Island Studies Journal, Vol. 12, No. 1, 115-134

The role of science in sustainability transitions: citizen science, transformative research, and experiences from Samothraki island, Greece

Panos Petridis
Institute of Social Ecology (SEC), Alpen-Adria University
Vienna, Austria
panos.petridis@aau.at

Marina Fischer-Kowalski
Institute of Social Ecology (SEC), Alpen-Adria University
Vienna, Austria
marina.fischer-kowalski@aau.at

Simron J. Singh
Faculty of Environment, University of Waterloo
Waterloo, Canada
simron.singh@uwaterloo.ca

and

Dominik Noll
Institute of Social Ecology (SEC), Alpen-Adria University
Vienna, Austria
dominik.noll@aau.at

ABSTRACT: We highlight the importance of island research that aims to achieve sustainability transitions. All too often, developmental priorities are largely defined by economic policy imperatives, and island research either ignores or masks such normative connotations. This article reports on ten years of transdisciplinary socioecological research on the Greek island of Samothraki. We sequentially: (i) introduce socioecological thinking and the conceptual framework of social ecology, and show how this is operationalised and applied on this case study, and (ii) highlight the importance of a transdisciplinary research approach, in promoting island sustainability. We conclude with a plea for more transformative research and citizen research in the direction of sustainability within island studies.

Keywords: citizen science, islands, Samothraki, socioecological systems, sustainability transitions, transformative research

https://doi.org/10.24043/isj.8

1. Introduction

Islands, vulnerability, and potentiality

It is often argued that most populated small islands share some key features that have been broadly categorised as issues of scale and issues of isolation/remoteness (Clark, 2009; Kerr, 2005). Under modern conditions, islands often depend heavily on imports, and face size constraints in the development of resilient water, sanitation, energy, and waste management systems (Deschenes & Chertow, 2004), which may be brought to a 'tipping point' by economic, ecological, or cultural drivers (Petridis & Fischer-Kowalski, 2016). Many of these qualities are shared with other remote places like mountain regions and sparsely populated areas (Armstrong et al., 2012). Yet, despite the many differences in size, population, and local culture, there is also a general understanding within island studies that islands, on top of their physical 'insularity', share a common feature and a particular complex *experiential identity* that has been termed 'islandness' (e.g., Baldacchino, 2004, 2006; Conkling, 2007; Stratford, 2008).

There are different ways in which insularity and islandness are perceived and described. Much of the recent island scholarship is less fixated upon physical borders and conceptualises islands as simultaneously open and closed systems, insular and at the same time embedded within complex multi-relational systems, highlighting interactions rather than boundaries (Hayward, 2012; Pugh, 2013a, 2016; Stratford et al., 2011). Still, the long-established 'fault line' of whether islands are characterised by vulnerability or resilience remains relevant and contested, and is still largely present within island studies but also dominant discourse (Hay, 2006, 2013).

Within development studies in particular, *vulnerability* is often highlighted more than resilience, and insularity is usually depicted in negative terms, a fact that is evident from the terms used: *vulnerability, handicap, disadvantage, suffer, fragile* (e.g., Adrianto & Matsuda, 2004; Briguglio, 1995; McGillivray et al., 2010). The mainstream view is that due to inefficient industrial and agricultural economic output, islands have a limited ability to achieve a high multiplier effect and achieve economies of scale (Archer, 1989), and island economies usually experience diseconomies of scale in production, consumption, and investment (Kakazu, 1994). While this may be true, the perception of vulnerability is *also* a product of access to economic, political, social, environmental, and geographical assets, and is thus co-determined by "the human and physical forces that shape the allocation of these assets in society" (Pelling & Uitto, 2001, p. 51).

The notion of Small Island Developing States (SIDS) is also largely based around a view that small islands have vulnerabilities that are innate and 'natural', and not dependent on the dominant world economic and socio-political context (Campling, 2006).[1] This discourse has been reproduced by the various indexes, such as the Economic Vulnerability Indicators (Briguglio & Kisanga, 2004; Briguglio et al., 2006), that carry similar normative connotations of islands as mostly backward, less developed, and less competitive. This is not surprising since these indicators assess economic performance using conventional economic metrics, but largely ignore issues such as political stability, democracy, social wellbeing, and environmental sustainability. The current

[1] In the context of a globalising industrial world, islands 'naturally' belong to the—generally disadvantaged—periphery. In contrast, in an agrarian world, insularity could be of great advantage, with the sea protecting against enemies and competitors, and providing a medium for facilitating trade. While land-based transport of bulk commodities was very difficult and costly, the use of the resources of other territories from an island base by ships was comparatively convenient. Islands played a very important role in determining early trade routes and trading posts and were sought after by colonial powers. In several regions of the world, these advantages still count.

focus on economic vulnerabilities emerged, among others, from viewing small islands with a neo-liberal lens (Campling, 2006). Unsurprisingly, the prescribed solutions revolve around finding a specialised niche in the global economy with some sort of competitive advantage (Grote, 2010). This view reinforces a perceived need of external dependence and restricts alternative developmental pathways (Connell, 2007; Scheyvens & Momsen, 2008).

There has been some criticism on the economic vulnerability concept, for carrying an element of fatalism (Armstrong & Read, 2002, 2003), but even when vulnerability is substituted by resilience or "strategic flexibility" (Baldacchino & Bertram, 2009; Bertram & Poirine, 2007) this does not sufficiently challenge the view that islands must follow a certain developmental trajectory (Barnett & Waters, 2016). Clark (2013) raises many important points in his critique to conventional views of island development dominated by 'ideal type' acronym models that position islands in the economic development ladder, and propose ways to 'grow up' the ladder by smart investments and policy options, emphasising flexibility, investment, and competition. Power structures remain out of view, and so do environmental effects.

> Sustainability is mentioned many times in the acronym model literature, but consistently with reference to sustaining the patterns of development identified in the models, thereby contributing more to *sustainababble* than to sustainability science. Sustainability is reduced to "sustainable material standard of living", "sustainable equilibrium states" and the question of how to "sustain imports". […] The silence on sustainability issues in the wider sense of social-ecological systems—including habitat destruction—is deafening (Clark, 2013, p. 132).

This narrow conceptualisation of 'development' also dominates other fields, such as tourism. Sustainability in island tourism is often equalled with *rejuvenating* tourism. Sustainable island tourism then becomes a synonym of sustaining a rebranded tourist product, in a process where improving competitiveness becomes an end in itself (Bianchi, 2004; Dodds, 2007). Since economic competitiveness implies winners and losers and, using conventional metrics, most islands tend to be disadvantaged, less competitive and economically vulnerable, they appear to be among the 'losers', to be helped out of this sad fate by ('sustainable') development. But: why define places by their economic vulnerability (or resilience), rather than any other non-economic quality? Instead of climbing up the development ladder but never quite getting up there, why not follow an alternative vision of development? Could it be that precisely islands offer an opportunity to reset the term sustainable development?

Towards emancipatory island studies

Drawing from the literature on the 'right to the city', Clark (2013) calls for the 'right to the island'. Against the imposed imperatives of being flexible, productive, efficient, and competitive, he proposes to make space for democratically choosing a preferred future, in a process of a common construction of place that does not involve the financialisation and commodification of nature. This view, despite offering a radically different perspective on island development, is equally normative like its economistic counterpart, "but with very different implications for researching, understanding, and contributing to island development" (Clark, 2013, p. 134). The problem with vulnerability indicators and other 'conventional' approaches is not their normative nature *per se*, but that this is made to appear as the only natural way to go. As long as the prerogative of economic growth is not questioned, the variety of possible futures to choose from remains invisible (Petridis

et al., 2015). Emancipatory island studies, in contrast, seek to reveal various possible and realistic alternative pathways to scrutiny, economic growth notwithstanding, contextualising sustainability and calling for people to make democratic choices.

Stratford (2008) suggests that it may be exactly the condition of islandness that can be used to strive for an identity in different terms, escaping "inappropriate" economic development.

> I do suggest that islandness may be described as an affect of particular land- and water-scapes, valued for their special qualities and deemed worthy of protection as such. […] The thesis I seek to advance is that, among those who govern, an appreciation of the ontological power of islandness could aid the protection of island places from inappropriate economic development. The term 'inappropriate' may be variously defined; what matters here is that the suitability of development is often not decided by islanders, or may be determined by a handful of resident elites in ways that hide, ignore or fail to notice the importance of islandness for others (Stratford, 2008, p. 161).

What does this mean for island sustainability research? We do not propose replacing top-down 'inappropriate development' imperatives with a version of romanticised localism. Instead, we stress the need to combine a reasonable understanding of the biophysical attributes and institutional specificities of insularity, as well as the emotional geography and insular identity (Depraetere, 2008) in a process of collectively designing an alternative vision of development (Benedicto, 2014).

Can scientific research facilitate the sustainability transition of an island? Schneidewind et al. (2016, p. 6) define transformative science as "a specific type of science that does not only observe and describe societal transformation processes, but rather initiates and catalyses them. Transformative science aims to improve our understanding of transformation processes and to simultaneously increase societal capacity to reflect on them." Transformative island research can be conceptualised as emancipatory in the sense that it seeks to creatively liberate actors' minds from resignation that there is only one path to follow. And it is transformative in the sense that, by careful systemic analysis, it explores, together with the people involved, the realistic option space as well as the constraints of more sustainable alternatives.

In the rest of the paper we introduce a socioecological systems research approach on island sustainability that builds upon a comprehensive analytical framework, but also offers a way to conceptualise potential interventions in the direction of sustainability. This perspective thus echoes earlier calls for emancipatory island narratives (Hauʻofa, 1994) and is in accordance with the 'relational turn' within island studies in the sense that, moving beyond categorising islands as vulnerable or resilient, it emphasises island potentiality as much as vulnerability and opens up new political, socio-economic, and ecological possibilities (Pugh, 2016; Stratford et al., 2011).

Yet, as the following sections will elaborate, our model diverges from 'archipelagic' studies. Analytically, it operates on the basis of a sociometabolic model that relies on a clear system definition. In this, we are in line with Deschenes and Chertow (2004), focusing on the 'island context' and using the island as our unit of analysis. We define social systems on all scales as a coupling of a communication system (i.e., cultural, political, and economic) with certain biophysical stocks (a population, a territory, built infrastructure, livestock). Such a social system needs to reproduce its stocks both culturally and biophysically. To do so, it draws on means and resources both from within (its own territory, or the competencies of its population, for example), and from outside, it imports and exports (Fischer-Kowalski & Erb, 2016). What is special about islands in this respect is that imports and exports can be more easily interrupted and/or delayed,

even under modern conditions, and are typically more costly. This might reflect itself in a higher degree of self-sufficiency (Horden & Purcell, 2000), or local cultural identity.

2. Transdisciplinary socioecological research on Samothraki

Towards sustainability transformation of an island

This section introduces the ongoing (transformative) research on the Greek island of Samothraki. What started as a response to environmental degradation by concerned citizens, some ten years ago, has developed into an ambitious and evolving research program, informing and informed by an alternative vision of local island development from the bottom up, and has led to the imminent designation of the whole island as a UNESCO Biosphere Reserve. The road to designation so far has been a truly transdisciplinary and open-ended process, in which ownership has gradually shifted from scientists to local actors (Fischer-Kowalski et al., 2011; Petridis, 2016), creating a research agenda along the way. (Information on the UNESCO bid, together with all past and ongoing research activities can be found at the project website: http://sustainable-samothraki.net/.) From a policy perspective, scientific presence from an early stage on has generated a unique opportunity to pre-structure, observe, and reflect on a process of evolving decision-making and management towards a sustainability transformation of an island.

Figure 1: The location of Samothraki in the NE Aegean Sea, Greece.

Source: NASA, nasaimages.org.

Samothraki is a mountainous island of the NE Aegean, Greece (Figure 1), with an area of 178 km^2 and 2,859 permanent residents that are mostly occupied with agriculture (mainly livestock keeping) and seasonal tourism services. Samothraki attracts about 40,000 visitors per year, in a relatively short season (Fischer-Kowalski et al., 2011); with 0.5 tourist beds per inhabitant, it ranks in the lower range of Greek islands (Spilanis & Vayanni, 2004). It has numerous freshwater streams and outstanding natural beauty (Natura 2000, for the most part), as well as significant cultural heritage, and is at the crossroads of development pathways. However, insistent ecological challenges, such as overgrazing, as well as impacts of the recent Greek socioeconomic and governance crisis, have jeopardized the viability of local services, so that crucial demographic

tipping points may be reached. Acknowledging those risks, since about 2007 a group of scientists started deliberating with local residents about the present and future state of the island. The point of departure was a general wish to preserve the character of the island from potentially destructive pathways and conventional tourism development as observed in other Greek islands and come up with an alternative development model. This led to the preparation of a feasibility study on whether a vision for a sustainable Samothraki could be achieved via its inclusion in UNESCO's World Network of Biosphere Reserves. The Biosphere Reserve concept—based on the pillars of nature protection, supporting local communities and fostering research, training, and education—seemed a suitable vision to pursue (UNESCO, 1996).

The feasibility study assessed whether there are natural and cultural endowments worth preserving, and also rigorously monitored, and—most importantly—whether this vision is shared by the island's inhabitants and local authorities. A double positive answer paved the way to intensify our efforts. Therefore, after several years of research and open dialogue, an abstract hypothesis in the minds of regular visiting scientists was scrutinised by the local community and gradually shared with a wider group of inhabitants and the local authorities. The community council has endorsed an application to UNESCO and committed itself to pursuing an operational plan in the direction of sustainability (Greek National MAB Committee, 2013). While the institutional obstacles and incremental steps toward full designation deserve another full article, here we will focus on the local development process, and the role of scientists in analysing, but also promoting, a sustainability transition.

Our results suggest that both the local administration and most of the inhabitants have a strong 'place identity' and, although there is a desire to develop, there is a wish to do so respecting Samothraki's cultural and natural assets. This trend is even more pronounced among the island's visitors, an overwhelming majority of whom support a conservationist scenario for the future of Samothraki (Fischer-Kowalski et al., 2011). Islandness is not always positively connoted by the local inhabitants, but is nevertheless a quality appreciated and recognised as a comparative advantage to be utilised, especially in areas of tourism and quality food provision (Petridis & Huber, 2017; Petridis et al., 2013; Rau et al., 2014).

The following steps, in our part as scientists, involved outlining a socioecological research agenda (see next section) and proposing areas of interventions for a sustainability transition, namely the economy, natural resource management, and social infrastructure. A focus on the practical implementation of local projects was supported by several PhDs and Master's theses, and complemented by on-site summer schools in social ecology (2012, 2014, 2016, planned for 2017), in collaboration with several universities, research institutions, local and national authorities, NGOs, as well as key UNESCO branches (for details, visit: http://sustainable-samothraki.net/). These summer schools typically include extensive rounds of explorative and visioning focus group interviews with different local stakeholder groups, where results are fed back to the community, and are planned in such a way as to achieve maximum synergistic effects between research and policy goals (Petridis et al., 2013; Sustainable Mediterranean, 2017).

The following sections will briefly introduce socioecological research, and show an application to the island of Samothraki.

A socioecological research approach

Socioecological research has emerged as a paradigm to enhance interdisciplinary communication within sustainability science (Fischer-Kowalski & Weisz, 2016). In assessing the development trajectory of a socioecological system and exploring transition pathways towards a more

sustainable future, one needs to account for biophysical flows, but also understand the social structures that support these flows. The concept of social metabolism (Haberl et al., 2004) provides a framework for this. Its inherent strength lies in incorporating both the natural and social systems and focusing on the interaction between them, in particular on the social activities which have a direct material impact on the ecosystem. The sociometabolic approach takes society as the unit of analysis, interpreted as a socioeconomic system that interacts with systems in the natural environment. Society is conceptualised as a hybrid between a natural (biophysical) and a cultural (symbolic) sphere of causation (Fischer-Kowalski & Weisz, 1999), each obeying a different logic. At the intersection of the two we find the biophysical structures of society: that is the human population, its livestock and durable infrastructure.

The social metabolism approach is inherently coevolutionary (Sieferle, 2011). Coevolution suggests that if technologies, values, institutions, and knowledge change, "in the process they transform environments, both materially and cognitively, but in turn are transformed by the environments they produce" (Norgaard & Kallis, 2011, p. 293). It is a coupled development in which human practices both modify the biophysical environment, and are being shaped by it; humans transform their natural environments and then adapt to the transformations (Godelier, 1986; Norgaard, 1994). Moreover, concerned primarily with questions of socioecological sustainability, the emerging interdisciplinary field of Long Term Socio-Ecological Research (LTSER) aims to observe, analyse, understand, and model changes in coupled socioecological (or human-environment) systems over long periods of time (Haberl et al., 2006; Singh et al., 2013).

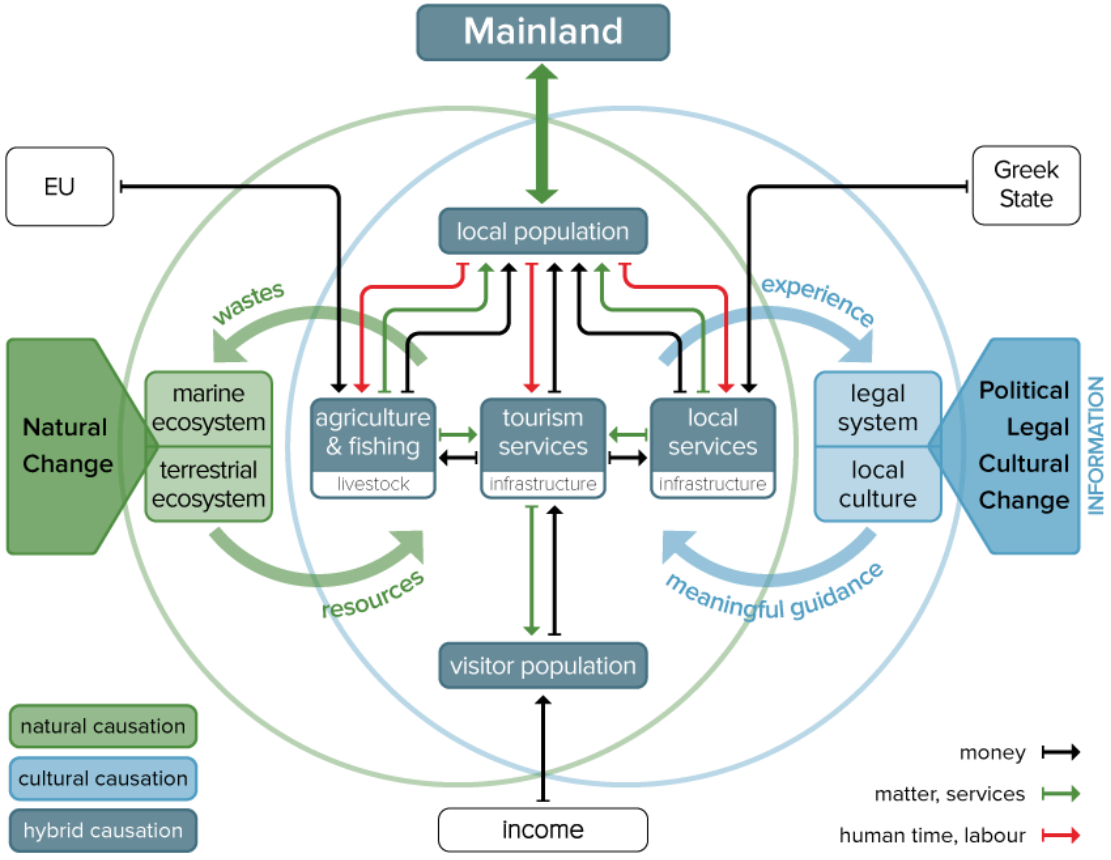
From an analytical perspective, the fact that islands have clear geographical boundaries that often coincide with administrative boundaries facilitates the integration of natural and social science approaches. This makes islands excellent focal points for studies that systematically analyse the interactions between human activities and the environment, in an attempt to move toward systems and practices that are sustainable in the long-term (e.g., Erickson & Gowdy, 2000; Lutz, 1994; Nguyen et al., 2011; Tsai & Clark, 2003). The field of industrial ecology, for example, explicitly models flows of materials and energy at the island system level, using the analytical results to offer recommendations for sustainable resource use (e.g., Conrad & Cassar, 2014; Eckelman et al., 2014; Krausmann et al., 2014; Sundkvist et al., 1999). More specifically, efforts have also been made to apply sociometabolic approaches in an island context in order to explore the dynamics of socioecological transition at a local (island) level and the consequences this may have for sustainability (Singh et al., 2001; Singh & Grünbühel, 2003). Wildenberg and Singh (2012) presented a multi-level model of the socioecological system of Kamorta island, in the Nicobar Archipelago, in order to better understand the complex impacts of the 2005 Tsunami, as well as post-tsunami development efforts. Chertow et al. (2013) provided cross-cutting reflections on human-nature interactions based on the examination of four islands: Singapore, Puerto Rico, Hawai'i, and O'ahu. They showed that the islands' socioeconomic borders are not fixed, but rather change with perceptions, economic relations, and political decisions, and moved on to conceptualise the difference between tightly and loosely coupled socioecological systems.

A socioecological research agenda on Samothraki

Samothraki still is in the process of a socioecological transition from a traditional agrarian society to a modern, industrial society and tourism destination. This presents new opportunities for the community, but also contains many risks: ecologically, culturally, and demographically. We are interested in how Samothraki can deal with these risks, sustain its local population, also economically, and maintain its natural and cultural heritage.

Figure 2 provides a comprehensive model of interaction between cultural and natural spheres of causation that serves as a guiding paradigm for understanding the self-reproduction of the socioecological system of Samothraki. On a fundamental level, the system and its various compartments can reproduce themselves only as long as the flows required for maintaining these can be naturally sustained and/or socially organised. The centre is occupied by the core (hybrid) compartments that are both naturally and culturally governed: the local and visitor population, the built infrastructures, and the livestock. These together make up society's stocks. The local population invests labour in the economic sectors and receives income and services in return. The visitor population brings money from outside and receives services in return. All economic sectors draw on certain resources from the marine and/or terrestrial environment and generate wastes in return. The behaviour of all actors is guided by the island's legal and cultural system, and this system, in turn, may incorporate new experiences.

<u>Figure 2:</u> A model of the socioecological system of Samothraki.



Source: Adapted from Petridis & Fischer-Kowalski (2016).

The socioecological system of the island strongly depends on the outside world. There is a shipping lifeline with the mainland that provides transportation for people, goods, and services. Terrestrial and marine ecosystems, as well as most hybrid structures, are influenced by external natural changes (such as depletion of fish stocks and climate change), and the island's legal and

cultural system is affected by external political, legal, cultural (e.g., religious), and economic changes in the outside world. Additionally, there are currently three regular major income flows originating from outside: the money visitors bring with them, European Union (EU) subsidies for the agricultural sector, and regional development and (net) payments made by the Greek state for local services, such as communal administration, schools, medical services, social security payments, energy services, public transport, and public infrastructure (Petridis & Fischer-Kowalski, 2016).

The ability of Samothraki's socioecological system to reproduce itself depends on whether flows required for maintaining the stocks can be organised. When critical stocks cannot be reproduced, the system might 'collapse'. To strive towards sustainability, in this context, means to develop and maintain a social metabolism that serves the needs of the people without destroying the ecological balances of the natural environment, while being resilient to changing contexts. This means to not increase socio-economic stocks excessively, to use natural resources carefully and efficiently, to evolve towards a circular economy (Ellen MacArthur Foundation, 2013; Hislop & Hill, 2011), to create effective synergies between the sectors of the economy (such as agriculture and tourism), and to develop a culture of social responsibility, collaboration, and fairness.

Our research approach therefore takes the following directions:

- Identify the key conditions of self-reproduction of the socioecological system of the island of Samothraki. This involves ecological issues of vegetation cover, forest regeneration, soil erosion, freshwater extraction, waste and sewage management, biodiversity loss, and animal health. Equally, it deals with relevant actors, their interests, cultures, world-views, and their action potential, as well as the main drivers of transformation (through statistical analysis, tourist surveys, focus group interviews, sociometabolic measurements, and participant observation).
- Integrate findings to a systems perspective. Reconstruct the system's compartments and dynamics and their interrelations.
- Make recommendations on how to avoid critical tipping points of certain subsystems and find viable pathways to a more sustainable functioning.

In a longer perspective, we aim to deliver data for a future LTSER platform on Samothraki (Gingrich et al., 2016). This will address the social metabolism and land use in historical times and its development over the centuries in a close collaboration between archaeologists, social ecologists, and land use scientists. Currently, we are about to outline a medium-term research plan and bring together the potentially interested parties.

Citizen science

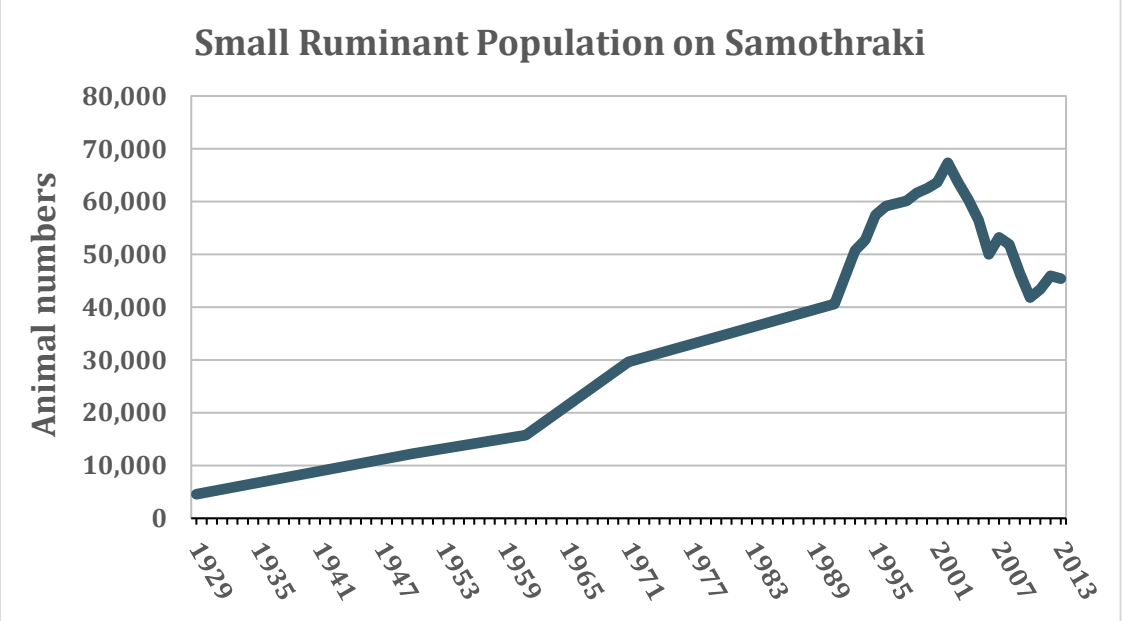
By its very nature, our research involvement has been conceived and designed by transdisciplinary principles (Lang et al., 2012), as we aim at giving scientific support to ongoing local initiatives, as well as to an institutional process of establishing a UNESCO Biosphere Reserve. Such a future horizon for the island opens multiple opportunities for achieving real local sustainable development, and ensuring the establishment of longer-lasting local institutions that would promote and apply more sustainable solutions to local socioecological challenges. In order to substantiate collaboration between scientists and the local community, further involve local citizens, co-define research questions, understand the challenges ahead, find a shared vision, and learn to apply specific research methods, we have recently delved into the world of 'citizen science'. Citizen science strategies complement traditional educational approaches in multiple ways, and bring about improved outcomes by establishing a joint knowledge ownership with local stakeholders (e.g., Johnson et al., 2014; Kobori et al., 2016).

Our ambition goes further than translating scientific research insights into lay terms. We seek to achieve real local empowerment as well as joint goal development, vision, and process ownership with the local community. Citizen science involvement in socioecological research should improve the outcome of scientific research, but also empower citizens to find creative solutions. Practically, this means achieving a continuous collaboration of scientists and local stakeholders, including the municipal administration. The goal is active participation of all sides at each stage of the process, from problem definition and data generation to agenda setting and interpretation of results, using an array of citizen science methods, including crowd sourcing, distributive intelligence, participatory and collaborative science, and transformative learning (Bela et al., 2016; Sterling, 2011). This 'formalisation' of the iterative feedback process between the research team and the local community is designed to (i) inform the local community of research findings, (ii) provide a plausibility check for scientific interpretations, (iii) highlight conflicts of interest, (iv) build synergies with already defined municipal priorities, and, finally, (iv) provide guidance to future decision-makers. At a later stage, we should be in the position to be more reflexive and evaluate the conditions of success or failure in light of our experiences.

Case study: The livestock system

We will now present an illustration of a critical priority area, namely agriculture, currently dominated by livestock herding. Over the past decades, mainly due to the agricultural policies of the EU, there has been an exponential growth in the number of sheep and semi-wild goats on the island, currently estimated at around 50,000 individuals (Figure 3). Nevertheless, animals are underutilised, and the island imports more meat (and possibly more cheese) than it exports. Goat and sheep populations are overgrazing the land, and most of the grain locally grown is fed to the animals. As feed prices rise, farmers can afford less feed; this further increases grazing pressure. Overgrazing, coupled with the steepness of the terrain, has led to dramatic levels of soil erosion, also within the Natura 2000 area, thus posing a major threat to current conservation goals (Biel & Tan, 2014).

<u>Figure 3:</u> Small ruminant population on Samothraki (1929-2013). Grazing carrying capacity estimated at ~20,000 animals.



Source: ELSTAT (http://www.statistics.gr/); Fuchs, 2015.

Following our research approach, we have identified various 'tipping points' in the future sustainability of the livestock system:

- Nature conservation: Severe overgrazing, erosion
- Animal health: Cheap and too little feed used, animals are undernourished
- Farmers' income: Feed prices rising, feed provides about 70% of animal nutrition, net income declining.

Farmers' past response to the increasingly difficult situation had been increasing their flock to receive more EU Common Agricultural Policy (CAP) subsidies. As subsidy strategies changed, this brought diminishing returns on profits, which partly turned negative. According to our calculations, on average, reducing animal numbers per farmer by half would result in an increase in farmers' net income and a reduction of farmers' labour time, while allowing for better food and better animal health (Fuchs, 2015). Such change would have to be flanked by new practices allowing a better utilisation of livestock through marketing and innovations that would improve the value-chain of (organic) agricultural products (Petridis, 2012).

In response to the above findings, together with research partners as well as with motivated and inspired 'pioneer' local farmers, we have started implementing a series of practical 'citizen science' projects:

- *'Happy goats' app*: In collaboration with IT firm *Integrated ITDC*, the Aristotle University of Thessaloniki, and the Leibniz Centre for Agricultural Landscape Research, we have been involved in the development of a decision support tool for farmers to better plan their animal numbers and their costs. The goal is to provide income planning in terms of management advice for sustainable small ruminant (sheep and goats) farming. The app guides sheep and goat farmers to explore and reconstruct the functional and economic features of their own farms, effectively simulating different economic and production scenarios for future years, thus creating knowledge that local farmers currently often lack. To put it simply: the app shows that having fewer animals may cost less, be better for the land, reduce work and, most importantly, not affect profit.
- *Sown biodiverse pastures*: In order to increase plant productivity and grazing tolerance of overgrazed lands, *Terraprima*, a spin-off of Lisbon Technical University, has developed special seed mixes. *Sown Biodiverse Pastures (*SBPs) are permanent, as they are self-maintained for at least 10 years, and biodiverse, as up to 20 species or varieties are sown, many of which are legumes, a "natural factory" of nitrogen, minimising the need for synthetic fertilisers (Teixeira et al., 2015). A pilot project is currently under way on Samothraki, in collaboration with local farmers, in order to assess the effectiveness of SPBs. Locally, the most significant dissemination effort will be undertaken with 'farm labs', a cooperative approach to innovation that aims at inducing farmers to learn practical research skills which they can implement in their own farms. This is an old concept, reconfigured by the Soil Association (MacMillan & Benton, 2014) to promote field-based practical innovation through dissemination of knowledge gathered by practical experience.
- Further, yet-to-be-elaborated interventions, often proposed by local farmers, include better management of the local slaughtering house (including packaging, cooling, and marketing), exploring ways to utilise wool, improving the synergy

between local agriculture and tourism (Samothraki as a supplier of high-quality food), and identifying other ways to encourage cooperation among local farmers.

Figure 4: Semi-wilde goats on Samothraki.

Source: Sophia Bourdanou.

3. Concluding remarks

Tentative insights from transdisciplinary research on Samothraki

Transdisciplinary research can pose several challenges to both researchers and citizens, such as conflicting interests, power plays, and disappointment caused by uncertainty and often slow progress. Yet, if based on an honest communication base that conceptualises local communities as part of a self-organising and self-maintaining socioecological system, it can be enriching for all (Haas et al., 2013). What are lessons from Samothraki so far? No doubt perpetual and consistent communication between researchers and local actors has significantly informed both sides, has helped to identify key challenges, continues to set joint priorities, enhances citizen control, and safeguards the plausibility of specific proposals. Increased participation is not a panacea, and does not come without its limitations, e.g., when confronted with higher-level institutional decisions (see also: Pugh, 2013b; Umemoto, 2001). Still, following a participatory model, as well as a holistic view of sustainability, of which sustainable local livelihoods are an integral part, is essential for the success of such a process.

An interesting yet challenging insight from our research is the fact that we constantly have to integrate simultaneous processes at various scales that all have different time frames and different control factors. Scientific research is constrained by available funding and required

deliverables; in contrast, social processes usually take their time to unfold and depend on several sociopolitical factors and events. Institutional procedures, such as the legal establishment of Natura 2000 areas by the federal government or Samothraki's designation as a Biosphere Reserve, pertain to even more actors and institutions, and this can cause delays and increase uncertainty.

A way to tackle those imbalances has been to identify synergies at all scales. Focus groups, for example, were consistently and primarily used to generate data, but also provided a platform for local residents to network and explore future opportunities for their island. This, in turn, has enhanced the robustness of a local action group, 'Sustainable Samothraki', an association of young locals sharing and promoting a vision towards sustainability on the island, advancing practical initiatives, organising information meetings, but also receiving training in several international meetings, thus becoming operationally part of a 'family' of practitioners committed to a vision of island sustainability. This, consequently, has been instrumental in facilitating the local development process, but has also brought other scientists into the process, thus acting as a solid foundation for scientifically guided decision-making (e.g., Lampou et al., 2015). Perhaps the best example of synergistic thinking has been the organisation of summer schools on the island that simultaneously provide education on socioecological methods and approaches, generate data that feed into current applied research, and support and empower local sustainability initiatives, all while enhancing alternative off-season visitation in practice. Above all, they create the *space* and the *conditions* for transformative learning to occur (Winiwarter, 2016), and facilitate a transition to more sustainable practices.

The strategic role of scientific inquiry to guide transformations

Science controls neither money nor power; it only has some control over the consciousness of people (knowledge, beliefs), depending on communication and trustworthiness. Moreover, a local community is not a hierarchical organisation that can be centrally 'planned' or 'managed'; instead, it must be seen as a network of actors (internal as well as external) and forces (attractors) of variable strength that pull and push in diverse directions. What does one need for doing research? A fascinating vision, funding, interested researchers, and supportive partners. We have been lucky enough to secure all four. Yet, the key for *transformative* socioecological research on Samothraki, so far, has been local support: the island's municipal administration, civil society groups, as well as many local citizens lending their support. With the use of citizen scientists, we aim at further reinforcing science-local community communication.

We make efforts at identifying those practices and elements of island culture that provide examples of "quiet sustainability" (Smith & Jehlička, 2013) within local tradition, such as the role of informal food networks (Petridis & Huber, 2017) that can reinforce a sustainability transition. We hope to be able to jointly develop a vision for the island that does not follow the ambitions of maximising income. We seek to utilise the island's specific qualities and advantages that may provide a reasonably good life for both inhabitants and tourists, without destroying the environment, enhancing their potential by eliminating inefficiencies, and finding smart solutions, while avoiding the "eco-island trap" (Grydehøj & Kelman, 2017).

What are implications for island studies? Responding to the call for island research that informs transformative practices (Stratford, 2013), we introduced social ecology, as an 'island' within an 'archipelago' of interdisciplinary approaches to sustainability research (Fischer-Kowalski & Weisz, 2016). In contrast to approaches that focus on islands' productivity and competitiveness potential in an otherwise unchallenged framework, or ignore the underpinning normative assumptions, we are interested in transformative island research that has a clear

direction towards sustainability, without compromising analytical rigour. In line with Clark (2013), and echoing relevant calls for doing "research *of* islands not just *for* islands" (Baldacchino, 2008), we propose performing transdisciplinary socioecological research as an example of research that views the insular conditions also as an opportunity. An opportunity for radical forms of change, building upon careful systemic analysis that explores the realistic option space for more sustainable pathways.

Acknowledgements

More people deserve our appreciation than can possibly fit in these lines, but we should at least mention the local initiatives 'Samothraki in Action' and 'Zathay', the association 'Sustainable Samothraki', and the Municipality of Samothraki for their longstanding support. We greatly benefitted from the continuous cooperation with our colleagues from the Hellenic Centre for Marine Research (HCMR) in Athens, and from the enthusiasm of students from all over the world engaging in research on Samothraki. We gratefully acknowledge financial support from the Austrian Science Fund (FWF) projects: Susaki (P27951-G7) and CiSciSusaki (F15TCS00022). Preparatory feasibility studies have been financed by the Austrian MAB National Committee. We also thank the two anonymous reviewers for their helpful comments.

References

Adrianto, L., & Matsuda, Y. (2004). Study on Assessing Economic Vulnerability of Small Island Regions. *Environment, Development and Sustainability*, *6*(3), 317-336. https://doi.org/10.1023/B:ENVI.0000029902.39214.d0

Archer, B.H. (1989). Tourism and Island Economics: Impact Analyses. In: C. Cooper (Ed.) *Progress in Tourism, Recreation and Hospitality Management, vol. 1* (pp. 125-134). London: Belhaven.

Armstrong, H.W., Giordano, B., Kizos, T., Macleod, C., Olsen, L.S., & Spilanis, I. (2012). The European Regional Development Fund and Island Regions: An Evaluation of the 2000-06 and 2007-13 Programs. *Island Studies Journal*, *7*(2), 177-198.

Armstrong, H.W., & Read, R. (2003). The Determinants of Economic Growth in Small States. *The Round Table*, *92*(368), 99-124. https://doi.org/10.1080/750456745

Armstrong, H.W., & Read, R. (2002). The Phantom of Liberty?: Economic Growth and the Vulnerability of Small States. *Journal of International Development*, *14*(4), 435-58. https://doi.org/10.1002/jid.886

Baldacchino, G. (2008). Studying Islands: On Whose Terms? Some Epistemological and Methodological Challenges to the Pursuit of Island Studies. *Island Studies Journal*, *3*(1), 37-56.

Baldacchino, G. (2006). Islands, Island Studies, Island Studies Journal. *Island Studies Journal*, *1*(1), 3-18.

Baldacchino, G. (2004). The Coming of Age of Island Studies. *Tijdschrift voor economische en sociale geografie*, *95*(3), 272-283. https://doi.org/10.1111/j.1467-9663.2004.00307.x

Baldacchino, G., & Bertram, G. (2009). The Beak of the Finch: Insights into the Economic Development of Small Economies. *The Round Table*, *98*(401), 141-160. https://doi.org/10.1080/00358530902757867

Barnett, J., & Waters, E. (2016). Rethinking the Vulnerability of Small Island States: Climate Change and Development in the Pacific Islands. In: J. Grugel & D. Hammett (Eds.) *The Palgrave Handbook of International Development* (pp. 731-748). London: Palgrave Macmillan. https://doi.org/10.1057/978-1-137-42724-3_40

Bela, G., Peltola, T., Young, J.C., Balázs, B., Arpin, I., Pataki, G., Hauck, J., Kelemen, E., Kopperoinen, L., Herzele, A., & Keune, H. (2016). Learning and the Transformative Potential of Citizen Science. *Conservation Biology*, *30*(5), 990-999. https://doi.org/10.1111/cobi.12762

Benedicto, J. (2014). Identity and Decision-Making for Sustainability in the Context of Small Islands. *RGCI-Revista de Gestão Costeira Integrada*, *14*(2), 199-213. https://doi.org/10.5894/rgci468

Bertram, G., & Poirine, B. (2007). Island Political Economy. In G. Baldacchino (Ed.) *A World of Islands, an Island Studies Reader* (pp. 325-373). Charlottetown, PEI: Institute of Island Studies.

Bianchi, R.V. (2004). Tourism Restructuring and the Politics of Sustainability: A Critical View from the European Periphery (The Canary Islands). *Journal of Sustainable Tourism*, *12*(6), 495-529. https://doi.org/10.1080/09669580408667251

Biel, B., & Tan, K. (2014). *Flora of Samothraki*. The Goulandris Natural History Museum, Kifissia, Greece.

Briguglio, L. (1995). Small Island Developing States and their Economic Vulnerabilities. *World development*, *23*(9), 1615-1632. https://doi.org/10.1016/0305-750X(95)00065-K

Briguglio, L., & Kisanga, E.J. (Eds.) (2004). *Economic Vulnerability and Resilience of Small States*, Islands and Small States Institute of the University of Malta and the Commonwealth Secretariat, Malta, Formatek.

Briguglio, L., Cordina, G., & Kisanga, E.J. (Eds.) (2006). *Building the Economic Resilience of Small States*, Islands and Small States Institute of the University of Malta and the Commonwealth Secretariat, Malta, Formatek.

Campling, L. (2006). A Critical Political Economy of the Small Island Developing States Concept South–South Cooperation for Island Citizens? *Journal of Developing Societies*, *22*(3), 235-285. https://doi.org/10.1177/0169796X06068031

Chertow, M., Fugate, E., & Ashton, W. (2013). The Intimacy of Human-Nature Interactions on Islands. In S.J. Singh, H. Haberl, M. Chertow, M. Mirtl & M. Schmid (Eds.) *Long Term Socio-Ecological Research: Studies in Society-Nature Interactions across Spatial and Temporal Scales* (pp. 315-337). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-1177-8_14

Clark, E. (2013). Financialization, Sustainability and the Right to the Island: A Critique of Acronym Models of Island Development. *Journal of Marine and Island Cultures*, *2*(2), 128-136. https://doi.org/10.1016/j.imic.2013.10.001

Clark, E. (2009). Island Development. *International Encyclopedia of Human Geography*, *5*, 607-610. https://doi.org/10.1016/B978-008044910-4.00849-X

Conkling, P. (2007). On Islanders and Islandness. *Geographical Review*, *97*(2), 191-201. https://doi.org/10.1111/j.1931-0846.2007.tb00398.x

Connell, J. (2007). Islands, Idylls and the Detours of Development. *Singapore Journal of Tropical Geography*, *28*(2), 116-135. https://doi.org/10.1111/j.1467-9493.2007.00284.x

Conrad, E., & Cassar, L.F. (2014). Decoupling Economic Growth and Environmental Degradation: Reviewing Progress to Date in the Small Island State of Malta. *Sustainability, 6*(10), 6729-6750. https://doi.org/10.3390/su6106729

Depraetere, C. (2008). The Challenge of Nissology: A Global Outlook on the World Archipelago. Part II: the Global and Scientific Vocation of Nissology. *Island Studies Journal, 3*(1), 17-36.

Deschenes, P.J., & Chertow, M. (2004). An Island Approach to Industrial Ecology: Towards Sustainability in the Island Context. *Journal of Environmental Planning and Management, 47*(2), 201-217. https://doi.org/10.1080/0964056042000209102

Dodds, R. (2007). Malta's Tourism Policy: Standing Still or Advancing Towards Sustainability. *Island Studies Journal, 2*(1), 47-66.

Eckelman, M.J., Ashton, W., Arakaki, Y., Hanaki, K., Nagashima, S., & Malone-Lee, L.C. (2014). Island Waste Management Systems. *Journal of Industrial Ecology, 18*(2), 306-17. https://doi.org/10.1111/jiec.12113

Ellen MacArthur Foundation (Ed.). (2013). *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition*. Cowes: Ellen MacArthur Foundation.

Erickson, J.D., & Gowdy, J.M. (2000). Resource Use, Institutions, and Sustainability: A Tale of Two Pacific Island Cultures. *Land Economics, 76*(3), 345-54. https://doi.org/10.2307/3147033

Fischer-Kowalski, M., & Erb, K.H. (2016). Core Concepts and Heuristics. In H. Haberl, M. Fischer-Kowalski, F. Krausmann, V. Winiwarter (Eds.) *Social Ecology: Society-Nature Relations across Time and Space* (pp. 29-61). Cham: Springer. https://doi.org/10.1007/978-3-319-33326-7_2

Fischer-Kowalski, M., & Weisz, H. (2016). The Archipelago of Social Ecology and the Island of the Vienna School. In H. Haberl, M. Fischer-Kowalski, F. Krausmann, V. Winiwarter (Eds.) *Social Ecology. Society-Nature Relations across Time and Space* (pp. 3-28). Cham: Springer. https://doi.org/10.1007/978-3-319-33326-7_1

Fischer-Kowalski, M., & Weisz, H. (1999). Society as Hybrid Between Material and Symbolic Realms: Toward a Theoretical Framework of Society-Nature Interaction. *Advances in Human Ecology, 8*, 215-252.

Fischer-Kowalski, M., Xenidis, L., Singh, S.J., & Pallua, I. (2011). Transforming the Greek Island of Samothraki into a UNESCO Biosphere Reserve. An Experience in Transdisciplinarity. *GAIA, Ecological Perspectives for Science and Society, 20*(3), 181-190. https://doi.org/10.14512/gaia.20.3.9

Fuchs, N. (2015). Sozial-ökologische Effekte der EU-Agrarsubventionen: Fallstudie zur Ökologischen und Ökonomischen Nachhaltigkeit der Schaf- und Ziegenzucht in Griechenland. Saarbrücken: AV Akademikerverlag.

Gingrich, S., Schmid, M., Dirnböck, T., Dullinger, I., Garstenauer, R., Gaube, V., Haberl, H., Kainz, M., Kreiner, D., Mayer, R., & Mirtl, M. (2016). Long-Term Socio-Ecological Research in Practice: Lessons from Inter-and Transdisciplinary Research in the Austrian Eisenwurzen. *Sustainability, 8*(8), 743. https://doi.org/10.3390/su8080743

Godelier, M. (1986). *The Mental and the Material: Thought Economy and Society*. London: Blackwell Verso.

Greek National MAB Committee. (2013). *Samothraki Biosphere Reserve Nomination Form: Final Official Document*, UNESCO Man and the Biosphere (MAB) Programme, September 2013, Athens.

Grote, J. (2010). The Changing Tides of Small Island States Discourse-A Historical Overview of the Appearance of Small Island States in the International Arena. *Verfassung und Recht in Übersee/Law and Politics in Africa, Asia and Latin America, 43*, 164-191. https://doi.org/10.5771/0506-7286-2010-2-164

Grydehøj, A., & Kelman, I. (2017). The Eco-Island Trap: Climate Change Mitigation and Conspicuous Sustainability. *Area*, *49*(1), 106-113. https://doi.org/10.1111/area.12300

Haas, W., Singh, S.J., Erschbamer, B., Reiter, K., & Walz, A. (2013). Integrated Monitoring and Sustainability Assessment in the Tyrolean Alps: Experiences in Transdisciplinarity. In S.J. Singh, H. Haberl, M. Chertow, M. Mirtl & M. Schmid (Eds.) *Long Term Socio-Ecological Research: Studies in Society-Nature Interactions across Spatial and Temporal Scales* (pp. 527-554). Cham: Springer. https://doi.org/10.1007/978-94-007-1177-8_22

Haberl, H., Fischer-Kowalski, M., Krausmann, F., Weisz, H., & Winiwarter, V. (2004). Progress Towards Sustainability? What the Conceptual Framework of Material and Energy Flow Accounting (MEFA) Can Offer. *Land Use Policy*, *21*(3), 199-213. https://doi.org/10.1016/j.landusepol.2003.10.013

Haberl, H., Winiwarter, V., Andersson, K., Ayres, R.U., Boone, C., Castillo, A., Cunfer, G., Fischer-Kowalski, M., Freudenburg, W.R., Furman, E., Kaufmann, R., Krausmann, F., Langthaler, E., Lotze-Campen, H., Mirtl, M., Redman, C.L., Reenberg, A., Wardell, A., Warr, B., & Zechmeister, H. (2006). From LTER to LTSER: Conceptualizing the Socioeconomic Dimension of Long-Term Socioecological Research. *Ecology and Society*, *11*(2)-13, 1-34. https://doi.org/10.5751/ES-01786-110213

Hauʿofa, E. (1994). Our Sea of Islands. *The Contemporary Pacific*, *6*, 147-161.

Hay, P. (2013). What the Sea Portends: a Reconsideration of Contested Island Tropes. *Island Studies Journal*, *8*(2), 209-232.

Hay, P. (2006). A Phenomenology of Islands. *Island Studies Journal*, *1*(1), 19-42.

Hayward, P. (2012). Aquapelagos and Aquapelagic Assemblages. *Shima: The International Journal of Research into Island Cultures*, *6*(1), 1-11.

Hislop, H., & Hill, J. (2011). *Reinventing the Wheel: A Circular Economy for Resource Security*. London: Green Alliance.

Horden, P., & Purcell, N. (2000). *The Corrupting Sea. A Study of Mediterranean History*. London: Blackwell.

Johnson, M.F., Hannah, C., Acton, L., Popovici, R., Karanth, K.K., & Weinthal, E. (2014). Network Environmentalism: Citizen Scientists as Agents for Environmental Advocacy. *Global Environmental Change*, *29*, 235-245. https://doi.org/10.1016/j.gloenvcha.2014.10.006

Kakazu, H. (1994). *Sustainable Development of Small Island Economies*. Boulder: Westview.

Kerr, S.A. (2005). What Is Small Island Sustainable Development About? *Ocean & Coastal Management*, *48*(7), 503-24. https://doi.org/10.1016/j.ocecoaman.2005.03.010

Kobori, H., Dickinson, J.L., Washitani, I., Sakurai, R., Amano, T., Komatsu, N., Kitamura, W., Takagawa, S., Koyama, K., Ogawara, T., & Miller-Rushing, A.J. (2016). Citizen Science: A New Approach to Advance Ecology, Education, and Conservation. *Ecological Research*, *31*(1), 1-19. https://doi.org/10.1007/s11284-015-1314-y

Krausmann, F., Richter, R., & Eisenmenger., N. (2014). Resource Use in Small Island States. *Journal of Industrial Ecology*, *18*(2), 294-305. https://doi.org/10.1111/jiec.12100

Lampou, A., Zogaris, S., Karaouzas, I., Gritzalis, K., & Skoulikidis, N. (2015). Samothraki Nature Observatory: Research and Monitoring that Supports the Conservation and Sustainability of

a Unique Aegean Island. Paper presented at the 11th Panhellenic Symposium on Oceanography and Fisheries. Mytilene, Lesvos island, Greece: University of the Aegean.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., & Thomas, C.J. (2012). Transdisciplinary Research in Sustainability Science: Practice, Principles, and Challenges. *Sustainability Science*, *7*(1), 25-43. https://doi.org/10.1007/s11625-011-0149-x

Lutz, W. (Ed.) (1994). *Population-Development-Environment: Understanding Their Interactions in Mauritius.* Springer-Verlag. https://doi.org/10.1007/978-3-662-03061-5MacMillan, T., & Benton T.G. (2014). Agriculture: Engage Farmers in Research. *Nature, 509*, 25-27. https://doi.org/10.1038/509025a

McGillivray, M., Naudé, W., & Santos-Paulino A.U. (2010). Vulnerability, Trade, Financial Flows and State Failure in Small Island Developing States. *The Journal of Development Studies*, *46*(5), 815-827. https://doi.org/10.1080/00220381003623822

Nguyen, N.C., Bosch, O.J.H., & Maani, K.E. (2011). Creating "Learning Laboratories" for Sustainable Development in Biospheres: A Systems Thinking Approach. *Systems Research and Behavioral Science*, *28*, 51-62. https://doi.org/10.1002/sres.1044

Norgaard, R.B. (1994). *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*. London: Routledge. https://doi.org/10.1111/j.1468-0467.2011.00383.x

Norgaard, R.B., & Kallis, G. (2011). Coevolutionary Contradictions: Prospects for a Research Programme on Social and Environmental Change. *Geografiska Annaler: Series B, Human Geography, 93*(4), 289-300.

Pelling, M., & Uitto, J.I. (2001). Small Island Developing States: Natural Disaster Vulnerability and Global Change. *Environmental Hazards*, *3*(2), 49-62. https://doi.org/10.3763/ehaz.2001.0306

Petridis, P. (2016). Establishing a Biosphere Reserve on the Island of Samothraki, Greece: A Transdisciplinary Journey. *Sustainable Mediterranean, 72*, 39-41.

Petridis, P. (2012). Perceptions, Attitudes and Involvement of Local Residents in the Establishment of a Samothraki Biosphere Reserve, Greece. *Eco.mont - Journal on Protected Mountain Areas Research, 4*(1), 59-63. https://doi.org/10.1553/eco.mont-4-1s59

Petridis P., & Huber, J. (2017). A Sociometabolic Transition of Diets on a Greek Island: Evidence of Quiet Sustainability. In E. Fraňková, W. Haas & S. J. Singh (Eds.) *Sociometabolic Perspectives on Sustainability of Local Food Systems*, under contract with Springer.

Petridis, P., & Fischer-Kowalski, M. (2016). Island Sustainability: The Case of Samothraki. In H. Haberl, M. Fischer-Kowalski, F. Krausmann, V. Winiwarter (Eds.) *Social Ecology. Society-Nature Relations across Time and Space* (pp. 543-557). Cham: Springer. https://doi.org/10.1007/978-3-319-33326-7_28

Petridis, P., Muraca, B., & Kallis G. (2015). Degrowth: Between a Scientific Concept and a Slogan for a Social Movement. In J. Martinez-Alier and R. Muradian (Eds.) *Handbook of Ecological Economics* (pp. 176-200). Cheltenham: Edward Elgar. https://doi.org/10.4337/9781783471416.00012

Petridis, P., Hickisch, R., Klimek, M., Fischer, R., Fuchs, N., Kostakiotis, G., Wendland, M., Zipperer, M., & Fischer-Kowalski, M. (2013). Exploring Local Opportunities and Barriers for a Sustainability Transition on a Greek island. *Social Ecology Working Paper* 142, Vienna, Austria. Available at: http://www.uni-klu.ac.at/socec/downloads/WP142_WEB.pdf

Pugh, J. (2016). The Relational Turn in Island Geographies: Bringing together Island, Sea and Ship Relations and the Case of the Landship. *Social & Cultural Geography, 17*(8), 1040-1059. https://doi.org/10.1080/14649365.2016.1147064

Pugh, J. (2013a). Island Movements: Thinking with the Archipelago. *Island Studies Journal, 8*(1), 9-24.

Pugh, J. (2013b). Speaking Without Voice: Participatory Planning, Acknowledgment, and Latent Subjectivity in Barbados. *Annals of the Association of American Geographers, 103*(5), 1266-1281. https://doi.org/10.1080/00045608.2012.706571

Rau, H., Gooch, P., Petridis, P., Cardoso, A., Rüther, A., & Wandl M.T. (2014). *Focus Groups - A Vision for Samothraki in 2030*. Final Report. Erasmus Intensive Programme 'Achieving Sustainable Development on an Island: Social Ecology Concepts and Methods in a Real World Context', Samothraki, Greece.

Scheyvens, R., & Momsen, J. (2008). Tourism in Small Island States: From Vulnerability to Strengths. *Journal of Sustainable Tourism, 16*(5), 491-510. https://doi.org/10.1080/09669580802159586

Schneidewind, U., Singer-Brodowski, M., Augenstein, K., & Stelzer, F. (2016). Pledge for a Transformative Science: A Conceptual Framework. *Wuppertal Papers* No. 191. Wuppertal Institut.

Sieferle, R.P. (2011). Cultural Evolution and Social Metabolism. *Geografiska Annaler: Series B, Human Geography, 93*(4), 315-24. https://doi.org/10.1111/j.1468-0467.2011.00385.x

Singh, S.J., Haberl, H., Chertow, M., Mirtl, M., & Schmid M. (Eds.) (2013). *Long Term Socio-Ecological Research: Studies in Society: Nature Interactions Across Spatial and Temporal Scales* (Vol.2). Springer. https://doi.org/10.1007/978-94-007-1177-8

Singh, S.J., & Grünbühel, C.M. (2003). Environmental Relations and Biophysical Transition: The Case of Trinket Island. *Geografiska Annaler: Series B, Human Geography, 85*(4), 191-208. https://doi.org/10.1111/j.0435-3684.2003.00142.x

Singh, S.J., Grünbühel, C.M., Schandl, H. & Schulz., N. (2001). Social Metabolism and Labour in a Local Context: Changing Environmental Relations on Trinket Island. *Population and Environment, 23*(1), 71-104. https://doi.org/10.1023/A:1017564309651

Smith, J., & Jehlička, P. (2013). Quiet Sustainability: Fertile Lessons from Europe's Productive Gardeners. *Journal of Rural Studies, 32*, 148-157. https://doi.org/10.1016/j.jrurstud.2013.05.002

Spilanis, I., & Vayanni, H. (2004). Sustainable Tourism: Utopia or Necessity? The Role of New Forms of Tourism in the Aegean Islands. In B. Bramwell (Ed.) *Coastal Mass Tourism: Diversification and Sustainable Development in Southern Europe* (pp. 269-291). Clevedon: Channel View.

Sterling, S. (2011). Transformative Learning and Sustainability: Sketching the Conceptual Ground. *Learning and Teaching in Higher Education, 5*(11), 17-33.

Stratford, E. (2013). Guest Editorial Introduction: The Idea of the Archipelago: Contemplating Island Relations. *Island Studies Journal, 8*(1), 3-8.

Stratford, E. (2008). Islandness and Struggles over Development: A Tasmanian Case Study. *Political Geography, 27*(2), 160-175. https://doi.org/10.1016/j.polgeo.2007.07.007

Stratford, E., Baldacchino, G., McMahon, E., Farbotko, C., & Harwood, A. (2011). Envisioning the Archipelago. *Island Studies Journal, 6*(2), 113-130.

Sundkvist, Å., Jansson, A., Enefalk, Å, & Larsson, P. (1999). Energy Flow Analysis as a Tool for Developing a Sustainable Society – a Case Study of a Swedish Island. *Resources,*

Conservation and Recycling, 25(3), 289-299. https://doi.org/10.1016/S0921-3449(98)00070-6

Sustainable Mediterranean. (2017). Special Issue, No 73: Summer University of Samothraki 2016: Integrated Management Approaches for Biosphere Reserves and Other Designated Areas, 9-22 July 2016.

Teixeira, R.F., Proença, V., Crespo, D., Valada, T., & Domingos, T. (2015). A Conceptual Framework for the Analysis of Engineered Biodiverse Pastures. *Ecological Engineering, 77*, 85-97. https://doi.org/10.1016/j.ecoleng.2015.01.002

Tsai, H.M., & Clark, E. (2003). Nature-Society Interactions on Islands: Introduction. *Geografiska Annaler: Series B, Human Geography, 85*(4), 187-189. https://doi.org/10.1111/j.0435-3684.2003.00141.x

Umemoto, K. (2001). Walking in Another's Shoes: Epistemological Challenges in Participatory Planning. *Journal of Planning Education and Research, 21*(1), 17-31. https://doi.org/10.1177/0739456X0102100102

UNESCO (United Nations Educational, Scientific and Cultural Organization) (1996). *Biosphere Reserves: The Seville Strategy and the Statutory Framework of the World Network*. Paris: UNESCO.

Wildenberg, M., & Singh, S.J. (2012). Integrated Modelling and Scenario Building for the Nicobar Islands in the Aftermath of the Tsunami. In M. Glaser, B. Ratter, G. Krause, & M. Welp (Eds.) *Human–Nature Interaction in the Anthropocene: Potentials of Social-Ecological Systems Analysis* (pp. 161-189). London: Routledge.

Winiwarter, V. (2016). Perspectives on Social Ecology: Learning for a Sustainable Future. In H. Haberl, M. Fischer-Kowalski, F. Krausmann, V. Winiwarter (Eds.) *Social Ecology. Society-Nature Relations across Time and Space* (pp. 577-589). Cham: Springer. http://www.sustainable-samothraki.net/