and collaboration amongst scientists, practitioners and citizens living or working on islands across Europe and help to disentangle the conundrum faced by management of island biodiversity and ecosystem services. This will be achieved by four main actions:

Establishment of a concrete interdisciplinary network amongst scientists across Europe and beyond and providing a forum for an open collaborative dialogue with researchers and practitioners on island spaces

Given the importance of small-medium islands and their vulnerability to externalities, there are currently many different aspects, published in outlets/conferences of several distinct disciplines. Efforts are fragmented and sectoral, while a common platform for sharing and integrating experiences is lacking. Moreover, there have been few arenas where scientists and practitioners across Europe have had opportunities to meet and interact and these rarely include a specific focus on peripheral areas or island environments. The amount and diversity of previous work is an opportunity: by creating a network of academics and practitioners working with islands across Europe, sharing of knowledge will become more effective, allowing novel methods and good practices to be more widely applicable. Within SMILES, we will follow a participatory process that will allow for an open dialogue amongst different scientific disciplines and the communities of practice that work on island spaces. The backbone of this network will be the creation of an ontological base, following the structural and methodological principles of the Linked Open Data framework that will allow different disciplines to share a common island vocabulary.

An open knowledge exchange, dialogue and capacity-building platform in Europe and beyond, directed at social awareness of the importance of small-medium islands

An open knowledge exchange, dialogue and capacity building within and between a number of stakeholder groups and amongst geographic areas across geographic regions, will allow for the representation of varying drivers of change, governance and socio-economic contexts and ecological processes. SMILES will develop multi-level approaches to assess and predict the impacts of cumulative and interactive global and local stressors, such as climate and land-use change, on island ecosystem services in the EU and Near Neighbour Countries (NNC) within diverse bio-regions. It will also share experiences and practices about risk assessments and local adaptation responses.

Evaluation and assessment of the efficiency of the developed methodologies for assessing and mapping ES indicators and drivers of change in supply, flow or demand, emphasising on required adaptations for island realities

Networking developed by SMILES will also result in rapid scientific progress and more effective management, as island decision-makers are exposed to new methods and ideas. SMILES will review the state of small-medium islands ES and related drivers of change as reported in the scientific literature and through targeted case studies. This will provide understanding of variation in pressures on small-medium islands across geographic regions and how their state is affected by the variation and diversity of global pressures (including land-use and climate changes). In addition, the role of those islands in national, but also EU policy and legislation will be analysed, which may underpin effective management and conservation. The overall aim will be to build up on existing methodologies to assess and map ES, adapting them to the specificities and needs of small and medium island spaces, thus developing a new island-specific framework (i.e. methods, guidelines, tools) for ES assessment and mapping.

Co-design of alternative futures for island development based on nature based solutions (NbS), which can be designed and tested by the network

Nature-based Solutions (NbS) – a paradigm shift: Planetary change and global crises (e.g. climate change, the Covid-19 pandemic) have severely affected island economies and human well-being (tourism, the cost of imported products, transportation etc.) worldwide, but recent UNWTO reports suggest a recovery or improvement of fragile island ecosystems (previously degraded by tourism). These recent crises, indicated once again the need for transformative change towards sustainable development in island regions. By using evidence-based implementation of NbS as an umbrella concept for different ecosystem and nature options to mitigate and adapt to change (Ecosystem-based Adaptation and Mitigation, ES, Ecological Engineering, Green and Blue

Infrastructure, Ecological/Landscape Restoration), SMILES will facilitate the transition to sustainable future and enhanced benefits to human well-being. Focus on pathways and solutions for sustainable futures, based on NbS across different contexts, is supported by scenarios, state-of-the-art methods and guided by the framing of Nature Futures Framework by IPBES (Pascual et al. 2023).

4. SMILES COST action - an initiative to meet the challenges of European islands' sustainability

SMILES seeks to address three main challenges in European's islands sustainability

Integrated assessments of island-related ecosystem services remain scarce

Although ES assessments have been carried out worldwide in different geographical areas, islands are still under-represented (Aretano et al. 2013). Even if the existing methods can adequately predict climate-induced ecological changes to the ecology of the larger islands, this is not the case for the majority of small and medium-size islands where refinement and standardisation of the existing techniques and datasets are necessary (Vogiatzakis et al. 2016). Despite the recognised island importance and vulnerability, research on the ES identification and supply in islands remains limited. To date, scientific research has mainly focused on ecological pressures island ecosystems are facing (e.g. Médail (2017)) or their ecological and social vulnerability (e.g. Veron et al. (2019)), but concrete and documented information on the benefits supplied, flowing or demanded by islands, as well as their spatial and temporal variability, is still very scarce (Balzan et al. 2018). Integrated approaches that consider the wide range of island-related terrestrial, freshwater, coastal and marine ecosystem services remain scarce (Vogiatzakis et al. 2020a).

Local specificities and needs are ignored in policy objectives

Another challenge faced by islands is that their natural resources are managed largely based on policy objectives that are designed nationally, regionally or even globally, often ignoring local specificities and needs. European islands need to also report on policy objectives related to European Directives, such as the Water Framework Directive, the Marine Strategy Framework Directive or the Habitats and Birds Directives. At the same time, they need to address global Sustainable Development Goals (SDGs or most importantly, local priorities, which in most cases, are vital for the well-being of island systems. Achieving all of those simultaneously is challenging, as it requires that conceptual and methodological approaches guiding, for example, Mapping and Assessment of Ecosystem Services (MAES) in Europe, are adapted locally to include local specificities of nature and culture arising from peoples' interactions with island spaces. Recent examples from Mediterranean islands (Vogiatzakis et al. 2020b) point to

a series of obstacles in carrying out island-based assessments conceptually and methodologically (in terms of data, mapping and stakeholder engagement).

Development or sustainability dilemma - the need of Nature-based Solutions

The new EU Green Deal sets priorities for achieving transformative change in societies and nature, towards a more sustainable future. Providing tools, but also supporting policies which address resilience in islands, is paramount to decision-making and requires a sound evidence base on the state of natural resources, as well as the ability to predict future changes to these resources. Nature-based Solutions (NbS) can address societal challenges sustainably, whilst providing multiple benefits. However, **their uptake in policy and planning in island environments remains limited** (Grace et al. 2021), whilst the perspectives of stakeholders are often lacking from current research on nature-based solutions (Hanson et al. 2020). Recent work has identified greater clarity about the scope of the NbS concept and the development of knowledge about their effectiveness. The costs and benefits associated with NbS implementation are key priorities to improve their uptake in islands (Grace et al. 2021).

5. Progress beyond the state-of-the-art and innovation potential of SMILES

Methodological approach

To address the challenges described, SMILES Action follows a **two-point intervention**:

1. a **multidisciplinary perspective in understanding** drivers of change, assessing impacts and designing ways of mitigation, adaptation and management options, through the prism of socioecological systems and ecosystem services.
2. a **research-policy interface** to better assess the strengths and weaknesses/vulnerabilities of islands under global change, so as to reassess the vision for islands' future development. This will be achieved through the creation of a network, willing to share knowledge and experience across researchers, decision-makers, civil society organisations and citizens, who will work towards a better understanding of the drivers of change in islands, setting priorities for a more resilient/sustainable future.

The Action revolves around five main themes (Fig. 2) that cover major gaps in European small-medium islands sustainability and ecosystem services assessment. While each of the themes has a specific focus, they will be conducted in parallel, with coordination and collaboration. By capitalising on existing knowledge, adapt and evolve conservation planning tools implemented in other regions of the world and develop new methodological and computational tools, databases and background information to

support the decision-making process. The overall approach will be based on the well-established DPSIR conceptual framework which has been applied with success in (similar) socio-ecological systems (Balzan et al. 2018).

SMILES themes and expected outcomes

Theme 1: Small-medium island ecosystems: natural capital assessment: This theme will evaluate the relationship between biodiversity and natural capital on small-medium islands. This will be achieved by:

- building a database on presence, abundance and distribution of insular biodiversity in Europe (habitats and taxonomic groups);
- building a database with direct and indirect current and future threats for island biodiversity; and
- performing an assessment of natural assets on islands.

Theme 2: Ecosystem Services of Small-medium islands: This theme will work towards an overview of the status of and trends in European island ecosystem services, accounting for all three environments (terrestrial, freshwater, marine) by:

- compiling existing data on the biophysical and socio-economic value of ecosystem services;
- identifying the key drivers of change for services;
- exploring future threats and opportunities to service supply and
- developing sustainable strategies to protect and enhance ecosystem services linked to human well-being.

Theme 3: Effects of Land-use and climate changes (LU/CC) on ES.

Land-use and climate change are the main drivers respectively on island environments. In close collaboration with other themes, this theme will assess projected global change impacts on European islands. Its objectives are to:

1. perform an integrated LU/CC assessment on European islands and
2. evaluate the relationship between LU and CC interaction and ES provision in European islands.

These activities will benefit from (and feed into) the LUCAS CORDEX FPS (https://www.hzg.de/ms/cordex_fps_lucas/index.php.en).

Theme 4: Nature-based solutions (NbS) for safeguarding ES of small-medium islands. The challenge of pursuing economic development, whilst providing co-benefits to biodiversity and people is particularly felt in islands, which depend on external markets and tourism and are susceptible to natural disasters and climate change, whilst having a constrained adaptation capacity. NbS can be used to tackle key societal challenges, whilst avoiding or mitigating the negative impacts of local and global stressors that threaten ES of small-medium islands.

Theme 5: Policy and Governance of Small Islands for ES provision: This theme will identify key aspects of major policy instruments (at EU and national levels) that reflect island sensitivity and contribute to building future island resilience. Based on this evaluation, it will provide recommendations on policy instruments improvement with special emphasis on the interaction of policies across and within different administrative levels and sectors (multi-governance approach).

6. Concluding remarks

The future of the European islands is intertwined with the continued provision of ecosystem services. This is challenged by the lack of integrated assessments of island-related ecosystem services, the neglect of local specificities and needs at the EU/national policy level and the pseudo-dilemma regarding development or sustainability. Sea, land, coast and their interactions all contribute to an island's character and its resource base. The increasing pressures/threats on island territory and character, in the light of climate and land-use changes, cannot be effectively managed with the current regulatory sectoral policy framework and ad hoc reactive approach. Since nature and culture are intertwined on islands, understanding of ecosystem functionality and resilience across various temporal and spatial scales requires understanding of the complex social-ecological systems developed over millennia and taking relevant actions in tandem with policy needs.

If we are to have a real impact on the future of the European islands, a holistic and truly interdisciplinary approach is necessary to address the gaps in island research. While this will capitalise on previous work, new combinations of ongoing studies will catalyse new understanding. SMILES aims to fill this niche in island research and contribute towards the EU sustainability goals towards 2030.

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Conflicts of interest

The authors have declared that no competing interests exist.

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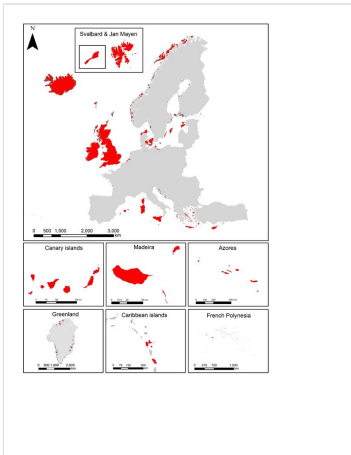


Figure 1.
European Islands including main Overseas Territories.

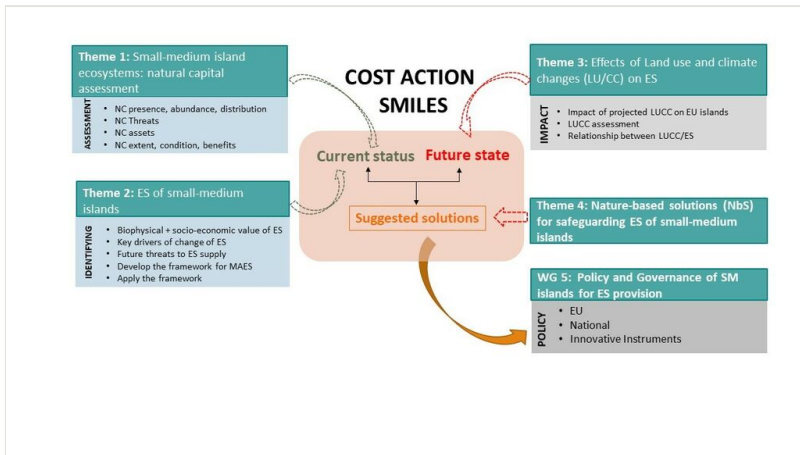


Figure 2.
Schematic representation of the five main themes of SMILES.