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Marina Fischer-Kowalski • Panos Petridis
(Editors)

5th Summer School on "Aquatic and Social Ecology" on Samothraki, Greece

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sec.workingpapers@boku.ac.at

Institute of Social Ecology Vienna (SEC)
Department of Economics and Social Sciences (WiSo)
University of Natural Resources & Life Sciences, Vienna (BOKU)
Schottenfeldgasse 29
1070 Vienna, Austria
https://boku.ac.at/wiso/sec

Social Ecology Working Paper

Marina Fischer Kowalski, Panos Petridis (Eds.)

5th Summer School on "Aquatic and Social Ecology" on Samothraki, Greece

3-12 June 2018

Organized by:
the Vienna Institute of Social Ecology (University of Natural Resources and Life Sciences) as part of the study program Social and Human Ecology at Alpen-Adria University
and the Hellenic Centre for Marine Research

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1 The 5th Summer School on "Aquatic and Social Ecology" on Samothraki: Introduction by the organizers and editors of this volume.

Marina Fischer-Kowalski[1], Panos Petridis[1] and Anastasia Lampou[2]

[1]University of Natural Resources and Life Sciences, Institute of Social Ecology, Vienna, Austria,

[2]Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, Greece.

The current working paper results from our ongoing 'transdisciplinary' efforts at supporting a sustainability transition on the Greek island of Samothraki (Fischer-Kowalski et al. 2011, Petridis et al. 2017). Our research activities on Samothraki revolve around identifying those ecological and social factors that cause insular societies to prosper and sustain themselves, and increasingly include local partners in different stages of the scientific process. A momentum has been reached, where long-lasting research efforts are bearing fruits and contribute to several policy achievements, but that is also critical in the sense that certain institutional constraints still need to be overcome (Fetzel et al. 2018). Our aim remains to further consolidate a research agenda for a sustainable island focused around restoring degraded ecosystems and reducing future environmental pressures, while securing a satisfactory level of well-being for the local community.

One of our main integration activities in the past years has been the organization of yearly summer schools, in collaboration with several universities, research institutions, local and national authorities, NGOs and UNESCO branches (Petridis et al. 2013, Sustainable Mediterranean 2016). These summer schools are organically part of our research activities, and are designed in such a way that they contribute to current research directions and help to simultaneously achieve maximum synergistic effects between research and policy goals. They involve student exercises, sometimes leading to Master's/PhD theses, but they are also small applied projects in themselves, often directly responding to requests from the local stakeholders.

The 5th Summer School on "Aquatic and Social Ecology" successfully took place on Samothraki between the 3rd and 12th of June 2018. The course was designed as a ten-day excursion with the aim to learn and apply aquatic ecology and social ecology approaches in a local setting while supporting current research and building synergy with the UNESCO Biosphere Reserve process. The course gave participants the opportunity to engage in a real-life project and utilise their scientific training to support the process further, namely the creation of a management plan with a set of activities towards sustainability, and a science plan for further research on the island that would also meet local interests. This provided students the experience of participating in a transdisciplinary research process, being exposed to a search for solutions for sustainability and development challenges, and learning to interact with stakeholders in a culturally challenging environment.

Following our customary setting, the summer school included a series of theoretical input sessions, but for the most part, students were then split into small groups and conducted fieldwork with an array of social and natural science methods frequently used in socioecological and aquatic research. Five modules were performed in parallel, each consisting of an information block, participating in field research, data analysis and reporting. Each method was practically demonstrated by a tutor guiding the small student groups throughout the field work. The work was structured into the following modules:

1. **Landscape assessment in an insular protected area**: This module (i) applied landscape assessment through field surveys and use of questionnaires, and (ii) assessed landscape integrity particularly under consideration of proposed wind farms within the protected area (Samothraki Natura 2000 sites). Methods included an analysis of cultural landscape attributes and a cultural ecosystem services framework.

2. **Coastal morphodynamics of Samothraki and management of anthropogenic activities using the principles of Integrated Coastal Zone Management (ICZM)**: Coastal morphodynamics through a holistic view including land area and submarine zone were surveyed. Field observations and in situ measurements as well as data analyses were carried out. Moreover the module attempted to integrate anthropogenic activities and coastal areas mainly using the adaptation principle.

3. **Hydrometeorological investigations and monitoring infrastructure for adaptive water management**: The aim of the module was to present ways of hydrometeorological investigations through installation of automatic monitoring stations and the use of models that could provide important information about the optimization of water resource management plans. Meteorological and hydrological equipment was presented and installed in a case study area while the role of the atmospheric forcing and topography on the local water and energy cycle was discussed. Optimization of existing or future water management plans was attempted by considering socioeconomic and climate change scenarios.

4. **Sustainable livestock farming**: The sheep and goat population on Samothraki reached unprecedented levels during the 1990s, causing widespread overgrazing and erosion. Still today, livestock numbers by far exceed sustainable levels and impede a recovery of the local ecosystems. In this module, we engaged in a dialogue with local farmers to learn more about the reality of their everyday lives, opportunities and obstacles for more sustainable farming practices. With help from our local partners we arranged interviews with farmers to collect socio-metabolic and qualitative data that contributed to ongoing research efforts.

5. **Energy metabolism**: How much energy does Samothraki need, and where does it get it from? In this module we provided a set of existing statistics and previous research results. The task for the students was to integrate those data into meaningful information and to complement them with estimates on missing parameters (such as fuelwood use for heating) by interviews with local experts and sample households.

The course concluded with a reflection on the experiences and written student reports on the results of their specific research. The current working paper presents the final results of the five groups.

We would like to thank our crew of dedicated teachers and researchers preparing and guiding the modules as tutors; they show up as co-authors in each of the chapters. In addition, special thanks go also to Marjan Jongen and Evgenia Tsianou. We would also like to thank our numerous partners on the island that supported us with their local knowledge and gave advice and organizational support, in particular Giorgos Maskalidis, Stella Kapetanidou, Jaqueline Kirby, Carlota Marañon and Mary Pitiakoudi, social cooperative Varades for hosting us at the Municipal camping, as well as the Mayor of Samothraki Thanasis Vitsas. Last but not least, all interview participants who shared with us their knowledge, views, concerns and visions for a sustainable Samothraki.

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2 A preliminary investigation into residents' perceptions of landscape during a wind farm proposal on Samothraki

Jan Danek[1], Eirini Gallou[2], Vassiliki Vlami[3], Stamatis Zogaris[4]

[1]Faculty of Humanities, Charles University, Prague / Global Change Research Institute, Czech Academy of Sciences, Czech Republic, [2]Institute for Sustainable Heritage, University College London, UK, [3]University of Patras, Faculty of Environmental and Natural Resources Management, Patras Greece, [4]Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, Greece

2.1 Abstract

A controversial proposal to build two industrial wind farms totaling 39 wind turbines on Samothraki's Fengari range has created concern among nature conservationists. Residents' perceptions were surveyed in June 2018 (98 people from 10 settlements were located at their place of residence, their work and in the field). This exercise shows that Samothraki's residents have a variety of views on landscape values but a large group of residents definitely appreciates the beauty of the landscape and other intangible services provided by the landscapes and their constituent ecosystems. It is also interesting to see that there is a pro-environment stance in a large proportion of the people surveyed (however this brief report does not provide a full analysis here). Societal values should be researched and better appreciated within the realm of landscape conservation, protected area management and the planning for low-impact wind farm developments.

2.2 Introduction

During the last decade there has been a rapid expansion of the literature on public responses to wind energy development and the so-called "landscape effects", especially visual impacts. The "landscape approach" which includes landscape ecology and human perceptions of their surroundings is potentially useful especially in the Mediterranean where cultural landscapes dominate. The European Landscape Convention (ELC 2000) adopts a broad definition where: "Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." The Convention's article 5, emphasizes the obligation to ensure the participation of the public in the definition and implementation of landscape policies. Hence, people's preferences for landscape experiences should be important in policy-relevant conservation development.

In looking at potential environmental impacts on small inhabited islands, a more strategic and holistic approach is needed to provide support to communities in dealing with important landscape challenges such as wind farms. The ecosystem services approach has been successful as a tool to measure the contributions of nature to human well-being. Ecosystems have an effect on people's quality of life and at the scale of landscapes also. As a spatial broader concept than ecosystem types, landscape areas contribute to people's well-being as well. Several researchers consider the experience of landscape as a form of cultural ecosystem services derived from landscapes, however this has not been researched in-depth in the Mediterranean countries.

In many Greek islands wind farms are sited in mountain ridges for efficiency and profitability but sometimes also because they are away from most people's view. In Greece the situation

of wind turbine development is perplexed to the degree that serious controversies and conflicts are spreading; however until recently aesthetic or other intangible cultural values and services provided by landscapes were not taken into consideration. In fact most interest still focuses on protecting biodiversity, and this is of policy-relevant concern especially when impacts of the wind farms are within protected areas. Our questions explore how residents feel about a wind farm proposal. The guiding questions we ask are: a) Do residents of Samothraki distinguish landscape as an important resource with benefits to society? b) Do they perceive threats to the integrity of their landscapes? and c) how is their opinion on the proposed wind farm developed in relation to their views on landscape? This brief report does not provide a full analysis, just some interesting points are developed.

2.3 Study area and the wind farm conflict

In 2015 first news of a proposal for industrial wind farms on Samothraki's mountains was announced: the location was to be in the wilderness area of Amoni-Louloudi (fig. 1) above the springs of the Fonias stream. The wind farm developments includes two projects, totaling in 39 wind turbines; they are meant to supply the mainland through an underwater cable. In 2017 there were two information sessions on the issue in Samothraki. In June of 2018, thirteen scientists under the auspices of the local NGO issued a statement objecting to the specific wind farms and citing environmental degradation reasons, including landscape degradation. No recent work on the social impacts of the industrial wind farm have been investigated.

2.4 Methods

Questionnaire surveys were developed during the first day of this summer school project; they were conducted between the 3rd to the 16th of June 2018 by fluent Greek speakers (3 of the above members of the study team). An expert-led approach helped categorize which resident groups where required for the survey, in order to have a balanced representation of the population. Specific residents were targeted to achieve the best possible representative sample in such a short time-frame. This includes a selection of public officials and official club and professional organization members. Many people were also randomly approached in cafes and other areas of the 10 settlements/villages where the investigation took place. Finally, a total of 98 people from 10 settlements participated in the face-to-face short questionnaires survey.

The survey had two components.

Component 1: Questionnaire to assess the perceived importance of ecosystem services.
Respondents were first asked to rate the importance of 20 different ecosystem services to people in their local community. Specific ecosystem service categories were inspired by CICES (v4.3) classification (https://cices.eu/). Ecosystem services included provisioning, maintenance and regulating and cultural services. A 5-point Likert scale scoring on importance plus the “I don’t know” option (zero value) were used. Completing this part of the questionnaire took about 10 minutes.

Component 2: Semi structured questions.
Nine semi-structured questions were asked immediately after the ecosystem services questions (Appendix 1). Finally details about the age, gender, resident village and professional structure of the people surveyed were gathered (Table 1).

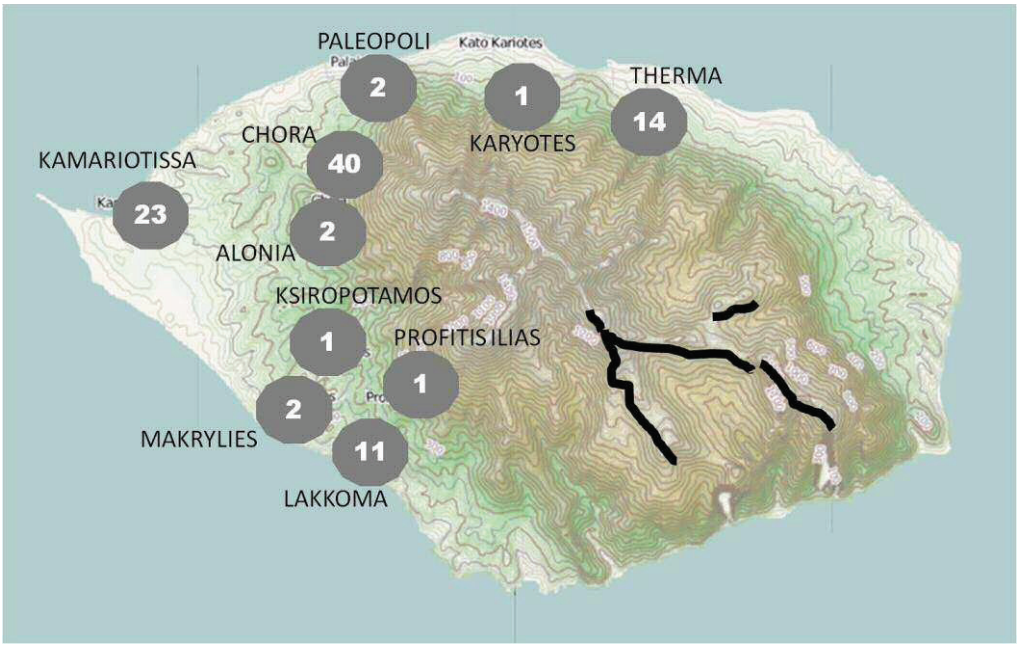

Fig. 1. Site of Proposed wind farms (black lines); charted from the Regulatory Authority for Energy - RAE (URL http://www.rae.gr/geo/, accessed 12 Aug. 2018). Areas where respondent residents were surveyed and the number of respondents from each location are shown in grey circles; location names in higher-case lettering.

2.5 Results and Discussion

The survey made every possible attempt to cover a representative set of residents; the island population being approximately 2800 residents. Before beginning the work we targeted residents which we deemed would be important since they have a stakeholder position (local authorities and various service sectors); we tried to find members of local organization and non-governmental organizations since their opinion may be influenced by wider societal trends (Table 1). We made many phone calls to make appointments and received much help from the Municipality of Samothraki. The pre-tourist season timing was helpful since many residents were willing to participate; many people were responsive in cafes in the villages, but many were literally stopped on the street and in the fields. Of the residents asked, most were willing to participate; but at Lakkoma two residents showed strong feelings in not participating.

Table 1. General structure of the set of residents surveyed. The initial respondent "Category" refers to a general employment category. The "other" category code includes people of multiple occupations, unemployed and some retired respondents as well.

Category	No of informants	Gender		Age group						
		Female	*Male*	1= 18-25	2= 26-35	3= 36-45	4= 46-55	5= 56-65	6= 65+	Total
Tourism	20	8	12	0	5	4	6	4	1	20
Services	25	13	12	0	8	7	5	2	3	25
Agriculture	17	2	15	1	3	5	4	2	2	17
Local Authority	13	6	7	0	0	8	4	1	0	13
Other	23	5	18	0	3	2	5	9	4	23
	Total	34	64	1	19	26	24	18	10	98
	Percentage	35%	65%	1%	19,4%	26,5%	24,5%	18,4%	10,2%	100%

2.5.1 *Ecosystem Services*

The ecosystem services approach was developed through a simple list evaluation. Nearly all residents had not heard of “ecosystems services” before and there were frequently questions about the definition. This kind of approach obviously has a level of uncertainty and a more integrated approach is required in further study. However this survey procedure has been applied before in village environments effectively elsewhere (Hartel et al. 2014, in Romania). This survey did give a description of primary perceptions about benefits provided to local society by the island's ecosystems/landscapes. The importance given to “freshwater resources” and aesthetic attributes (fig. 2) were also corroborated in the semi-structured questionnaires that followed.

In figure 2 it is clear that the top five services include “aesthetic values” and “recreation in nature”. The lowest five services include hunting, wood provision, renewable energy. People responding “I don't know” were mostly in the “pest control”, “pollination”, “renewable energy”, “cultural identity” and “spiritual values” categories. We feel that in these ecosystem service categories there is a high amount of uncertainty, especially since the overwhelming number of people had not encountered the idea of ecosystem services before.

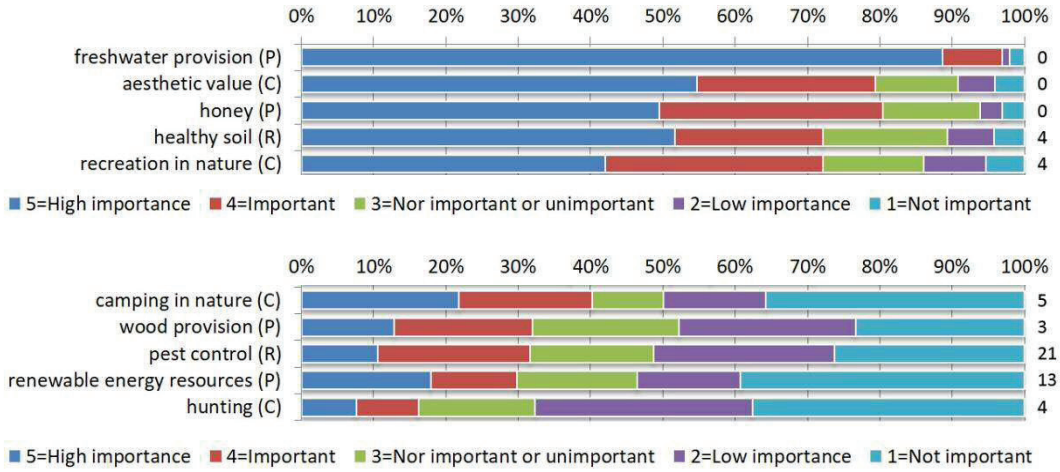

Fig. 2. The importance of ecosystem services for residents (P = provisioning service, S = supporting service, R = regulating service, C = cultural service. The number of people responding “I don’t know” is given on the right side of the figure. Only 10 of the 20 selected ecosystem services categories are presented here: The top graph shows the most favoured ecosystem services, the bottom graph the least favoured ecosystem services.

An assets-based approach such as an ecosystem services framework may be positive in creating understanding concerning environmental issues and conflicts. This kind of quick survey format may also make participants think about these issues. First, the approach informs local people to participate in resource issues and conservation challenges. This can then strengthen local peoples’ capacity to discuss sustainability and improve their interest in well-being, including reference to non-anthropocentric issues such as natural beauty usually hard to define.

2.5.2 Landscape and wind parks

As would be expected in a rural and fairly isolated Greek island world, the term “landscape” has many different meanings for locals. It seems many respondents equate landscape generally to “scenery” or “nature” or “environment”; many respondents asked back “what do

you mean by landscape?" during the face-to-face interviews. In the Greek language, landscape (Τοπίο) literally means "small-place/small locality"; it is quite an abstract concept. In fact it is easy to equate landscape with multiple ecosystems in a given area. Perhaps for many respondents the idea of landscape translated to specific place-areas.

We feel that the work shows that there is a pro-environment stance in a large number of residents. For example, in fig. 3 we compiled and coded the responses to an indirect question that explores resident's appreciation of the natural value of Samothraki: an overwhelming number of respondents answered within the code that encompassed "nature". There are also some interesting "contradictions" in the survey. In terms of "threats to the ecosystems and landscape", a very low percentage mentioned the wind farm development (although a substantial number were "against" it when interviewed specifically). The overwhelming pressure on landscape on the island is identified with "livestock overgrazing"; this is the top "anthropogenic pressure" cited most in this survey. Why are the interviewed residents so sensitive to this specific issue?

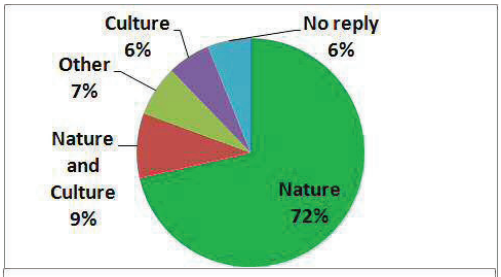

Fig. 3. Answer to the question: What makes Samothraki unique? This is indicative of the other questions that help interpret respondent's feelings about nature.

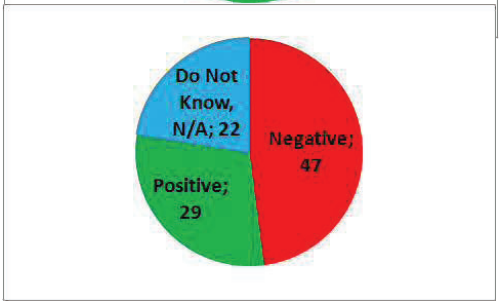

Fig. 4. Simple analysis of the respondent's stance on: Do you have a positive or negative stance towards the specific wind farms on Amoni-Louloudi ridge? (N: 98 respondents).

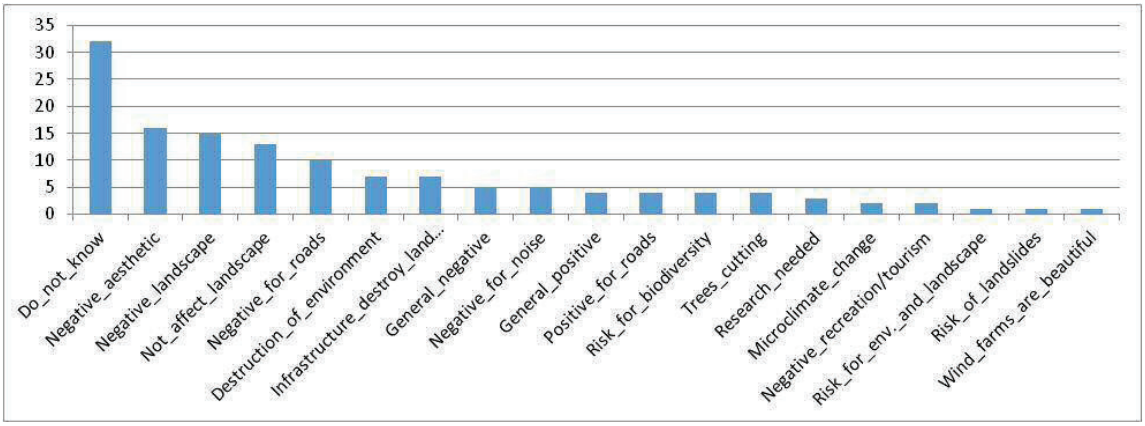

Fig. 5. Preliminary analysis of coded terms used in answers to the question "How do you believe the wind turbines could influence the landscape?" These are not % of respondents but percentages of answers (how many times each one features among the 136 answers that were totally collected out of 98 participants).

We also gleaned the first evidence that some residents perceive the important aesthetic benefits of the island of Samothraki. Many residents do appreciate the island's natural beauty and scenic areas; we gained evidence for this when they were asked to cite specific places on

the island of important cultural and spiritual value to them: most replies referred to natural landscapes (beaches, view-points, riverscapes). The “sacredness” of some of these places, a type of intangible cultural value, has been poorly evaluated in conservation studies. Figure 5 shows that the negative terms used for both landscape and aesthetics were prominent in the surmised effects the wind farms would have on Samothraki.

In contrast, a few people are glad to have the proposed wind park “out of the way” in the mountains, “where they will not bother people” (see fig. 5; “not affect landscape”). These “not-in-my-back-yard motives” are evident among a fairly large percentage of respondents. Through this survey, we feel that it is evident that Samothraki's respondents were generally poorly informed and conflicting interests remained unclear. More work on perception and education on landscapes (landscape literacy) may be important for the management and conservation of protected areas in Greece in general. This is also in line with the European Landscape Convention which obliges parties to ensure participation of the general public in the definition and implementation of landscape policies (Article 5, ECL 2000).

In the conservation history of protected areas in Greece, social factors and local community structure have been shown to significantly influence environmental policies and implementation; this reveals the importance of investigating local knowledge and perceptions during land-use planning and conservation management within protected areas. It has been shown in other protected areas in Greece that the provision of information significantly influences resident's perceptions on conservation issues; could the recent research on grazing by researchers in recent years be the reason “livestock grazing” is cited as the “top” environmental anthropogenic pressure on Samothraki in this survey? To our knowledge, issues of landscape protection, which include road-network planning, architecture conservation, urban and touristic sprawl, and industrial-scale developments in wilderness areas or on special habitats have not been well researched on this island so far, and these may become real threats to the future of the protected Natura 2000 site on Samothraki.

2.6 Appendix 1

Questionnaire

1. Ecosystem services rating 20 ecosystem service types, plus one provided by one of the respondents.

Semi-structured questions

1. Do you believe that the landscape of Samothraki is threatened? Circle: Yes, No, I do not know/ Why?
2. If Yes, which are the most pressing problems of the landscape? a. Currently, b. In the future.
3. What do you like most in the landscapes of Samothraki?
4. What is the most precious commodity in the landscape of Samothraki?
5. What makes Samothraki unique?
6. Are there special places which you visit for their unique cultural or spiritual values?
7. Have you heard about the proposed wind farms?
8. What is your opinion about the proposed wind farms?
9. How do you believe the wind turbines could influence the landscape?

3 Coastal morphodynamics of Samothraki with a focus on anthropogenic activities and sustainable development of coastal areas

Sophie-Marie Hohenwarter[1], Ann-Kristin Winkler[1], Rodrigo Zilleruelo[2], Christos Anagnostou[3], Anastasia Lampou[4]

[1]University of Natural Resources and Life Sciences, Institute of Social Ecology, Vienna, Austria,

[2]University of Edinburgh, School of GeoSciences, [3]Hellenic Centre for Marine Research, Institute of Oceanography, Greece,

[4]Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, Greece.

3.1 Introduction

Samothraki is an island in the Mediterranean Sea. Its location, geomorphological features and climate conditions make it special in terms of preserved nature. Furthermore, it is an excellent site for posing questions about sustainable development, in the context of an interaction between social systems and ecosystems. The human activities on Samothraki are embedded in a complex frame of socio-political structures, ranging from supranational to local institutions, which interact with the natural environment. Anthropogenic activities such as agriculture, aquaculture, industrial and tourist development can modify coastal processes and morphodynamics (Komar 1989, DHI 2017), whereas wave dynamics and sediment transportation shape the coastal areas[1] where these activities are carried out.

Through anthropogenic activities, like the modification of costal processes and morphodynamics, human activities can undermine the way in which certain ecosystem services are provided. This is ultimately affecting human wellbeing (MEA 2005). The objective of this report is to document the main aspects of Samothraki's coastal morphodynamics and understand how human activities are modifying them, while highlighting the importance of an Integrated Coastal Zone Management (ICZM).

3.2 Methodology

3.2.1 Study area

Samothraki is located in the north-eastern Aegean Sea, has a surface area of 178 km^2 and a population of 2,859 inhabitants. The climate on the island is of a Mediterranean type, but strongly influenced by humid sub-Mediterranean and continental winters (Skoulikidis et al. 2013). Winters bring rain and snow, and summers are hot and dry. The mean annual rainfall fluctuates between 604 mm and 671.4 mm (DEI 2011, Romaidis et al. 2010, Lampou 2012). The maximum elevation of the island is 1611 m.a.s.l. (Fengari top of Mt. Saos) and is characterized by short and high gradient rivers.

[1] Waves are determined by predominant winds, tidal influence and bathymetry. Sediment transportation is determined by river basin geomorphology, rainfalls precipitation and sediment size.

3.2.2 Field observations

Throughout the fieldwork, observation and analytical description was used to document the conditions of the Ammos and Fonias riverbeds and beaches. Moreover, the situation of two lagoons in the west of Samothraki as well as at the port of Therma was assessed. The drainage basins of the Ammos and Fonias rivers were classified according to the major water-drainage divisions. For each river the number of major bifurcations separating the drainage were recorded from the lowest order bifurcation to the bigger order. The size of each order, per river, was calculated using the measure tools within ArcMAP 10.4.

Measures of beach profiles were taken on Ammos and Fonias beaches, following the methodology proposed by Emery (1961). Sand samples were taken on each beach for a sand grain analysis. The sand size was measured using a mechanical sieve, separating fractions of >4, 2-4, 1-2, 0.25-1, 0.125-0.25, 0.063-0.125, <0.063 mm. The sediment sample size was classified qualitatively according to Ihwin et al. (2013, p. 194).

3.3 Results

3.3.1 Ammos drainage basin and coastal system

The predominant materials forming the Ammos river basin are granite with inclusions of feldspar and quartz crystals. The Ammos river basin has less streams than the Fonias river basin and three orders are clearly identified (fig. 1). The main stream of the river is from a third order. The upper part of Ammos river is dominated by the presence of big stones that are left behind while the smaller sediments have been transported further down. Because the general slope of the upper part of the river basin is very steep, the transportation process of the material is fast.

Before arriving at Ammos beach, a lowland is clearly visible. The biggest rocks that have been transported remain on the river mouth, on an area which precedes the beach itself. After this area, the smaller sediments form a sandy pocket beach. This situation leads to the wave-dominated beach dynamics instead of being influenced by the riparian dynamics. The beach dynamics are also influenced by aeolian transport of fine sand which has formed dunes on the beach back.

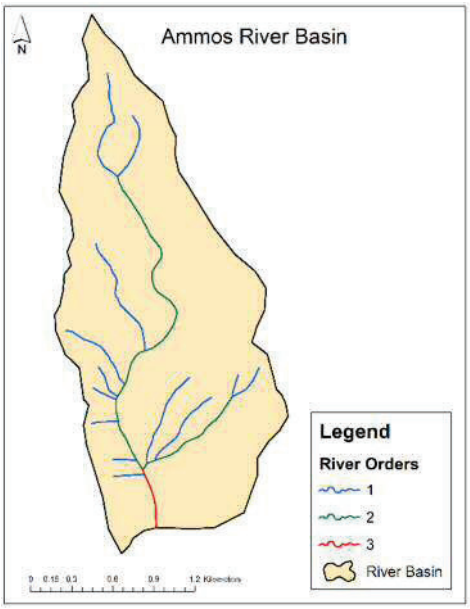

Figure 1. Ammos river basin drainage orders

Ammos beach profile presents a homogeneous slope along all the transect with a small crest (at PAR 2, fig. 2). Ammos beach is mainly composed of granites, quartz and feldspar sediments, ranging from fine gravel to medium size sand (1 - >4 mm). The approximate position of the PAR 1-7 samples on Ammos beach can be seen in figure 2. There are evident differences among the seven samples collected. PAR 1, 3, 5 are almost completely composed by a fraction bigger than 4 mm, while PAR 2, 4 and 7 have a more heterogeneous composition (fig. 3).

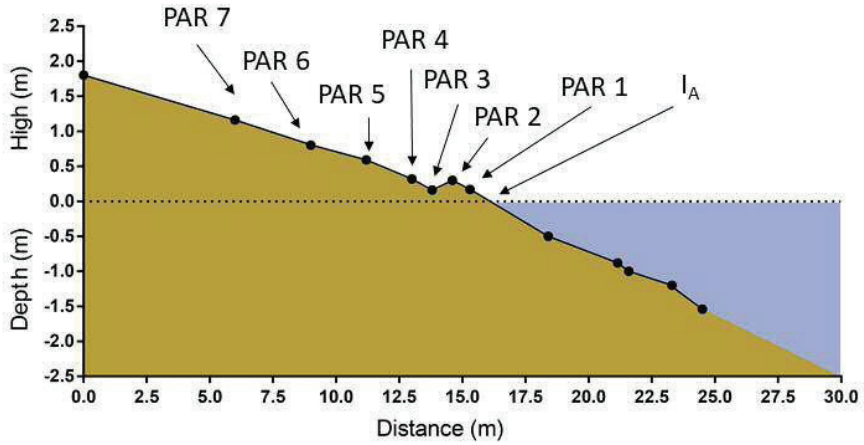

Figure 2. Ammos beach profile. PAR 1-7 correspond to sand samples. I_A is the point where the beach and the sea intersect.

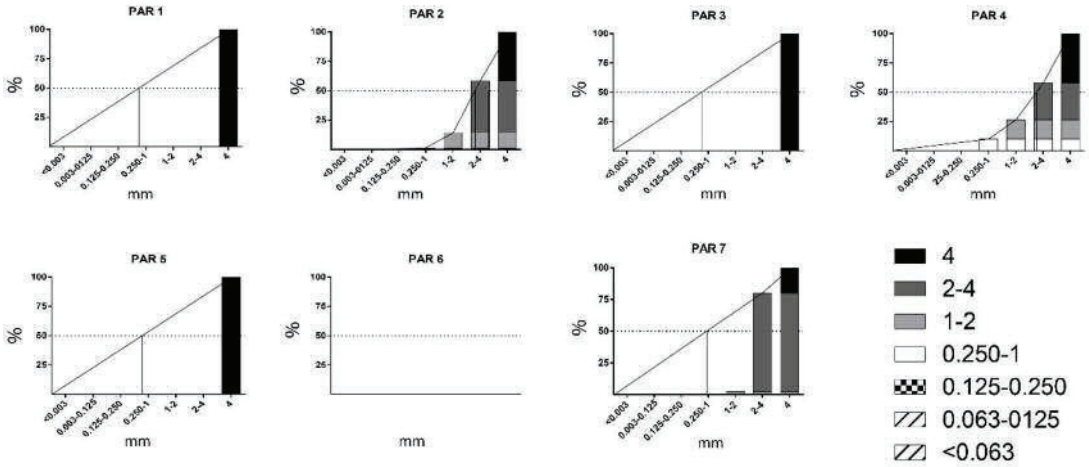

Figure 3. Sediment size analysis of different samples (PAR 1-7) collected at Ammos beach. The vertical line intersecting the 50% of cumulative indicates the mean sample size.

3.3.2 Fonias drainage basin and coastal system

The Fonias river basin is located at the North-East part of Samothraki (fig. 4). The drainage system is characterized by exhibiting a dendritic form and has four orders; the main stream runs on a fourth order bifurcation. Fonias tower beach profile shows a slightly upward zone in the first 0 - 6.3 m (point A, fig. 5). Afterwards the slope goes downward with a smooth shape and only one small (0.55 m) crest at point B (2.8 m from point I_{FT}). It reaches a depth of 2.0 m at point C (28.30 m from the point I, fig. 5). Sediments from the Fonias River Bed (FRB) are mainly composed of materials bigger than 0.250 mm; 45.89% of the sediments are formed by fine up to medium sand grains (0.25 – 1 mm); 40.41% correspond to medium (1-4 mm) and coarse sand and 11.99% is fine to coarse gravel (>4 mm; fig. 6). The sediments are mainly formed by granite and basalt.

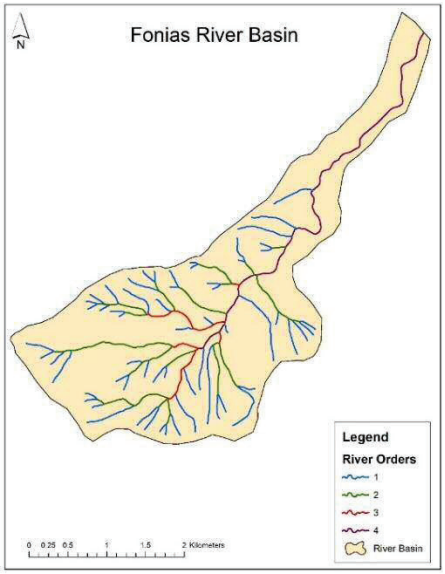

Figure 4. Fonias river basin drainage orders.

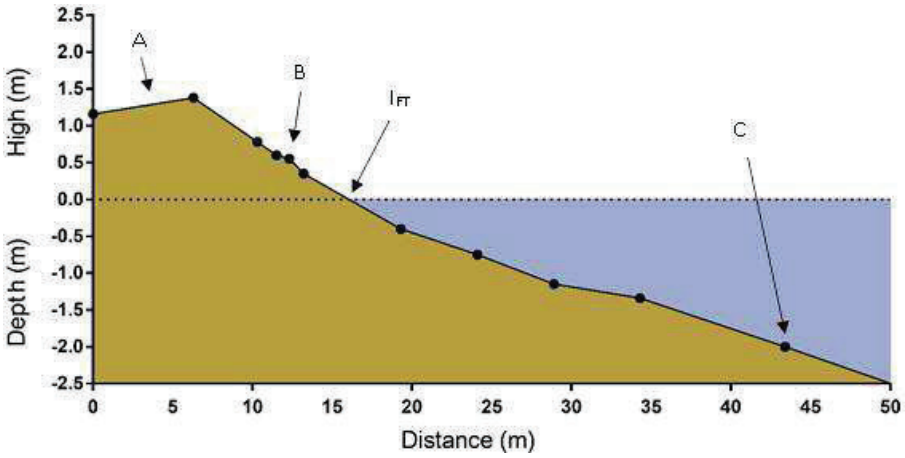

Figure 5. Fonias beach profile. Point A represent an upward zone; B a small crest on the beach profile; I_{FT} the point where the beach intersects with the sea and C the deepest measured point.

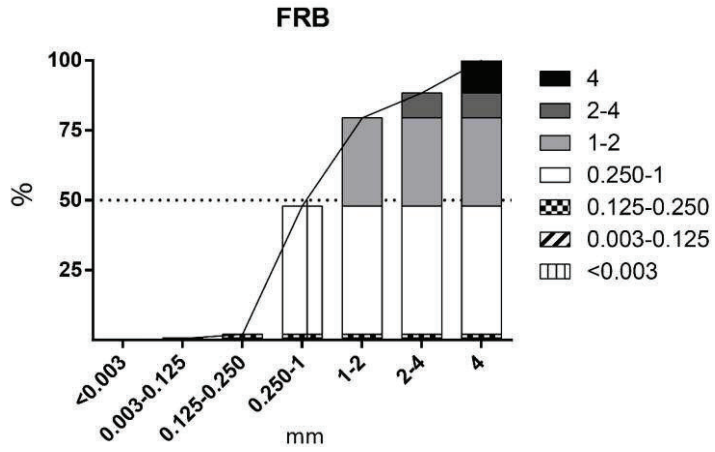

Figure 6. Fonias River Bed (FRB) sediment size. The accumulative composition of sediment size (x axis, mm) percentage is represented on the y axis. The vertical line intersecting the 50% indicates that the mean size of the sample collected in FRB is on the 0.250 - 1 mm fraction.

3.3.3 Therma Harbour

In Therma, which is located on the Northern part of the island, a harbour was constructed 22 years ago. The construction has modified the natural patterns of sediment transportation along the coastline. The sediment transportation in coastal areas is determined by the longshore-drift, which in turn is determined by the predominant winds and currents. However, this process is highly sensitive to the construction of hard engineer structures (Komar 1998). Consequently, the harbour construction has produced undesired effects.

First, the harbour's breakwater interrupted the sediment supply for the area where the seawall has been constructed to hold the road (Point 1, fig. 7), while the long-shore transport keeps moving sediments to the West. This process has caused coastal erosion on this area and has lead to the road being undermined. Second, the harbour's breakwater is accumulating a sandbar on its Western end. This process is continuously closing the harbour's mouth, forcing the community/authorities to dredge the sand bar in order to keep the harbour functioning, or it will become too shallow for the boats. The same situation has been reported on similar harbours (see Komar 1998, pp. 380-390). Finally, the hard-engineer armouring of the

coastlines produces a negative effect on the aesthetic appeal of the island. The concrete structure has a disruptive effect on the natural and beautiful landscape of the island (Scyphers et al. 2015).

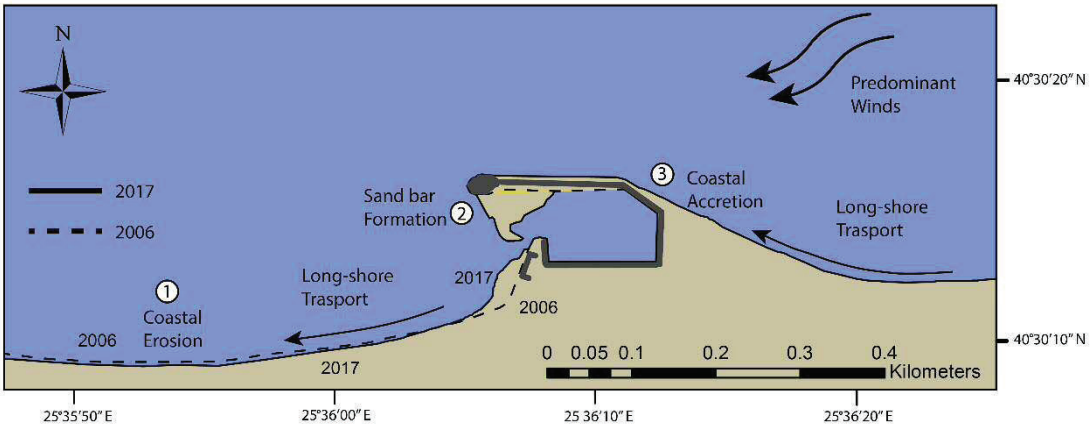

Figure 7. Therma harbour coastal dynamics. The diagram shows the temporal evolution from 2006-2017. Point 1 shows coastal erosion, 2 the sand bar formation and 3 coastal accretion (Data source: Google Earth).

This situation poses a significant risk to the communities that live in the North-East of the island. The erosion of the road can lead to an isolation of the major settlements on the island (e.g. Kamariotissa). As a general conclusion, the construction of Therma harbour is an example of weak planning. The harbour must continuously be dredged to be operative and introduces a visual disruption on the natural landscape.

3.4 Discussion

This report is documenting basic information about the Ammos and Fonias river basins and coastal systems, such as drainage orders, beach profiles and grain sizes of the sediments. By using the Therma harbour as an example, this report presents the problems associated with public projects that are implemented without following an Integrative Coastal Zone Management. Therma harbour reveals the necessity of an interaction between different disciplines; not only engineers are needed to design a harbour. A social-ecological perspective on future projects on the island could be helpful in order to achieve sustainable development and prevent damage from wrong decisions. Scientists coming from natural sciences and those coming from social sciences need to collaborate with engineers, authorities and of course the local population. This iterative process would prevent resolute views on future projects and would serve as a self-regulating system.

Since coastal areas, such as beaches, are common goods and subject to the tragedy of the commons (Daly and Farley 2011, Hardin 1968), the development of public projects must be carefully addressed. For example, the aquaculture project proposed for Southern Samothraki should be studied and approved by the local community and also by scientists. Although this has not been commented upon on the current report, the authors are aware that a project like this could produce undesired effects on the coastal-marine environment, including coastal erosion, eutrophication and pollution.

In order to further empower the Samothraki inhabitants to contribute in shaping the future of the island into a direction they like, communication between authorities and the locals must

be on top of the agenda. Moreover, collaborations between people living on Samothraki, as well as tourists and visiting scientists would enhance the social-economic infrastructure. Local associations and organizations, such as "Sustainable Samothraki", could be helpful in this respect, because they can act as intermediates between multiple stakeholders. Project evaluation should consider analytical use of Cost-Benefit Analysis (CBA) and especially Social Multi Criteria Analysis (SMCA; Garmendia and Gamboa 2012) to develop a transparent and deliberative process of decision making.

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4 Hydrometeorological and hydrochemical analysis of the Fonias river basin on Samothraki, Greece

Lucia Pollakowski[1], Victoria Matejka[1], André Baumgart[1], Anastasios Papadopoulos[2], Elias Dimitriou[2], Nikolaos Skoulikidis[2]

[1]University of Natural Resources and Life Sciences, Institute of Social Ecology, Vienna, Austria,

[2]Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, Greece.

4.1 Introduction

Monitoring the water quality of streams in areas under touristic pressure, such as on Samothraki island, is an important task to ensure that both sustainable development and environmental preservation is achieved (Skoulikidis et al. 2014). Such measurements must be conducted on a regular basis for long periods in order to be able to identify degradation trends and undertake the appropriate mitigation measures on time. Moreover, the hydrometeorological conditions should be considered in combination with the water quality monitoring results to assess the actual status of the water resources and interpret the measured values effectively. For the design of policy measures to reduce pollution levels it is imperative to study the impacts of climate change on the local hydrologic regime and incorporate the identified impacts in the water resources restoration plan. In this report, a water quality assessment, trend and climate change scenario analysis has been attempted for the Fonias river on the Greek island of Samothraki. The report is based on past and recent hydrometeorological and hydrochemical data sets, covering the period from 1982 to 2018. It also includes stream quality data gathered during the 2018 Summer School. In the present effort, potential temporal trends in the nutrient pollutants' loads have been analyzed and the impacts of the reduction of rainfall as a result of climate change on the future nutrients levels have been quantified.

4.1.1 Case study area

The case study area is the drainage basin of the Fonias river in the north east of Samothraki. The whole catchment covers an area of approximately 9 km^2. The majority of tributaries are situated in transitional forests, shrubs and low vegetation areas. In the lower part, the river flows mainly through forest areas and it finally outflows, near the Fonias tower, in the northern Aegean Sea. Within the basin, 70,2% of land use is occupied by grazed scrubland (Skoulikidis et al. 2014). In contrast to other cold-water streams of the island analyzed by Skoulikidis et al. (2014) there are no permanent human settlements in the river basin. The Fonias river has a permanent flow throughout the year.

Description	Area (m2)	% of total
Bare Land	148437.46	1.58%
Forest	1432649.36	15.25%
Shrubs and low vegetation	2326760.68	24.77%
Transitional Forest to low vegetation area	5300527.10	56.42%
Wetlands	22732.74	0.24%
Natural Meadows - Grasslands	164011.38	1.75%

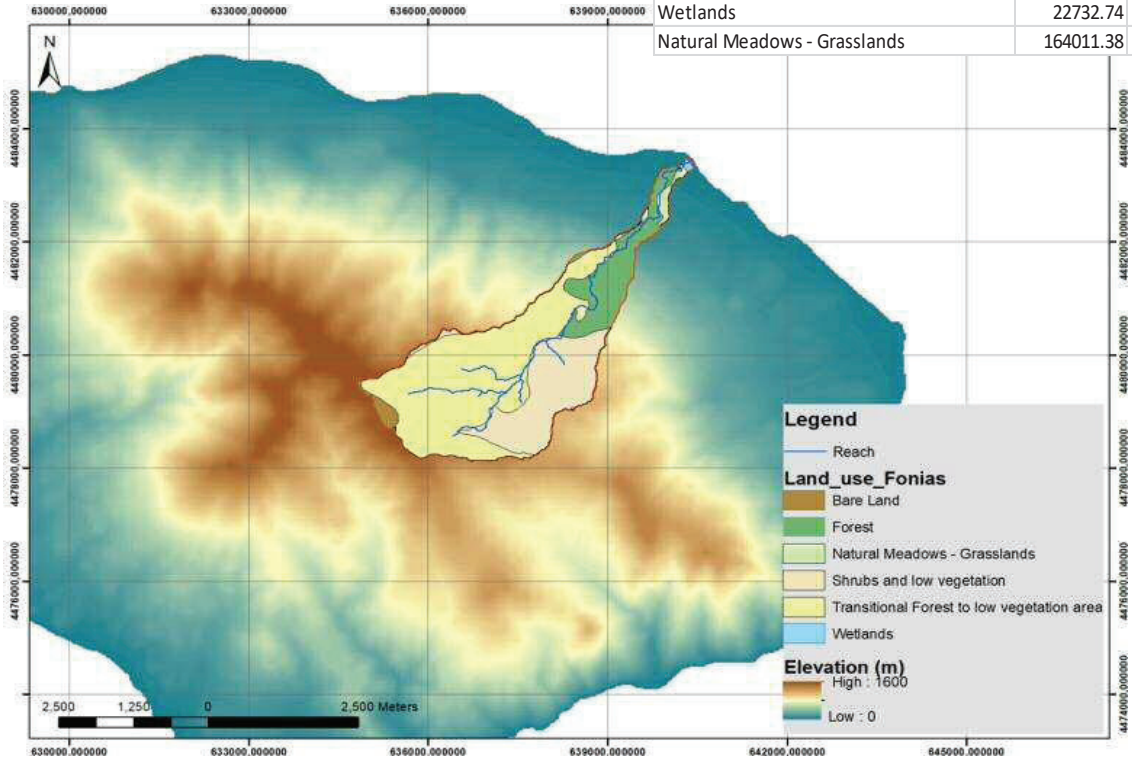


Fig. 1. Map of the Fonias basin on Samothraki island and its surrounding land use types.

4.1.2 Geology of the basin

Geologically, the Fonias basin is predominantly covered by granite (81,7% of the total extent, Skoulikidis 2014), which is a hard, plutonic rock and therefore provides waters with low content of ions (and therefore low electrical conductivity values). The remaining geological components are ophiolite and alluvial sediments.

4.1.3 Meteorological conditions of Samothraki

The meteorological characteristics of Samothraki are comparable to those of the Evros region in north-eastern Greece with dry summers and high rain- and snowfall during the winter months (Matzarakis 2006). The average temperature reaches 25 °C in July and 10 °C in January, while the mean annual precipitation is estimated to be 605 mm in the lowland and is highest in December with an inter-annual mean of 140 mm (fig. 1). The lowest precipitation is observed in July (inter-annual mean 8 mm).

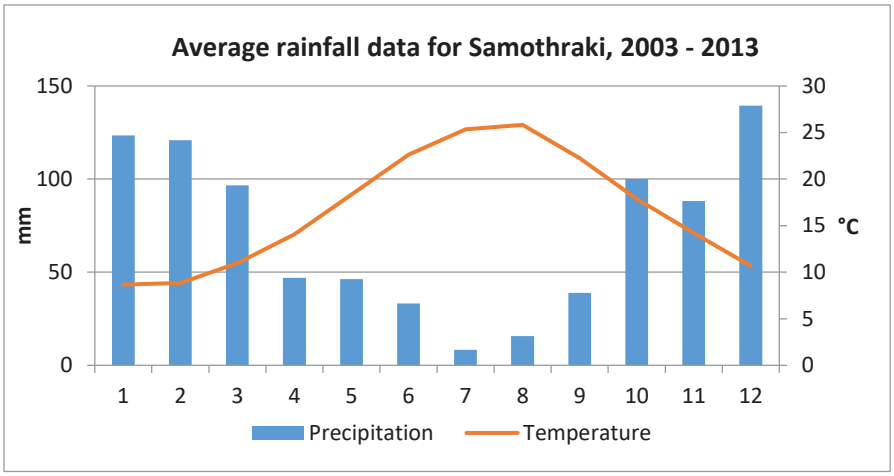


Fig. 2. Mean monthly inter-annual precipitation variation.

4.2 Methodology

The main hydrochemical parameters related to the pollution pressures on Samothraki island (urban sewage, animal waste and fertilizers) are the nutrients (NO_2, NO_3, PO_4 and NH_4). Thus, in this effort, dissolved nutrients in eleven river sites (two sites in six different streams, one site upstream and another downstream) have been measured in situ by using Merck Spectrophotometer Nova 60. Moreover, the basic physicochemical parameters (pH value, temperature, dissolved oxygen, electric conductivity, turbidity) have been also measured in situ with a Horiba U-50 Multiparameter water quality meter. Nevertheless, a complete analysis and interpretation of the results on Fonias river only is presented in detail in this report.

Moreover, discharge measurements were recorded by using a Swoffer 2100 flow meter in order to estimate the pollutant loads (kg/s). Pollution load gives important information since it expresses the total mass of a specific pollutant that is either produced or reaching a water body at a given time and is calculated by multiplying discharge (m^3/s) and concentration of a pollutant (kg/m^3).

The Nutrients give us important indices for pollution from fertilizers, animal and human wastes and atmospheric deposition. Skoulikidis et al. (2006) established a system to classify the quality status of rivers in 5 classes (from “high” to “bad”), according to nutrients concentrations, which we use in this report.

Table 1. Nutrient Classification System (NCS) for $N\text{-}NO_3$, $N\text{-}NH_4$, $N\text{-}NO_2$ and $P\text{-}PO_4$

	HIGH	GOOD	MODERATE	POOR	BAD
$N\text{-}NO_3^-$ (mg/l)	<0,22	0,22-0,60	0,61-1,3	1,31-1,8	>1,8
$N\text{-}NH_4^+$ (mg/l)	<0,024	0,024-0,060	0,061-0,2	0,21-0,5	>0,5
$N\text{-}NO_2^-$ (µg/l)	<3	3-8	8,1-30	30,1-70	>70
$P\text{-}PO_4^{3-}$ (µg/l)	<70	70-105	106-165	166-340	>340

The discharge is the volume of water flowing in a river at a given moment and is calculated by multiplying depth, width and velocity of river water at a cross section of the river. Discharge changes influence aquatic ecosystems and also the available resources for drinking, irrigation and industry of a society. The comparison of pollution loads with the concentrations will provide important information about changes in the polluting patterns and hydrologic regime of the island. Significant changes in pollutants concentrations without corresponding alterations in the respective loads implies higher impact from the hydrometeorological conditions and vice versa. Strategic water management needs to take these data into account in order to design water infrastructure and mitigation measures for pollution.

By analyzing the trends in both pollutant concentrations and loads over time we can identify changes in the pollution patterns of the island. By incorporating climate change scenarios the impacts of potential hydrologic alterations on the pollution regime can also be studied. For this purpose, we used regional predictions for northeastern Greece of the Intergovernmental Panel of Climate Change (IPCC) for precipitation and air temperature changes until 2100 (IPCC 2014) to estimate the surface runoff and the associated water quality changes in the river. In this way the future pollution loads were estimated and compared to the current ones to identify the potential climate change impacts on the pollution levels of the island.

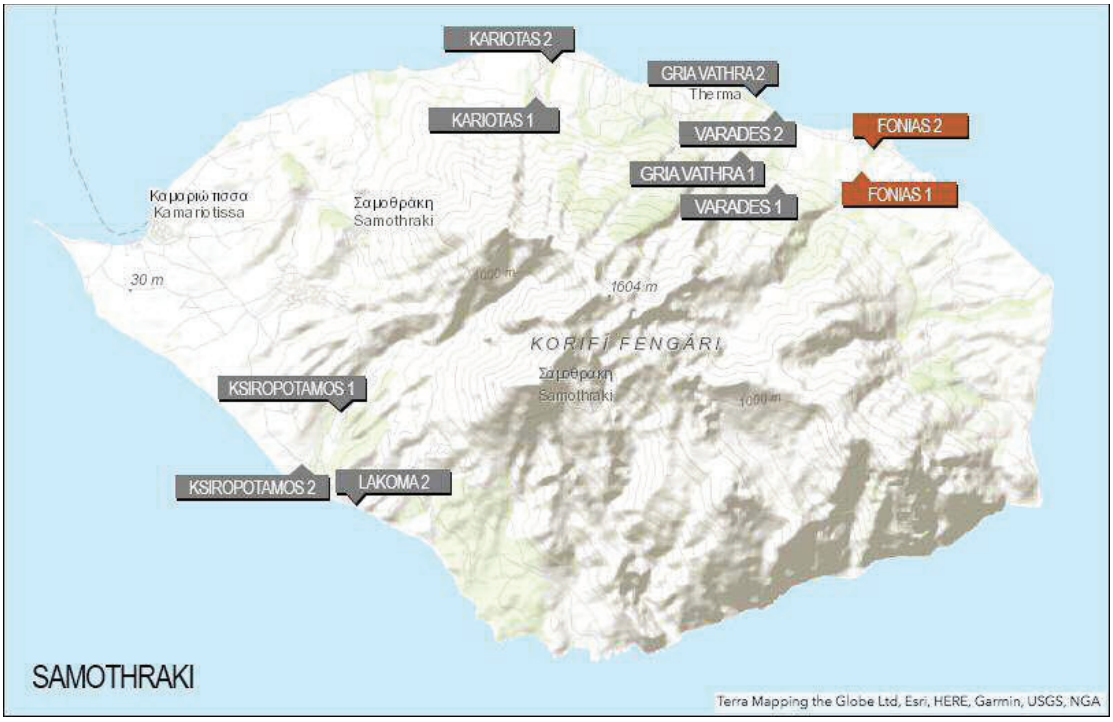


Fig. 3. Map of Samothraki island indicating sampling sites.

4.3 Results

4.3.1 Trends of temperature and precipitation

The past data allows us to reveal trends in the Island's hydrometeorological conditions which will be then used to explain the water quality monitoring results. The parameter R^2 has been used to identify the strength of a trend while the p statistical parameter has been used to justify the statistically significant trend only. The R^2 between two data series indicates how well the variability of the first data series is explained by the values of the second data series.

If R^2 is just above 0.3, we can infer that the data shows a relatively weak trend, while if it is above 0.6 the identified trend-relationship is strong.
Figure 4 shows an increasing trend of temperature on Samothraki between 1979 and 2014, whereas precipitation is highly fluctuating without indicating a significant trend.

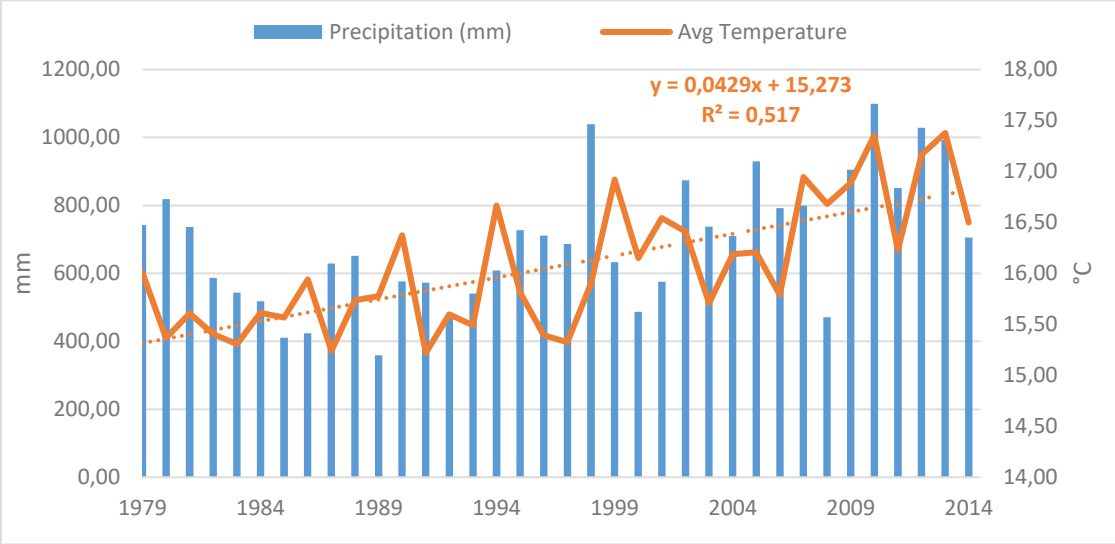


Fig. 4. Precipitation and mean annual temperature on Samothraki from 1979 to 2014
As shown in the following figures, precipitation varies most dramatically in winter, showing a slightly increasing trend. Here the R^2 has a value of approximately 0.07. In spring, R^2 is lowest with a value of 0.065. However, the data of all four seasons indicate a trend of increasing precipitation.

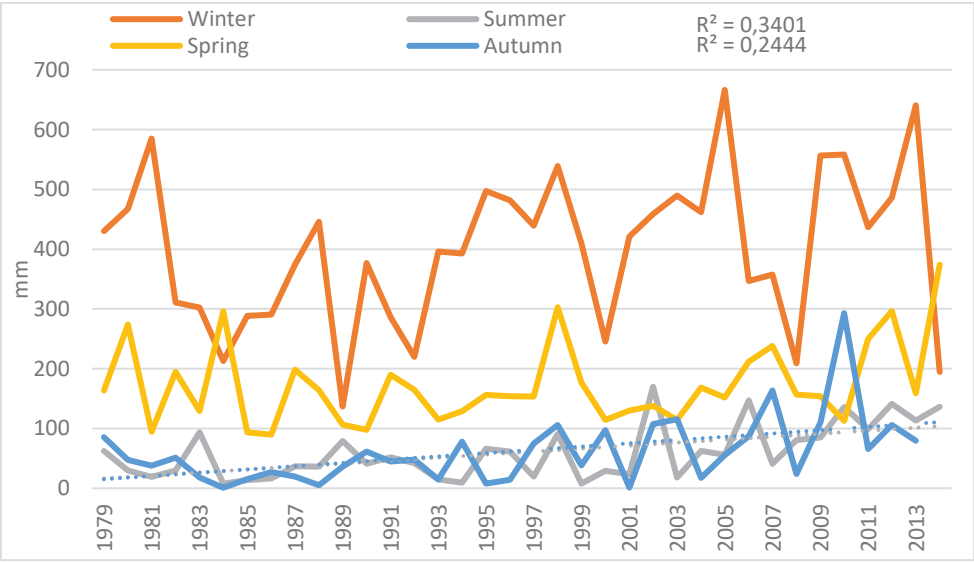


Fig. 5. Seasonal precipitation on Samothraki from 1979 to 2013.

4.3.2 Water quality assessment for the study case Fonias River

Nutrients are important indicators for the socio-ecological interactions in a given area. An increase of nitrogen is an indicator for a potential increase of fertilizers dissolved in the water, because of an increase of human and animal waste or of atmospheric deposition. The main driver for ammonia is usually human and animal waste, while changes in phosphate can be explained by alterations in the disposal of waste water in fertilizer application. Phosphorous

remains mainly in the soil and therefore a relatively low percentage is dissolved in water. However, in case of intensive soil erosion one can find higher levels of phosphate in the water.

An increase of all mentioned nutrients can lead to eutrophication (an explosion of aquatic plants such as algae that cause a decrease of oxygen in the water). As a result, biodiversity in the river ecosystem decreases and species which are tolerant to the lack of oxygen dominate.

Table 2. Descriptive statistic table of nutrients in Fonias from 1982 to 2018, compared to data from 2018.

Years	NO_3 (mg/l)	NH_4 (mg/l)	PO_4 (mg/l)
Average	1.94	0.04	0.12
Max	4.74	0.23	0.40
Min	0.15	0.00	0.01
STD	1.32	0.07	0.12
2018	3.11	0.01	0.10

There are physicochemical data of the Fonias river from 1982 to 2018 with major gaps (data for 13 years are available only). In comparison to the overall average across all years, the value of NO_3 in 2018 (3.11 mg/l) is quite high but lower than the overall maximum. NH_4 and PO_4 values are both lower than the overall average.

As nutrient concentrations typically change throughout the year, comparing the average concentrations of the same month would give even more relevant information. Unfortunately, 2018 was the first measurement in the month of June. However, in comparison to the average concentration of May and August throughout the years since 1982, the value of NO_3 is very high, while NH_4 and PO_4 are close to the average.

Table 3. Average data of May and August (1982–2018) in comparison with data from June 2018.

Months	NO_3 (mg/l)	NH_4 (mg/l)	PO_4 (mg/l)
Avg May	1.042	0.006	0.012
Avg August	1.610	0.149	0.247
June 2018	3.11	0.01	0.1

Tables 2 and 3 show high values of nitrogen. There is no known fertilization in the catchment area of the Fonias river, so this can be excluded as a driver for increased NO_3. The impact of atmospheric pollution can be neglected. It can therefore be assumed that in spring and early summer 2018 there was an increased deposit of human and/or animal waste in the area around Fonias river or its tributaries. For an increase of human waste a higher amount of touristic activity in this area could be responsible. An increased amount of animal waste is conceivable due to more pasturing activity of goats.
Further monitoring of the NO_3 values has to be done. If the nitrogen level continues to rise, then the exact drivers have to be found and an appropriate management plan has to be set up to avoid eutrophication of the rivers and a decrease in biodiversity.

4.3.3 Classification of water measurements

According to the classification scheme of Skoulikidis et al. (2006), the water samples from Fonias river for 1982 to 2018 are classified in table 4.
The classification shows that NH_4 and PO_4 are most of the time in good condition whereas the value of NO_3 varies, sometimes even classified as poor. The values for 2018 show a moderate condition for NO_3. On average, the water quality varies between moderate and high and therefore one can say that the physiochemical condition of the Fonias stream is not critical and in rather good condition.

Table 4. Classification of nutrient values in the Fonias stream according to NCS (for an explanation of the colour codes, see table 1).

Years	Avg N-NO_3 (mg/l)	Avg N-NH_4 (mg/l)	Avg P-PO_4 (µg/l)	Avg Classification
1982	0.092	0.039	-	HIGH
1983	0.055	-	-	HIGH
1985	0.799	-	-	MODERATE
1986	0.571	-	-	GOOD
1988	0.685	-	-	MODERATE
2000	1.153	0.177	197.5	MODERATE
2001	1.271	0.016	135	GOOD
2010	0.575	0.010	40	HIGH
2011	0.092	0.001	7.764	HIGH
2012	1.744	0.016	40	GOOD
2013	0.461	0.003	15	HIGH
2014	0.632	0.009	3.948	GOOD
2018	1.146	0.010	50	GOOD

Unpublished data from Skoulikidis (personal communication) show that in 2014, the theoretical contribution of the goat excrements may have been as high as 15% for nitrogen and even 83% for phosphorus. This indicates that an intensification of goat farming has a strong impact on the water quality.

The Fonias river is a major attraction for tourists to walk up the valley and swim in the river. As a consequence, it is threatened by pollution of human waste (e.g. urine containing ammonia) more than other rivers due to higher touristic activity. However, this effect is not visible in the data, quite possibly due to the fact that “any pollution sources existing in the basins (i.e. small-scale agro-industrial development, municipal wastes and localized tourism activities) seem to be balanced by high quantities of clean, turbulent waters resulting from the extensive mountainous topography and steep slopes” (Skoulikidis et al. 2014). With increasing tourist numbers, the pollution could rise, which is why the quality should be monitored.

Tables 5 and 6 show a water classification of all six rivers measured in June 2018. The Lakkoma stream has exceptionally high levels of phosphorus and only moderate quality of NH_4 (NO_3 could not be measured due to technical difficulties). The Ksiropotamos stream has rather poor results concerning NO_3. High amounts of algae could be observed on site.

Table 5. Classification of nutrient values of the streams (sample 1 = upstream, sample 2 = downstream site).

Stream (sample)	N-NO_3 (mg/l)	N-NH_4 (mg/l)	P-PO_4 (mg/l)
Fonias 1	1,7	0,01	0,05
Fonias 2	0,6	0,2	0,05
Varades 1	<0,5	0,03	0,04
Varades 2	1,1	<0,2	0,01
Kariotas 1	0,5	<0,2	0,03
Kariotas 2	0,8	<0,2	0,03
Lakkoma 2	-	<0,2	0,39
Kria Vathra 1	0,5	<0,2	0,02
Kria Vathra 2	0,6	<0,2	0,03
Ksiropotamos 1	1,7	<0,2	0,03
Ksiropotamos 2	1,4	<0,2	0,01

Table 6. Physicochemical and nutrient measurements of the streams (sample 1 = upstream, sample 2 = downstream site).

Stream	pH	Conductivity mS/cm	DO mg/l	Temp. °C	Turb. NTU	N-NO_3 mg/l	N-NO_2 mg/l	N-NH_4 mg/l	P-PO_4 mg/l	Discharge m3/s
Fonias 1	7,4	76	10,2	23,9	0,9	1,7	0,022	0,01	0,05	0,04845
Fonias 2	7,8	83	7,7	25,8	0,9	0,6	0,018	0,2	0,05	0,09876
Varades 1	6,9	109	7,8	21,1	1,8	<0,5	0,019	0,03	0,04	0,0117
Varades 2	6,7	111	8,5	20,9	3,3	1,1	0,021	<0,2	0,01	0,0126
Kariotas 1	7,3	206	7,7	18,1	0,5	0,5	0,019	<0,2	0,03	0,000368
Kariotas 2	8,1	171	8,5	20,8	0,4	0,8	0,015	<0,2	0,03	0,0056
Lakoma 2	8,2	580	5,8	25,4	33,2	-	0,023	<0,2	0,39	-
Kria Vathra 1	7,2	108	8,4	20,5	0,5	0,5	0,017	<0,2	0,02	0,05
Kria Vathra 2	6,9	155	6,1	19,9	0,7	0,6	0,016	<0,2	0,03	0,004825
Ksiropotamos 1	8,2	266	9,0	19,7	0,8	1,7	0,016	<0,2	0,03	0,07425
Ksiropotamos 2	7,9	369	9,3	18,8	0,7	1,4	0,018	<0,2	0,01	0,00672

Variations in the results can be observed, especially in the values of conductivity. This may well be due to the existence or absence of granite rocks in the river basins. Granite is a rather hard material which does not dissolve easily in the water and therefore does not release significant amounts of ions into the river water. The Fonias river, for example, was shown to have a low conductivity because of the presence of granite rocks in the catchment area.

4.3.4 Nutrient loads and concentration over time

Figures 6-8 show historical data of nutrient concentrations and loads in the Fonias river since 1982. Concentrations vary strongly over the years. For NO_3 we can observe an extremely high load in 1986, while the average concentration is relatively low (fig. 6). This means that the NO_3 production was very high but the discharge level in the specific measurement period was also very high. Moreover, it can be seen from figure 6 that during the period 1982 to 1986, there was an increasing pollution trend in NO_3 which was then significantly reduced in the following years and remained within low levels until today.

Regarding NH_4 and PO_4, relatively high levels were observed in the periods 1982-1983 and 2000-2001 respectively, while in the next years the levels dropped significantly (fig. 8,9). These periods may coincide with changes in the waste water and agrochemicals management on the island and/or with significant hydrologic alterations (eg. transitions from wet to dry periods). Grazing animals are also another important source of NH_4 and PO_4, and the number of animals as well as their fluctuation over time is a crucial factor expected to influence nutrient concentrations. According to Fetzel et al. (2018), based on data from ELSTAT, there has been a strong increase of livestock numbers on Samothraki from the mid 1980s (with about 35.000

animals) to about 65.000 in 2002, then decreasing again down to about 45.000. This is not so clearly mirrored in the pollution indicators for the Fonias river below.

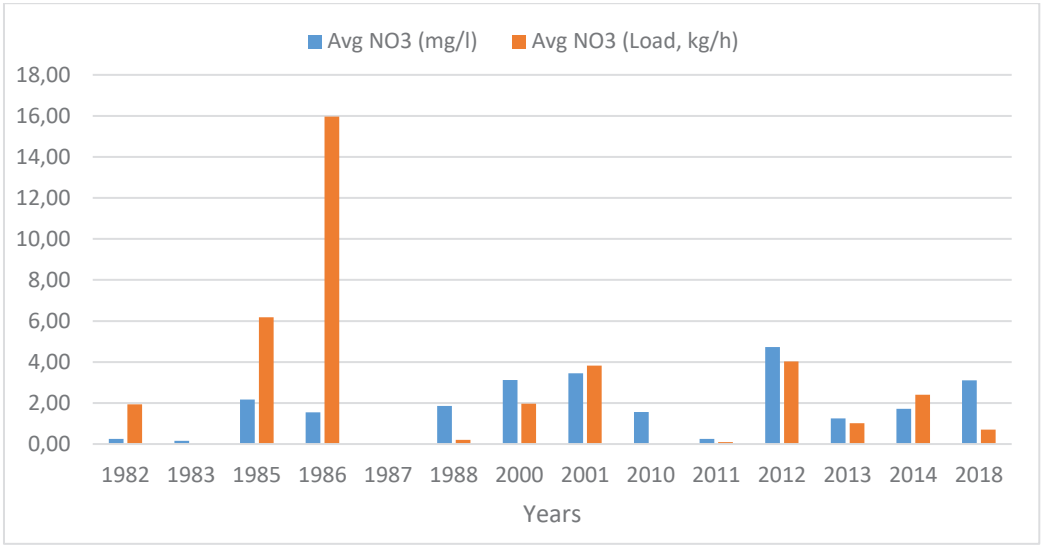
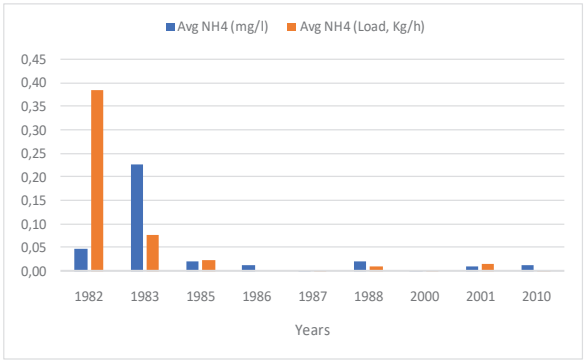


Fig. 6. Annual fluctuation of NO_3 concentration and load from 1982 to 2018.



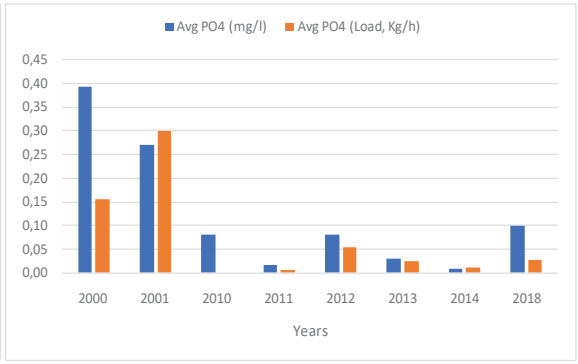


Fig. 7. Annual fluctuation of NH_4 concentration and load, Fig. 8. Annual fluctuation of PO_4 concentration and load.

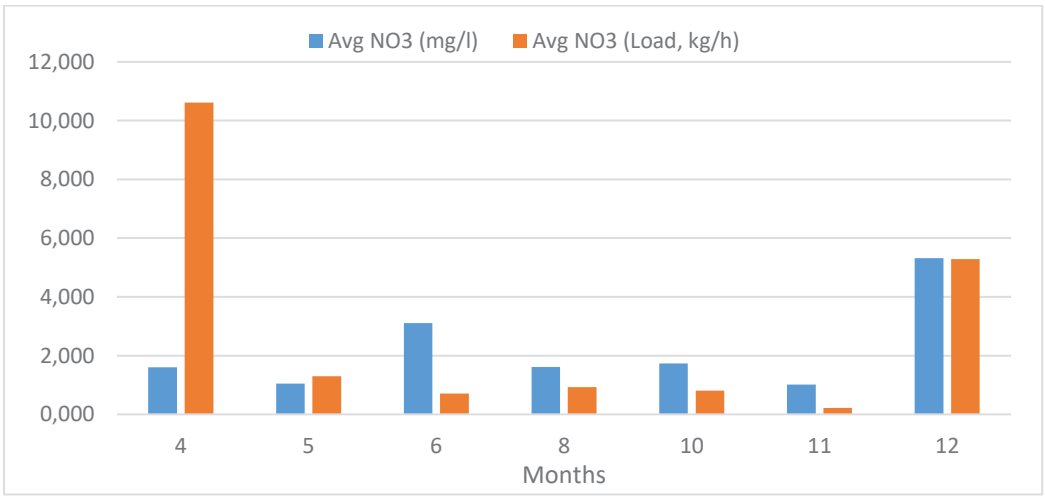


Fig. 9. Monthly fluctuation of NO_3 concentration and load (averages across 1982 to 2018).

Less precipitation in the summer months leads to reduced load and high concentrations in general. The highest loads of NO_3 were observed in the months of April and December (fig. 9) and the highest concentrations in December and June. The reason for high concentrations in the winter months could be the flush-events: After a long dry period, heavy rain washes out a large amount of nutrients from the catchment into the rivers. However, the figures have to be used with caution since in some months, there has been only a low number of measurements.

4.3.5 IPCC scenarios

The IPCC developed several climate change scenarios to predict changes in the water cycle in the next 40 to 80 years according to the anticipated socioeconomic changes. The main assumptions for each scenario are illustrated in Table 7.

Table 7. Main characteristics of each Representative Concentration Pathway (RCP).

Scenario Component	RCP2.6	RCP4.5	RCP6	RCP8.5
Greenhouse gas emissions	Very low	Medium-low mitigation Very low baseline	Medium baseline; high mitigation	High baseline
Agricultural area	Medium for cropland and pasture	Very low for both cropland and pasture	Medium for cropland but very low for pasture (total low)	Medium for both cropland and pasture
Air pollution	Medium-Low	Medium	Medium	Medium-high

4.3.5.1 Surface runoff

The following graph shows a comparison of the monthly surface runoff in the past (1961-1990), the present (1991-2015), and for four different IPCC-Scenarios. It should be noted that the data used are from climate models that present average changes for Greece, which are not necessarily representative for Samothraki.

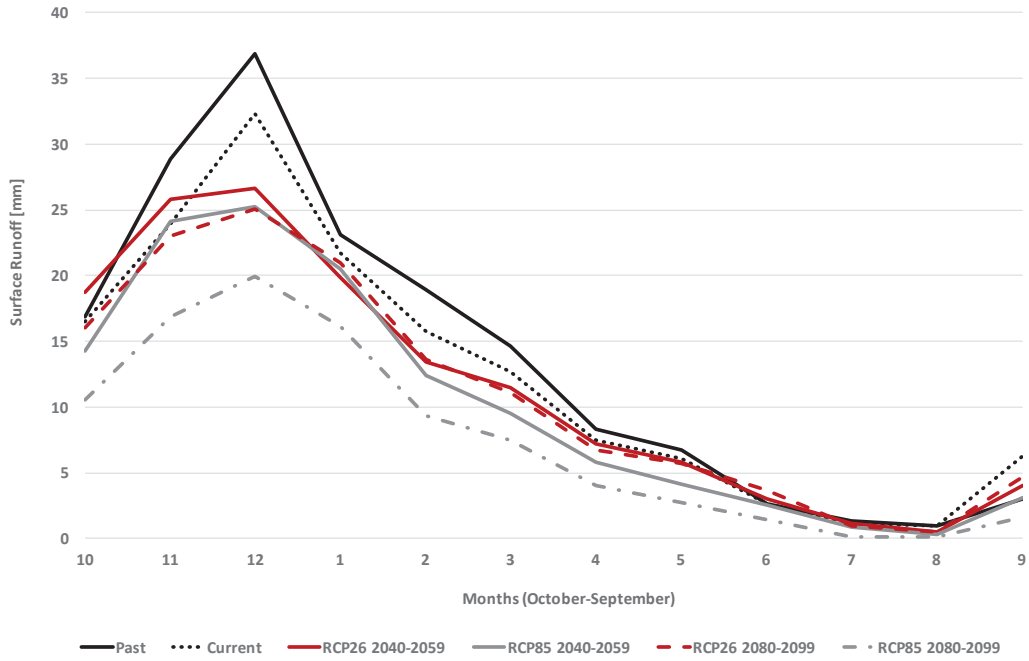


Fig. 10. Surface runoff: Comparison of IPCC scenarios

All scenarios forecast a decrease of surface runoff. The most pessimistic scenario (RCP8.5) shows a decrease of around 10mm. The largest changes take place in the winter season, while winter precipitation (fig. 5) has not decreased during the last 40 years on Samothraki. Most probably this can be explained by the fact that snow is not taken into account in calculating the increase of precipitation. Snow is not estimated in local data measured by meteorological stations which is why there has been no decreasing trend in precipitation over the past four decades, while at the same time the IPCC data from figure 10 shows a clear decrease of precipitation from the past (1960-1990) to today (1991-2015). Possibly, the amount of snow will decrease a lot more than rain will increase. These changes in runoff have been transformed to respective changes in the measured discharge values, on Samothraki island so as to estimate the potential impacts on the nutrients concentration levels.

4.3.5.2 Nutrient loads

The following two graphs (fig. 11, 12) show the average concentration of the nutrients NO_3, PO_4 and NH_4 for the past, the present, and for the four scenarios from figure 10. The underlying assumption is that pollution loads remain stable over time. All scenarios forecast an increasing trend for all described nutrients, due to the reduction of river discharge. The magnitude of change in the nutrient concentrations surpasses 50% in the worst case (RCP 8.5) in relation to the current levels. If the worst case scenario is realized, then the water quality status for NO_3 will degrade to poor, while for PO_4 will become moderate and for NH_4 it will still be good.

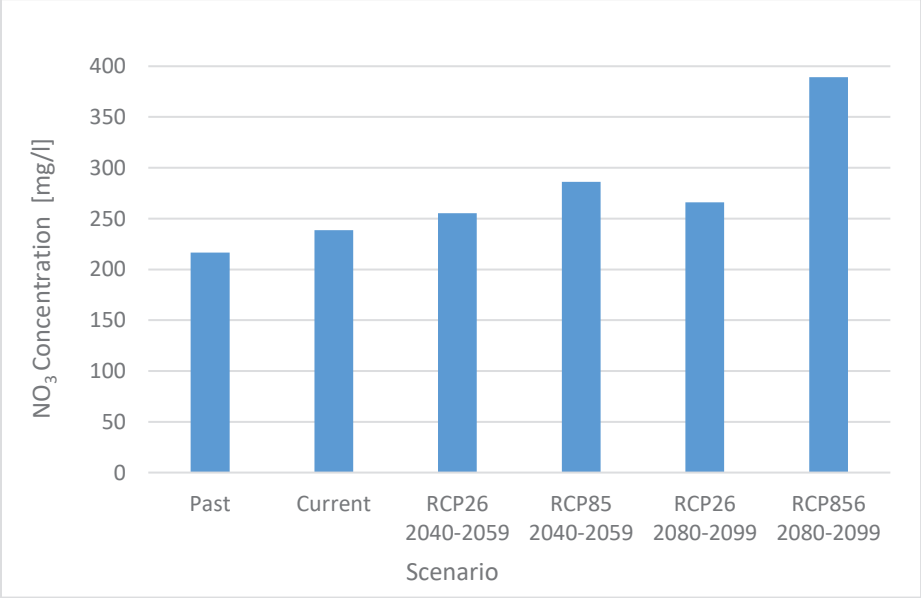


Fig. 11. IPCC Scenarios for NO3 concentration.

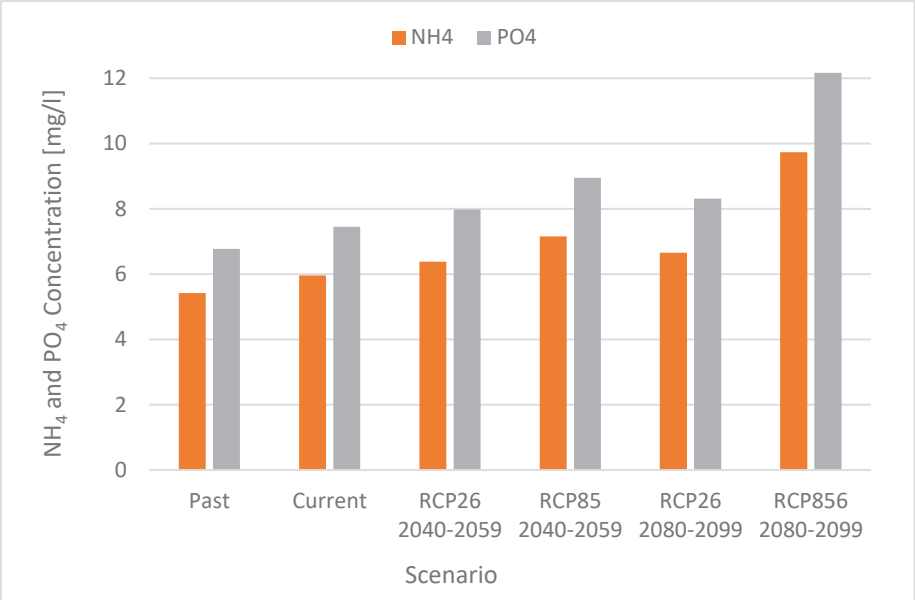


Fig. 12. IPCC Scenarios for NH_4 and PO_4 concentration.

4.4 Conclusions

The present report with field physicochemical measurements, laboratory analyses, water quality assessment and scenarios of river quality impacts, contributes to the collection of long term data for the island of Samothraki. It supports further research activities and can be helpful for policy and environmental decision makers.

The results of the physicochemical analysis carried out in situ at the Fonias river provides us with valuable information about the concentration of nutrients that are connected to human activities and their impact on water quality. Results from this case study show that water quality is fairly high, but the island is confronted with a variety of factors regarding its river's water quality, including overconcentration of free grazing goats and tourism. Other factors that may impact stream water quality are waste water management and the accumulation of organic matter (such as leaves etc.).

A comparison of monthly average nutrient concentrations in the Fonias river provides us with insights about the high degree of fluctuation of the values over the course of each year. The first intensive rainfall events are crucial for transferring pollutants from the catchment areas to the rivers, while the low flow conditions of dry years are responsible for the very high nutrient values during summers. Even though the yearly average ammonium and phosphate concentrations have fluctuated intensively over the past few years, they are nevertheless well within the range of values low enough to indicate high water quality. Nitrate values for 2018 were high enough to only allow for a classification as moderate.

Climate change is expected to affect the pollution levels in Samothraki's rivers significantly. It can lead to a 50% increase in pollution relative to the current levels, if pollution pressures remain unchanged. Nevertheless, Skoulidikis et al. (2014) concluded that pollutants in the basin seem to be compensated by the high volume of unpolluted, turbulent water from the upper regions of the river.

4.5 Literature

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5 Farmers' perceptions of cooperatives

Stathis Apostolopoulos[1], Joachim Raich[2], Ricardo Suarez Garcia[2], Dominik Noll[2]

[1]National and Kapodistrian University of Athens, Department of Biology,

[2]University of Natural Resources and Life Sciences, Institute of Social Ecology, Vienna, Austria.

5.1 Abstract

On the Greek Island of Samothraki, situated in the north-eastern Aegean Sea, a group of scientists and students in collaboration with locals and NGOs have since 2007 tried to tackle the island's sustainability problems. Overgrazing represents one of the most pressing ecological problems on the island: it led in combination with deforestation, frequent fires and the steepness of the terrain to excessive soil erosion, putting the viability of certain ecosystems at stake. Overgrazing on the island is related to a sharp increase in the numbers of sheep and semi-wild goats since the 1960s. It is believed that EU CAP subsidy schemes implemented in the early 1990s further contributed to the population increase of small ruminants. Moreover, local farmers find themselves in a very difficult financial situation, where they on the one hand depend on EU subsidies and on the other hand can't sell their products due to a lack of dairies and proper marketing possibilities. There have been efforts in search of ways to improve the financial situation of farmers and – at the same time – to decrease the animal numbers to a more sustainable level. To achieve this, a number of group discussions, focus groups and surveys have been carried out in the past.

As part of these efforts, we conducted interviews with 11 farmers in order to (1) get a better picture of the overall farming system in quantitative terms and (2) to find out about the farmers' attitudes towards the future of agriculture on the island, possible cooperatives between them and further collaborations with scientists. Since we regard possibilities for cooperatives between farmers as central for a sustainable future of the farming sector on the island, this report focuses on the farmers' understanding and attitudes towards them. Our findings suggest the following: the overwhelming majority of the farmers interviewed do want to have cooperatives, but are not prepared to take any initiative towards actually realizing them. This seems to be mainly due to a deep-seated mistrust among the farmers themselves and against representatives and local authorities. But we find also a lack of know-how about what to do to create cooperatives.

5.2 Introduction

5.2.1 Research on the livestock farming system of Samothraki

Socioecological research has been conducted on Samothraki since 2007. In this transdisciplinary research project scientists, together with local partners, have been trying to find sustainable solutions for the ecological and social problems.[2] Part of these research efforts are concerned with the agriculture on the island, and more particularly with the livestock farming system.

Samothraki's livestock is mostly composed of small ruminants. In 2016 there were approximately 50.000 sheep and goats on the island, declining from almost 70.000 in 2002 (fig. 1). The carrying capacity of the island's ecosystem is estimated at around 15.000 small ruminants (Fuchs 2014). One of the major reasons for the high numbers of sheep and goats were subsidies from the *Common Agriculture Policy (CAP)* of the EU, implemented in the early 1990s, that resulted in an unprecedented increase in population numbers. In a nutshell, the subsidies were paid per animal and thus the farmers had big incentives to increase their herd sizes (Hadjigeorgiou 2011). At the beginning of the 1990s, farmers increased the number of their animals but didn't increase the fodder at an appropriate pace (Fetzel et al. 2018: 25). This resulted in a feeding gap and consequently in an even higher grazing pressure on local ecosystems.

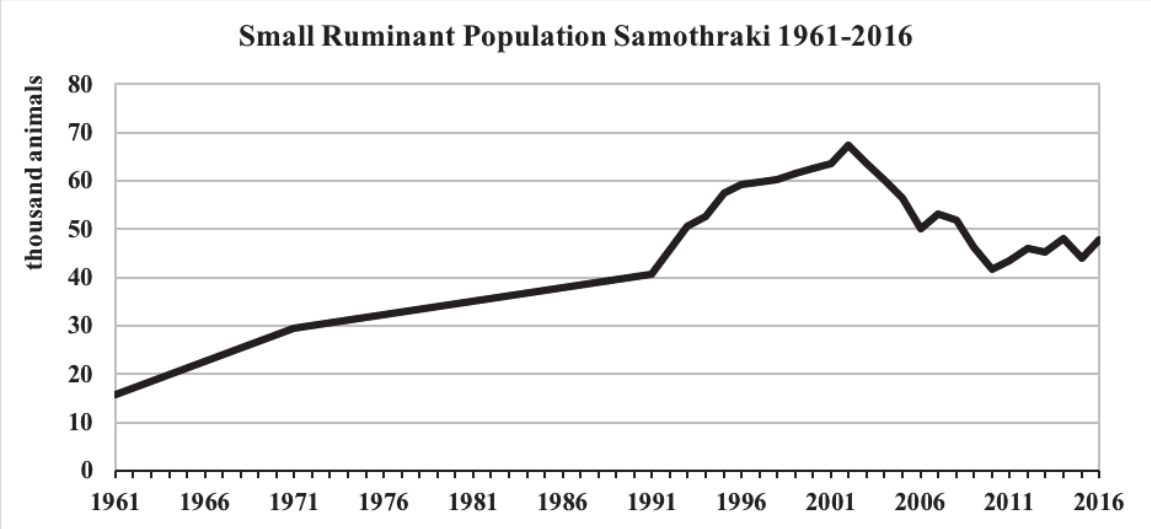

Figure 1: Small ruminant population development on Samothraki from 1961 to 2016 (source: ELSTAT).

While CAP policies in the EU had been departing in 2003 from a dependence on animal numbers, special regulations for Greece retained this connection up to now (Baierl 2019). In the case of Samothraki, it seems that this subsidy system generated an unhealthy increase in the number of animals as neither the perspective of carrying capacity of the land nor strategies for community-building between farmers to improve product development and marketing opportunities were put in place.

This shortly describes the context of the research we conducted on Samothraki during the Summer School 2018. In the module "livestock farming system" we aimed at conducting comprehensive interviews with 11 farmers in order to collect quantitative data on the farms,

[2] Cf. the detailed description of the project at http://sustainable-samothraki.net/research/

their overall production regarding meat and dairy products, as well as their sales. Secondly, we also aimed at producing qualitative information on the farmers' attitudes towards their situation and their possibilities – with a special focus on their attitudes towards forming farmers' cooperatives. This was a special point of interest since cooperatives were seen as a crucial pathway to overcome the weak bargaining position of the farmers and could also allow for decreasing the animal numbers while stabilizing farmers' income.

5.2.2 The goats of Samothraki

A customary farming practice for the goats of Samothraki is to let them graze freely on mountainous land, which can be either property of farmers or a public pasture as designated by the Hellenic Ministry of Environment and Energy. The rights to use the public pastures are granted by the animal husbandry associations and the farmers pay rent to the municipalities to which the pastures belong. This practice is a typical example for semi-feral or feral conditions of keeping breeds on islands in Greece: since Greece has so many inhabited islands, a farmer may move his herd on an island that is close to his residence. Islands provide a perfect barrier and animals can roam free without being able to escape. The farmer's only obligation is to provide water and maybe small amounts of supplementary feed in hard times. For herds that turn semi-wild (usually in cases where natural water exists on the island and the animals do not depend on the farmer), catching animals proves difficult and is usually done by shooting, setting traps or with the aid of dogs and long crooks. In other cases, animals are caught when gathering to drink water.

Wild goats belong to the species *Capra aegagrus*. The wild goat of the island of Samothraki has been described as *Capra aegagrus pictus* and it is one of the three subspecies of wild goats found in Greece. *Capra aegagrus pictus* is the subspecies described for the islands of Samothraki and also of Antimilos, located five marine miles off the north-western coast of Milos (Western Cyclades, Aegean Sea). This ancient Aegean goat may have been introduced to the islands in Neolithic times (Masseti 2009). It seems to have become extinct on Samothraki before the end of the 1980s, although its genes still exist in the local semi-wild goat population (Sfougaris 1995). A couple of decades ago there has been an attempt to set up a captive breeding program for the ancient *Capra aegagrus pictus* of Samothraki both for touristic and environmental reasons. Although the effort foundered, interbred animals with the resilient ancient phenotype still exist on the island.

To sum up, there has been a hybridization between the farmers' goats and the wild goats because at some point in time the herds have met in the wild. It is important to note that individuals of *Capra aegagrus pictus* reach only half the size of the wild goats of the mainland, an example of the well-known insular dwarfism of ungulates (Masseti 2009). This is partly reflected in the size of the farmers' goats as well. More fieldwork is necessary in order to come to a conclusion. Moreover, a possible resurrection of the species (*C. a. pictus*) would be significant for the ecology of the island as well as for the local culture.

5.2.3 Recent history of cooperatives in Greece

To better understand the situation on Samothraki and provide a broader context for our findings, it is important to look at the recent history of cooperatives in Greece. Iliopoulos and Valentinov (2012) provide a short but thorough analysis of that recent history. They state that Greek cooperatives in the past were detrimental for the members due to two main reasons:

(1) government regulation of cooperatives and (2) the opportunistic behaviour of agricultural cooperative leaders.

Ad (1): In the 80s and 90s the legal rules for cooperatives were changed several times and there were often internal political struggles between board members, because they "*represented and were supported by different political parties*" (Iliopoulos and Valentinov 2012: 16). This led to a focus shift: Agricultural cooperatives more and more became battlegrounds for politics. That was on the one hand driven by politicians who realized that farmers, who were members of cooperatives, held around 20% of the total voting power, and on the other hand many cooperative leaders used this development opportunistically – to pursue their "*individual goals – pecuniary or otherwise – even if their actions harmed cooperatives*" (Iliopoulos and Valentinov 2012: 16).

Ad (2): The opportunistic behaviour of agricultural cooperative leaders is explained by the benefits such a role brings with it. Due to their close affiliation with policy makers they can influence "*resource allocation decisions*", support for further elections from the side of political parties, and gain "*access to personal benefits in various forms*" (Iliopoulos and Valentinov 2012: 17). Moreover, the mutually beneficial relationship between agricultural cooperative leaders and politicians unfolded in two major ways: Cooperative leaders used "their position as a stepping stone to a political career" and politicians could more easily influence the members of the cooperatives.

The main result of this favouritism were (among others) "*serious organizational inefficiencies […], low-quality products and an inability to protect members' income*". The consequences of these trends were "*lost markets and generalized public distrust of cooperatives as a sustainable business model*" (Iliopoulos and Valentinov 2012: 17). This development of cooperatives, namely to have become political instruments to the mutual benefit of politicians and cooperative leaders, as well as the resulting financial losses and instabilities – if not collapses of the cooperatives – can explain the widespread distrust of farmers towards both cooperatives and political institutions.

5.3 Methods

5.3.1 Data collection

In the context of the Summer School 2018, we conducted a total of 11 interviews with farmers. Out of 171 livestock farmers on the island that received more than 1.250€ subsidies in 2014, a random sample of 30 was drawn and contacted in order to ask them for their willingness to be interviewed. However, once we had our first interviews, we also used the snowballing-principle[3] in order to get more contacts of farmers. We then conducted interviews with those farmers who were willing to collaborate with us. Therefore, we would term the method of selecting the farmers as semi-random.

Our team consisted of six people. We formed two groups each with a translator, a note keeper and an interviewer. At the start of the summer school we had a group discussion on a pre-

[3] In sociology and statistics research, snowball sampling is a nonprobability sampling technique where existing study subjects recruit future subjects from among their acquaintances.

developed questionnaire which was based on the parameters of the HappyGoats-App[4]. The questionnaire contained 92 quantitative and qualitative questions, asking for the main parameters of the farm economy as well as perceptions and attitudes towards collaboration and the future of farming on the island. The interviews were conducted on six subsequent days, mostly in taverns or at the farmers' homes, where an uninterrupted conversation was possible. Most interviews took just over an hour to complete. Some of the farmers were very willing to answer our questions whereas others were more reluctant, especially when we referred to financial issues.

5.3.2 Data analysis

Our group focused solely on the evaluation of the qualitative questions, and in particular on the farmers' attitudes towards cooperatives. The reasons for this were that we regard this as a central aspect within the socioecological research process on the island, and that the farmers often talked unsolicited about cooperatives as an important concern of theirs.

The evaluation of the qualitative answers followed an unconventional route. Due to restrictions regarding the focus of the survey on quantitative questions but also language barriers and time constraints, the basis of the analysis was not a transcript of the complete interview. Rather the basis of the interview were the notes we took during the interview. Hence the procedure of analysis did not follow the established route of "*paraphrasing – writing headlines for all the passages – comparing the different interviews with regard to similar topics – conceptualization – theoretical generalization"* (Meuser 1991: 455-66). Instead, we analysed the interviews by starting with the specific answers to our questions of which we had taken extensive notes when the farmers' answers were longer. The topics were thus provided by the answers themselves. So the first step in our analysis was to extract topics from the data which could serve as points of comparison between the expressed opinions. We already generalized those topics into broader categories, such as "possible benefits", "institutional obstacles", "initiative", "know-how". In this way we tried to cluster the expressed views so that they would yield a better understanding of the questions at hand. Our analysis therefore ends with the discussion of some possible theoretical generalizations.

5.3.3 Findings

<u>*General attitude:*</u> 10 out of 11 farmers were positive or very positive about the possibility of being part of a cooperative. Only 1 farmer had a neutral attitude and said he wouldn't need a cooperative. However, two farmers spoke of the difficulties regarding founding a cooperative. One such farmer told us that he had tried in the recent past to form a cooperative, but at the end of a meeting where 30 farmers were present, only 5 had actually been prepared to found a cooperative while the others backed out. On the basis of this information one critical question arises. Why are the interviewed farmers so positive about farmers' cooperatives while in reality any attempt to form one fails? At least two possible reasons could be at play here: (1) there is a bias in the interviewed group, namely those farmers who were willing to give an interview were perhaps also more likely to be prepared to form cooperatives; (2) there is a discrepancy between the expressed positive attitude towards cooperatives, and the actual readiness to realize one. Moreover, as mentioned in the introduction, due to the corruption

[4] The Happy Goats App is a web-based decision support app that was developed with Greek partners in order to support small ruminant farmers in optimizing their farm economy (http://happygoats.eu).

of cooperatives in the past (in Greece, but also on Samothraki in particular), there may be a deep-seated mistrust towards cooperatives in general.

In fact, the farmers pointed some *general difficulties* when it comes to forming and managing cooperatives. The most frequently mentioned problem (4 out of 11) in the interviews was mistrust amongst the farmers. Some farmers (3) also spoke about mistrust against agencies and representatives as a central issue. Just as frequently mentioned by the farmers (4 out of 11) was the problem of their low know-how about cooperatives. Two of those expressed the feelings of "being left in the dark" and "having been intentionally misinformed" [unclear by whom]. What is more, three farmers also mentioned the unwillingness of their children to take over their farm in the future.

In the category of *institutional obstacles*, the union of traders was mentioned (3 out of 11) as not only agreeing on low prices beforehand, but also dividing the farmers. One farmer said that the traders would exploit them, while another mentioned the monopoly of the dairy to be a big problem for selling their products. Moreover, one farmer mentioned that many farmers had too many occupations (apart from farming) and therefore were not really interested in improving the situation of their farms. However, 10 out of 11 farmers had mentioned *possible benefits* from having cooperatives. 7 out of 11 farmers mentioned that they would have a better trading position when confronted with the mainland traders and would be able to get a better price for buying feed and selling their products. 4 out of 11 farmers also said that this would help them to get better deals with the only dairy on the island.

To summarize, albeit seeing clear benefits from possible cooperatives, farmers have strong reservations about actually realising them. This reluctance may be caused by a variety of reasons. The most crucial – next to the issue of low education – appears to be the issue of mistrust against representatives, agencies, the government, and traders who actively try to split the farmers in negotiations and – in succeeding to do so – arguably produce mistrust among them. We think that these forms of mistrust should be viewed against the background of the recent history of failed and corrupted cooperatives in Greece and on Samothraki. Thus we regard the general result to be the following: The overwhelming majority of the interviewed farmers do want to have cooperatives, but are not prepared to take any initiative in actually realizing one, mainly due to a deep-seated mistrust amongst each other and against representatives and local authorities. This is complemented by a – in their own eyes – low know-how about cooperatives. In the discussion we look to provide some theoretical context on the relevant issues for the case of Samothraki, that is community-building and its obstacles, namely mistrust, lack of knowledge and the question of succession.

5.4 Discussion

From our perspective cooperatives would have clear advantages for achieving an ecological transformation, because the management of resources and pastures can be addressed more effectively through a collective body.

Founding cooperatives is a form of community-building. On Samothraki, farming involves the management of a common good, namely the pastures, which are rented from the municipality. According to Ostrom, there are plenty of things to look at when one tries to

explain the difficulties to construct a community and a set of rules on the appropriation of a common resource. For example "*the larger the resource system and/or the number of appropriators, and the more unpredictable the flow of resource units and the market prices for these units, the more difficult and costly it is for anyone to obtain accurate information about the condition of the resource itself and the likely value of the flow of resource units under any set of rules*" (Ostrom 1990: 196). Ostrom here points out that increasing size also increases difficulties. This suggests that it could be beneficial – also for Samothraki – to have several smaller cooperatives rather than a single large one.

For a deeper analysis of this matter further research is required because, even if sometimes individual farmers are positive about the idea of generating institutional rules, the context conditions do not always favour an agreement. This seems to be the case in Samothraki too, where farmers are generally in favour of cooperatives, but there are at the same time a lot of obstacles – institutional and otherwise – in place.

5.4.1 Mistrust as a multi-dimensional problem

In order to understand the often mentioned mistrust in the community better, it is pivotal to overcome the difficulties in forming cooperative ways to confront the farmers' problems. Ostrom's analysis over common property resource regimes construction in all world regions gives a high importance to this topic by stating that: "*when individuals who have high discount rates and little mutual trust act independently, without the capacity to communicate, to enter into binding agreements, and to arrange for monitoring and enforcing mechanisms, they are not likely to choose jointly beneficial strategies*" (Ostrom 1990: 183). In Samothraki farmers sometimes get discount rates by agreeing on individual deals with the traders. Not only is this not a jointly beneficial strategy for the farmers, but also these individual deals with the traders produce an additional source of mistrust between farmers. We further argue that mistrust in the case of Samothraki should be analysed as a multidimensional problem, because one not only has to consider the relationship between the farmers, but also between them and potential newcomers (to the agricultural sector) as well as between them and representatives, local authorities and traders. It is multidimensional, because these various dimensions are not just independent aspects, but rather influence one another.

Another key concept that Ostrom points out as a precondition to a successful process of community-building and sustainable change is recognition and support from the state when developing new rules and ways of management at the local sphere. The lack of state support on Samothraki could therefore be another important barrier to a change of the local farming system. Three farmers told us that there is also a high level of mistrust against the official agencies. In the category of know-how we found that the general knowledge about cooperatives amongst the farmers was very low to low in 4 out of 11 interviewees. Two of those even expressed the feelings of "being left in the dark" and "having been intentionally misinformed" [unclear whether by agricultural representatives or state representatives]. It is clear that there is a high need to improve support from the state, but especially the knowledge of the farmers, in particular their know-how about cooperatives.

5.4.2 Future of farming and the question of succession

Farmers generally share a dark outlook regarding the future of farming on the island. This may be another big reason for the low initiative in making efforts to change the status quo towards working cooperatively. Linked to the grim outlook on the future of farming is the question

regarding succession. 3 out of 11 farmers mentioned that the process of succession is one of their biggest problems, because their children don't want to take over their farm and they don't know who else could. When a local society seeks its reproduction, one of the possible strategies "*is the adaptive one, which through changes in production or in the organization and composition of the domestic group tries to adapt to the changing conditions of the situation*" (Ortega y González de Molina 2000: 9). But if the local productive system has significant difficulties in reproducing itself in the following generations, it is very easy for the individuals who compose it to show aversion towards making changes or investments to improve it due to the lack of confidence that the fruits of this effort can be reaped in the future.

What may further contribute to the problem of succession is the fact that nowadays there is a devaluation of pastoral labour in younger generations. Agricultural jobs are generally not considered attractive anymore for the young and this creates a discount rate on the willingness of farmers to invest and/or change the way they work. Dorninger et al. call this process human-nature disconnection, to describe the fact that "*many modern societies have—for better or worse—disconnected themselves from the natural productivity of their immediate regional environment*" (Dorninger 2017: 1).

This problem has become so big in the last decades that authors like Lopes think that "*the rural world is undergoing a continuous depletion of its structures and its heritage and that reduced as it is in terms of size and significance, it risks to end up as a mere reference for social and cultural ethnological and anthropological studies*" (Lopes 2003). This seems to also apply to Samothraki, if nothing is done to reverse the unsustainable ecological and economic conditions; and to do so we believe the question of succession will eventually have to be addressed, in order to increase the initiative of the farmers towards actually realising cooperatives. A lot could be done in order to increase the attractiveness of agriculture – also for young people – on Samothraki. Distinctive products marking quality and origin to open new markets, local distribution circuits and consumption, multifunctionality of the production system, social and environmental responsibility and association with other sectors like tourism (García 2016) are some of the rural development strategies that institutions like the EU advises and that can be potentially beneficial to solve economic and environmental problems in cases like Samothraki. But once again, we believe cooperatives to be pivotal in establishing these trends and values.

5.5 Conclusion and outlook

Samothraki's farmers see a lot of benefits in forming cooperatives, namely better trading positions and thus better prices, which count for their purchasing of fodder as well as their sales – whether it be meat or milk. However, even though farmers on Samothraki see many benefits in cooperating, they have strong reservations about the actual realisation of cooperatives. These reservations can partly be explained by institutional obstacles, such as lack of state support, the disrupting actions of traders and lack of good information on economic as well as organisational aspects of cooperatives. In addition, farmers' reservations against realising cooperatives can also be explained by taking into account their overall grim outlook about the future of farming on the island (which is connected to the fact that many of their children do not want to take over their farm in the future), their low knowledge about organisational, economic and management aspects, and the widespread mistrust.

In our assessment the most crucial reason for the farmers' reservations against forming cooperatives – next to the issue of low education – appears to be the issue of mistrust against representatives, agencies, the government in general and against the traders, who actively try to split the farmers regarding negotiations and – in succeeding to do so – arguably produce mistrust amongst the farmers themselves. We have argued that these forms of mistrust should be viewed against the background of the recent history of failed and corrupted cooperatives in Greece and on Samothraki, and for addressing mistrust as a multi-dimensional problem.

Hence we regard the general result to be the following: the overwhelming majority of the interviewed farmers do want to have cooperatives, but are not prepared to take any initiative in actually realizing one, mainly due to a deep-seated mistrust amongst themselves and against representatives and local authorities, as well as – in their eyes – low know-how about cooperatives. Consequently, the issues of mistrust and lack of knowledge would have to be tackled first and foremost, in order to help the farmers overcome their reservations about forming cooperatives. Because the mistrust is deep-seated and relates to bad experiences from the past, we believe some sort of reconciliatory process should be in order, so that the farmers can regain confidence in possible cooperatives. For this people responsible for the failing (and corruption) of past cooperatives would need to be held accountable. Only then, in a second step, state support in terms of resources for further education in organisational, economic as well as management aspects of farming could remedy the lack of knowledge identified as an obstacle to forming cooperatives. Although our findings clearly point in these directions, further research is needed that looks more closely at mistrust as a multi-dimensional problem, and explore ways to increase the value of the agricultural sector on the island – for example by establishing better linkages with tourism – so that a younger generation will take over the farms and secure a future for both the Samothraki goat and the endangered ecosystems.

A final note: In 2018, after the end of the summer school, a new farmers cooperative was actually formed and will become operational in 2019 (when we hope to explore it during our next summer school). *Marina Fischer-Kowalski (April 2019)*

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6 Energy metabolism on Samothraki island: Fuelwood consumption

Lena Brody[1], Alanna Johnston[2], David Pleschko[1], Stefan Stadler[1], Marina Fischer-Kowalski[1] and Simron Singh[3]

[1]University of Natural Resources and Life Sciences, Institute of Social Ecology, Vienna, Austria, [2]University of Edinburgh, School of GeoSciences, [3]School of Environment, Enterprise and Development, University of Waterloo

6.1 Introduction

The Greek island of Samothraki, located in the north-eastern Aegean Sea, has been the focus of socioecological research since 2007. This research focuses on the interaction between social and natural systems in the context of sustainable development and global change, in cooperation with diverse scientific communities and stakeholders from social, economic and political sectors of society. Main concepts include social metabolism with material and energy flow analysis, colonisation of natural systems, socio-ecological systems modelling and a focus on environmental history and socio-ecological transformations (Haberl et al. 2016). The research on Samothraki focused on different topics including infrastructure (Noll et al. 2018), diet (Petridis and Huber 2017), farming (Fetzel et al. 2018, Fuchs 2015) and forest regeneration (Heiling 2018).[5]

Another field of research in the last years has been energy metabolism. Energy flow analysis is a key issue of sustainability research and sustainable development since "*most sustainability problems are directly related to the quantity and quality of energy used by a society*" (Haberl 2016). This is further amplified by the fact that "*almost all technologies used in production, transport, distribution and consumption activities require energy*" (ibid.).

Our research aimed at contributing to an assessment of the island's current social metabolism in terms of material and energy flows, through field observation and expert interviews. In this particular module, our aim was to analyse the consumption of fuelwood, an understudied factor in the context of the social metabolism of Samothraki. Our research builds on previous findings that the import of fossil fuels, especially heating oil, decreased since the global financial crisis in 2007 (unpublished data). The declining heating oil imports, we assumed, had to be substituted by another energy source, as there is no reason to assume a decrease in demand.

The island of Samothraki has a surface area of about 180 km^2. This area is characterised by a mountainous region (up to 1,611m high), and the coastal area where almost all settlements and the agricultural land are located. The main economic sectors are agriculture (mainly goat farming and olive production) and tourism. Most tourist visits take place during the months of July and August. As a result of this seasonal availability of employment opportunities, only about 2000 of the island's official 2840 residents remain on Samothraki during the winter months.

[5] For more on sustainability research on Samothraki see Fischer-Kowalski et al. 2011 & 2014.

In the following sections we will first explain our methodology and then present our results, split into a qualitative and a quantitative part. This is followed by a discussion of the results and conclusions that put our results into a broader context.

6.2 Methodology

The research for this study was conducted within the framework of the 5th Summer School on Aquatic and Social Ecology, organized on Samothraki island in June 2018, by the Vienna Institute of Social Ecology, Alpen Adria University in partnership with the Hellenic Centre for Marine Research. Around 20 participants came from different European universities and worked within the context of five smaller research groups.

Our team covering energy metabolism research and wood consumption on Samothraki consisted of four students with different academic backgrounds such as historical archaeology and prehistory, international development, ecological economics and social ecology from the Alpen Adria University and the University of Edinburgh. The tutors, Marina Fischer-Kowalski and Simron Singh, were involved in the research project on Samothraki prior to the summer school and provided us with valuable guidance in both a systemic understanding of the social metabolism and methods for investigating local rural systems.

Conventional energy balances mainly look at commercial forms of energy. They do not account for the energy contained in biomass such as food, feed and fuelwood - energy sources that are highly relevant in rural societies (Singh et al. 2010). Energy flow analysis "*considers all energy crossing the nature-society boundary*" (Haberl 2016). In our attempt to analyse the fuelwood metabolism of Samothraki, we consider all aspects of livelihood on the island amounting to the total extraction and consumption of fuelwood.

Field work and data collection were prepared and conducted using the Vienna School of Social Ecology's model of socioecological metabolism. This refers to a systemic understanding of society-nature interactions, as can be seen in Figure 1, in the form of a model of material flow analysis. Considering the different input and output flows in this model we arrive at possible sources of fuelwood: imports and domestic extraction (DE). Domestic extraction denotes the amount of material that is extracted from the local natural environment. By adding imports and subtracting exports from the DE we arrive at the Domestic Material Consumption of fuelwood for Samothraki.

According to the model of the socio-ecological metabolism we were able to identify relevant stakeholders on the consumption side and the sources of supply. These were households and businesses (restaurants, cafés, bakeries, etc.) on the consumption side, and importers, transporters, and distributors on the supply side. Other data sources identified in order to understand the local system were the municipality and the forest administration of the island and employees of the forestry department of the region in Alexandroupoli, mainland Greece.

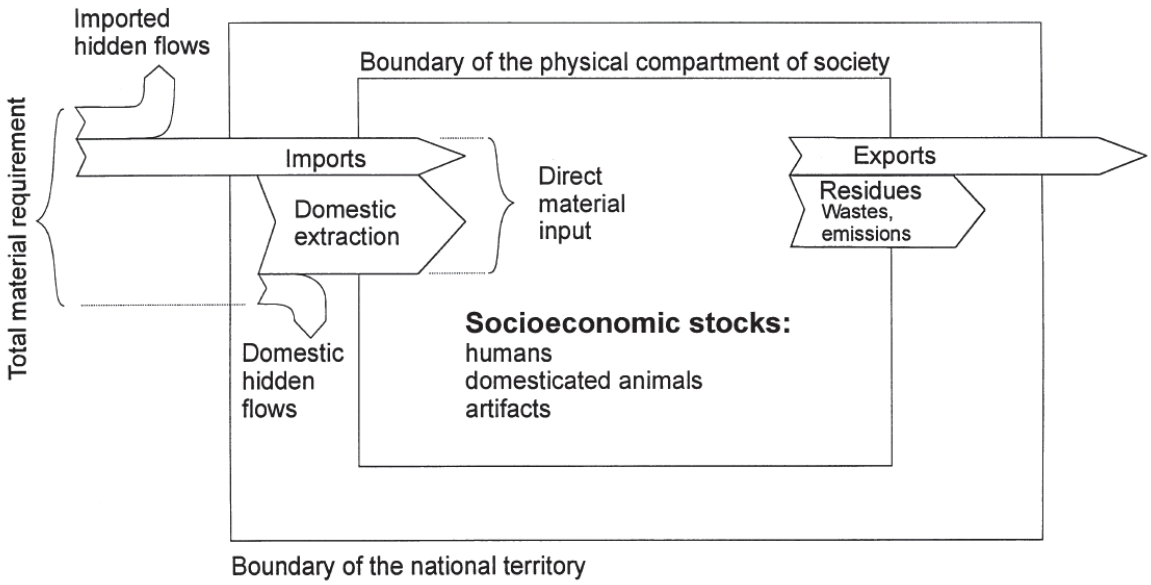

Figure 1: Diagram of an economy-wide material flow analysis, figure from Haberl 2001.

The research done throughout this study supports the objectives and efforts of the Sustainable Samothraki association. The association has come into existence in 2016 and concerns itself with different aspects of a sustainability transition on Samothraki, including waste management, farming, tourism, societal stocks and flows and forest regeneration (for more information visit: http://sustainable-samothraki.net). The association has created a network of valuable local connections and simplified our approach to the field and facilitated us in identifying our first interview partners.

6.2.1 Data Collection

Based on an initial assessment, we conducted semi-structured interviews with experts in the local administration, traders, local business owners and consumers of fuelwood. In a period of four days during June 2018, we conducted 18 interviews. The five largest villages were visited, Kamariotissa, Therma, Chora, Lakkoma and Profitis Ilias. An overview of the interviews is provided in Table 1.

From the 18 interviews conducted by the research group on Samothraki, three were with local officials (Interview 1-3). These local experts were introduced to us by members of the Sustainable Samothraki association and our tutors to gain a better understanding of the local regulations and sourcing customs. For the first interview, a forest ranger was interviewed as an expert for local forest management with regards to his knowledge of the translation of administrative guidelines to local practice.

Table 1: The general profile of the 18 interviews, their categories and wood use; own illustration and data.

Local Administration				
Interview	*Title / Position*			
1	Forest Ranger			
2	Forest Director			
3	Technical office of the municipality			
Traders				
4	Owners of Import/Export Business			
5	Owner of Supermarket			
Taverns and Cafés (in combination with households)				
Interview	*Type*	*Commercial Fuelwood Use*	*Personal Fuelwood Use*	*Household size*
6	Bakery	Heating, Oven	Heating	1 household, 2 people
7	Tavern	Heating	NA	2 households, 3 people
8	Café	Heating, Warm Water, Cooking	Heating, Warm Water, Cooking	2 households, 4 people
9	Tavern	Heating	Heating	1 household, 4 people
10	Tavern	Heating	NA	2 households, 4 people
11	Taverna	Heating, Cooking	Heating	NA
12	Café	Heating	Heating	NA
13	Café	Heating, Cooking	NA	1 household, 3 people
14	Café	Heating	Heating	1 household, 3 people
15	Bar	Heating	Heating	NA
Households				
16		NA	Heating	1 household, 4 people
17		NA	Heating	1 household, 4 people
18		Heating, Cooking in tavern	Heating, Cooking	NA

From the second interview with three members of the Technical Office of the municipality of Samothraki we aimed to gather information about the population, infrastructure, imports and exports of the island as well as any government programs providing fuelwood for the island.

Our interview with the regional forest director was conducted by phone through a member of the Sustainable Samothraki association due to his office being in Alexandroupoli. His job includes providing permits for cutting trees in public forests. We wanted to inquire about this procedure. From these first interviews we got information that led us to other stakeholders, such as import-export businesses.

Households and local businesses that use fuelwood for heating were also introduced to us in part by Sustainable Samothraki association. We wanted to know about their household size, heating systems, sourcing of fuelwood, types of wood and price. The interviews were conducted in a semi-structured style to allow for other topics to come up in the discussion (for more on semi-structured interviews see Drever 1995). The interviews took about half an hour on average. After the first interviews were held, further interviews were conducted in a more

informal, conversational manner with restaurant, tavern, and café owners and involved only asking them simple questions concerning their heating system and wood use.

During these interviews, team members assumed different roles. First, there was a lead interviewer, who explained the purpose of the interview and the research we conducted to the interviewee and asked the first, more general questions. One or two members took notes with the consent of the interviewee and asked further supplementary questions. Recording of the interviews was avoided to allow a more open conversation. Since the team members do not speak the native language (Greek), there was a translator present to allow interviewees to express themselves in their first language.

We worked with four translators, of whom three can be considered locals as they have spent considerable time (2+ years) on the island, have lived there, and therefore have an understanding of the local social structures which helped facilitate interviews by acquiring contacts and being able to introduce the non-Greek research team to participants. All of the translators had Greek as their first language. Three of the translators had experience with socioecological research and translating in qualitative research. While having local supporters facilitated the interviews, it also interfered with trying to keep the exchange neutral by potentially influencing the discussion with their subjective experiences and knowledge of local structures causing potential bias.

Additional potential for bias came from a few of the informal interviews. Those were mostly done for gaining additional understanding of the context and were conducted in either English or German. As those were not the first language of the interviewed participants, this might have led to misunderstandings.

6.3 Results

After the interviews were conducted, the research was divided into two sections. First, a qualitative part explored the social organization of fuelwood consumption. Second, a quantitative part focused on estimations and calculations of fuelwood flows in relation to current data and information provided during interviews.

6.3.1 Qualitative Section

Most of the fuelwood consumed on the island is extracted from the local forests. This domestic extraction is regulated by the municipality and the forest administration. Every inhabitant has the right to collect fallen dead wood in the forests of Samothraki during four two-week periods in October, December, January and March. Every household is allowed to collect 6 tons per year of dead trees and branches from public (state-owned) forests as well as private forests with the permission of the land owner (Interview 1).

In our interview with representatives from the technical office of the municipality of Samothraki we learned that the island has approximately 2,800 inhabitants residing in about 700 households with an average of 4 residents per household (Interview 3). The primary consumption of fuelwood is used to heat homes and businesses during the winter season between October and March (180 days per year), with the exact amount depending on the seasonal climate (Interview 1). Only 500 households inhabit the island during winter

(Interview 3). This is because of the few employment opportunities and the reduced number of tourists visiting the island in these winter months.

Since the global financial crisis of 2007/08 and especially the Greek debt crisis from 2009 onward, a substantial amount of households (the amount doubled according to the forest ranger) switched from burning oil for heating to fuelwood because of increasing oil prices and decreasing incomes (Interviews 1, 3, 6, 8). Unfortunately, there is no data from the municipality on the exact amount or ratio of different heating systems installed in households and businesses on the island. The forest ranger estimates that 15% of the households use oil, 60% collect fuelwood and 25% use fuelwood from olive trees as their energy source.

Most households interviewed told us that they are collecting fuelwood themselves with family or friends (Interviews 6-9, 11-15, 17, 18). Most people use their cars and some machinery to chop up logs and branches. This leads to an uneven distribution of pressure on the forest, with most pressure located within a radius of 100-150 meters along the roads where people can park their cars (Interviews 3, 6). Some interviewees have noted a decrease in the amount of fuelwood that is easily accessible near roads and a general degradation of the forest in the years since the financial crisis (Interviews 3, 6, 16). Others do not see a notable degradation and believe the forest is strong and can sustain the current amount of extraction (Interview 18).

While people told us that legal regulations are monitored by the forest ranger, the island's large forested areas cannot be closely monitored to rule out illegal collecting practices. These include logging, collecting outside the allowed periods or the deliberate damaging of healthy trees (girdling) to create more dead wood for collection (Interview 18), and are linked to accessibility. There is obviously less dead and dry wood available for collection in more accessible areas and this could have been be created using illegal collecting practices. We also heard about conflicts between collectors and land owners when collecting in their private forests. This might be due to some land owners collecting themselves and then selling this wood for about 130-150€/t (Interview 8). This topic of selling wood from domestic extraction has only come to our attention during our field work and we were not able to talk to landowners or farmers who do this, so further research is needed.

One person has a license from the municipality to cut down trees (Interview 3) that have been marked for cutting by the local forest ranger and controlled by the forest director from Alexandroupoli. Although this has not happened in the last couple of years (Interview 2), this person still has the equipment and animals, mainly donkeys, to collect wood in places that most people cannot reach with their cars. According to one interviewee, this advantage of donkeys over cars has led to an increase in the donkey population on the island from five to thirty in the last seven years (Interview 13).

Another source of fuelwood on Samothraki are olive trees. Their branches need to be cut regularly and are then used for fuel. All households we interviewed who own olive trees follow this practice (Interviews 8, 14).

There is no export of fuelwood from Samothraki, and only very little is imported to the island. Even though it is allowed, there seems to be no import of fuelwood by private businesses because it doesn't pay off (Interviews 1, 4). Some fuelwood was imported from the mainland

by a trader, but not anymore (Interview 2). We heard of a practice of trading animal feed for olive branches, which are then sold (Interview 4), but could not confirm this.

The main importer of fuelwood is the municipality. Based on a federal law, it imports oak from forests around Alexandroupoli on the mainland since 2009 as a form of subsidy for low-income households and pensioners who cannot collect themselves. The demand for this has been increasing noticeably. About 120 horika (1 horiko ≈ 0.575 tons) were imported in 2009. This number rose steadily to about 200 horika in 2014. Because the Forestry Director in Alexandroupoli decides how much the municipality of Samothraki can import, this number has not increased since then even though there is high demand and complaints that 200 horika are not enough. This is indicated by the number of applicants, around 100 households per year, compared to the number of recipients, 40 households per year. Every recipient gets five horika and is chosen along different criteria, namely income, age, disabilities and pension. These five horika cost 23.50€/horiko or the reduced price of 14€/horiko if one receives an agricultural pension (prices for 2018) (Interview 3).

Other wood-based imports to Samothraki include charcoal and wood pellets. Charcoal is mainly used by taverns and restaurants for barbecues, especially during the summer months when tourists visit the island. Since there is no more charcoal production on the island, all of it has to be imported. One tavern owner mentioned that he uses about three tons of charcoal per year imported from Argentina (Interview 11). This was further confirmed by one importing supermarket (Interview 5). So the sustainability of this practice is questionable. Wood pellets are imported from Bulgaria for about eight households by an import/export business (4t in 2016/17 and 20t in 2017/18). According to this business this number is not increasing (Interview 4).

6.3.2 Quantitative Section

All data provided within this section was gathered from the interviews mentioned above. Estimates gathered from interviews show between 4-6 tons of fuelwood are consumed per household per year (Interviews 7-18). In contrast, the forest ranger estimated the fuelwood requirement per household and year to be around 10 tons, with the assumption that fuelwood is the only energy source used (for warm water, heating and cooking). However, this estimate seems to be too high regarding that the heating period lasts six months at most (October to March) and many households use other energy sources as well. According to the forest ranger there is a legal document that permits the collection of 6 tons of fuelwood in the forests per year, which is one plausible explanation for the consistent estimates gathered in household interviews.

When asked to give estimates of wood consumption, we were surprised to consistently find the unit of tons used, as wood is frequently measured in volume rather than mass. The corresponding volume unit for fuelwood used on Samothraki is ‘horiko’ which translates to approximately one stacked cubic metre. Furthermore, there are several ways to gain energy from fuelwood. The energy efficiency depends on the wood quality, combustion systems and water content, the latter is influenced in turn by preparation methods and storage strategies.

Wood quality varies between wood types because each type has a different energy density. The identification of different types of collected fuelwood is difficult and therefore only based

on a raw estimation by the forest ranger (Interview 1: plane: 50%, oak: 20%, other: 30%). Finally, many different combustion systems were observed, from basic rural wood stoves to more advanced wood burners.

6.3.3 Domestic Extraction

The attempt of calculating domestic extraction of fuelwood on the island is accompanied by many data insecurities. The following aspects show the range of challenges that have to be met. The surveyed households mainly use a combination of energy sources like fuel oil, gas, electricity, solar and fuelwood for heating, cooking and warm water preparation with fluctuating shares depending on the individual technical equipment, financial situation and energy demand. As mentioned above, about 15% of the households use oil, 60% collect fuelwood and 25% use wood from olive trees as their energy source.

Regarding domestic extraction of households, we estimate a demand of 6 tons of fuelwood per year for heating, plus an additional 20% to balance the possible underestimation in the statements mentioned before. Therefore, we calculate 500 households, minus 15% of oil using households, multiplied by 7.2 tons per year minus the imported fuelwood and pellets. We consider consumption to be between five and ten tons per household, and assume an average of 7.2 tons. As a result, the households' domestic extraction amounts to approximately 2925 tons per year.

Table 2: Yearly Domestic Extraction of fuelwood on Samothraki, split into households and businesses; own calculations.

Domestic Extraction				
	Total number	Winter	Use of fuelwood (per user)	**DE total**
Households	700	500	7.2 t/yr	**2925 t/yr**
Businesses	No data	20	6 t/yr	**120 t/yr**
Bakery	1	1	1.0 – 1.5 t/week	**60 t/yr**
Total				**3105 t/yr**

Other users of fuelwood are taverns and a bakery in Kamariotissa. The bakery needs 1.5 tons per week in the main season (~16 weeks) and 1 ton per week in the rest of the year (36 weeks). Those estimates amount to 60 tons per year. Moreover, during winter time, there are about 20 taverns in operation and many of them use fuelwood for cooking and heating, leading to an estimate of 6 tons per year per tavern (Interviews 6-14). This amounts to a total consumption of fuelwood by taverns of 120 tons per year.

6.3.4 Imports

The municipality imports 200 horika of oak wood per year (Interview 3). One horiko of oak wood corresponds to 0.50 - 0.65 tons (Interviews 1, 3). As a factor we use the arithmetic average and convert horika into tons with the factor 0.575. Thus, the municipality imported 115 tons of oak in the year 2017. Moreover, private businesses import charcoal and wood pellets. About 40 tons of charcoal is imported per year (Interview 5). In 2016, traders imported 4 tons and in 2017 20 tons of wood pellets. There have been no imports of wood pellets before 2016. In 2017 there were 115 tons of oak wood, 40 tons of charcoal and 20 tons of pellets imported to the island.

Table 3: Imports of fuelwood and other related items to Samothraki in 2017 in tons; own calculations

Estimated Imports for 2017			
	Municipality	Private Businesses	**Total**
Oak fuelwood [t]	115	0	**115**
Charcoal [t]	0	40	**40**
Pellets [t]	0	20	**20**

6.3.5 Domestic Material Consumption

The total consumption of fuelwood is the domestic extraction (bakery, taverns and households) plus the imported fuelwood (115 tons) and results in 3220 tons per year (assuming 7.2 tons per fuelwood using household). Also included are the imports of charcoal with 40 tons per year and the imported wood pellets with 20 tons per year. As mentioned earlier, no fuelwood is exported.

Table 4: Domestic Material Consumption of fuelwood (split into different wood types), charcoal and pellets; own calculations.

Domestic Material Consumption	
	Total [t/yr]
Fuelwood	**3220**
Plane (platanus)	1103
Oak	556
Olive trees	900
Other	662
Charcoal	**40**
Pellets	**20**

The fuelwood split into wood types amounts to 1103 tons of plane, 556 tons of oak, 900 tons of olive tree branches and 662 tons of other wood types. The calculation behind these numbers is the following: the fuelwood from olive trees is not collected in the forests, but gathered from the seasonal olive tree cuttings. 25% of the households use olive wood and need 7.2 tons per year, this results in 900 tons of olive wood per year. This amount is then subtracted from the domestic extraction value leading to 2205 tons of collected fuelwood. From this number we take the assumptions mentioned before (plane 50%, oak 20% and others 30%) and divide it by the factors. The fuelwood imported by the municipality (115 t) consists of oak only, so we add these imports to the oak fraction.

The following table sums up our quantitative results regarding fuelwood consumption per household, domestic extraction and domestic material consumption.

Table 5: Quantitative results of fuelwood consumption based on 18 interviews, split into Consumption per household, Domestic Extraction (DE) and Domestic Material Consumption (DMC); based on own calculation.

Estimated Totals for Fuelwood Consumption			
	Minimum	**Most likely***	Maxima
Estimated Consumption per household [t/yr]	4	**7.2**	10
Domestic Extraction [t/yr]	1745	**3105**	4295
Domestic Material Consumption [t/yr]	1860	**3220**	4410

*Based on an average collected from the interviews which we consider to be the most probable scenario. For more information refer to section 4.2.1.

6.4 Discussion

Our findings indicate that collection practices (including illegal ones) on Samothraki have an impact on the forests of the island, especially near roads accessible by car. There was no mention in our interviews of a household that could not meet its fuelwood demands. Instead there were several mentions in a decrease in available fuelwood and degradation of the forests (Interviews 3, 6, 16). Further research is needed to assess this uneven distribution of pressure on the forests by fuelwood collection, especially given the already degraded state of the island's woodland caused by overgrazing from goats and resulting erosion (Heiling 2018, Fetzel et al. 2018, Fuchs 2015). Even more pressure on areas near roads could inhibit forest regeneration and result in a decline in forested land.

In our interviews we did not explicitly ask whether interviewees participated in illegal activities, as we did not expect reliable responses, but we rather attempted to establish whether the municipal regulations meet the population's needs and offer a viable model. Therefore, we cannot suggest reliable estimations on the amount of illegal wood collecting or logging but can assume the need for a reworking of forest management plans that take into account the increasing need for fuelwood to counteract (potentially) damaging practices.

If future research reveals an unequal pressure to be damaging to forest ecosystems, different collection practices than the ones in place now (households collecting alone or in small groups, with cars near roads) could be considered. Such a process should include all stakeholders affected by a change in practice to gather sufficient input and information on ideas, needs and visions from the local wood-burning households, land owners, the forest administrations and the municipality. Participatory processes have been part of the research project on Samothraki before (for example Rau et al. 2013) and are an important technique to include the local population in the research and increase the possibility of a successful outcome.

One such approach could be a community-based collection system either organised by a cooperative (like the olive oil cooperative established on the island a few years ago) or by the municipality. By making use of the island's increased donkey population for transportation, larger areas of forests could be used for collection. This would spread the impact of fuelwood collection, but the state of the forests has to be kept in mind. Carina Heiling has shown in her master thesis that even the island's oak forests in higher altitudes are degrading (Heiling 2018).

We heard quite often that the reason for using fuelwood were financial (Interviews 7, 8, 13, 15, 17) and that some households would switch to a heating system and fuel source that does not require personal effort to collect fuel if possible (Interviews 8, 13). So a practice that would not require everyone to collect their own fuelwood would possibly provide an incentive to keep using fuelwood instead of switching to a fossil fuel-based heating system. A community-based collection system would also benefit the people who are not able to collect themselves, like the elderly and disabled. This group of people can apply for subsidised fuelwood from the municipality. But measured by the ratio of applicants to granted subsidies (100:50) there is not enough fuelwood available from this source. As mentioned above, this has to do with the forest administration in Alexandroupoli.

Another option seems to be buying fuelwood. This has come up in interviews multiple times (Interviews 4, 7, 8, 13, 17, 18) but needs further research because we could not locate any sellers of fuelwood. Apart from the municipality there seems to be no import of fuelwood to the island (Interview 4), so locally collected or logged wood could be sold by farmers or land owners.

The topic of charcoal should also be further investigated, especially given there once was charcoal production on the island but now all charcoal used is be imported. The origin of that charcoal is Argentina (Interviews 5, 11), so the sustainability of that practice is questionable. The link to tourism could also be of interest because most of the charcoal is used by taverns during the summer months to prepare their famous goat dishes and other specialties.

Another highly relevant aspect of energy consumption on Samothraki concerns the use of heating oil. Heating oil is imported by the only local gas station. Preliminary data on the development of oil imports to the island provide the following results (Noll, unpublished data): The imports have decreased from 1100 tons in 2005 to 300 tons in 2015, resulting in a strong decline of 80 tons per year. If we assume this trend has continued until 2017, we reach an estimation of 140 tons of imported heating oil - a higher number seems realistic. Heating oil has a density of approximately 0.85 kg per liter (depending on the oil quality and corresponding density value) and we assume a household with 4 people to burn between 2000-3000 liters per year for heating and warm water (depending on architecture, heating system, combustion technique, floor space, etc.) Our estimation was 75 oil using households (Interview 1). This would result in a need of 160 tons per year approximately - which could be realistic (assumption: demand of 2500 liters per year and oil using household).

Yet the declining heating oil imports must be substituted by another energy source as we have no indication to assume a decrease in demand. In our interviews we gathered that households switched mainly from heating oil to fuelwood. To substitute 800 tons of heating oil (~41 MJ/kg) with fuelwood, approximately 2400 tons of fuelwood (14.4 MJ/kg, depending on quality, heating system, architecture and handling; for more information see reference Agrar Plus) are necessary. Some of the energy demand could be substituted by other energy sources like solar, gas or electricity systems. This number shows the increasing pressure on Samothraki's forests and also confirms our assumption of approximately 3000 tons of fuelwood extracted.

We further cross-checked our calculations with forest ecologist Georg Gratzer (pers. comm.), who confirmed our calculations for oak fuelwood extraction to be realistic. Yet further

research is needed to assess the long-term effect and sustainability of fuelwood extraction from Samothraki's forests, especially regarding the extenuated regeneration of forests caused by overgrazing.

We can also compare our results with another small study conducted by one of our team members where he interviewed an Austrian farm household with three adults using only fuelwood (mainly spruce and pine) as energy source. This household has a total consumption of 35 "Raummeter" (stacked cubic meter) per year. The fuelwood is used during the whole year for cooking, heating, warm water preparation and production of smoked meat. One "Raummeter" is equal to 0.7 "Festmeter" (solid cubic meter) and one "Festmeter" is equal to 0.475 tons (FHP 2007: 27). The total consumption per year is 11.64 tons. Spruce and pine are wood types with a far lower energy density than plane and oak (25% lower) (Donner 2018).

Although the heating season usually lasts from October to April the household burns fuelwood every day of the year (no vacation, daily cooking, daily warm water preparation). To compare these data with a Samothraki household, we have to be aware of differences in wood types, architecture, climate and furnace types. Taking all these aspects into account, the number of 10 tons per year for a Samothraki household, that only uses fuelwood as energy source seems plausible (Interview 1). Considering that most households on Samothraki use more than one energy source, we consider our calculation of 7.2 tons of fuelwood per year realistic.

6.5 Conclusion

Our findings show that almost all of the fuelwood consumption on Samothraki is based on domestic extraction (3105 t/yr). Only the collection of dead wood is allowed. Logging or damaging healthy trees is prohibited. Six tons of fuelwood may be collected during four two-week periods every year. Most people that collect do so on their own or in small groups. They use their cars for transportation and therefore mainly collect near roads. The only import of fuelwood is organised by the municipality, mainly to assist pensioners, people with disabilities and low income households (115 t/yr). No fuelwood is exported from Samothraki. This results in a DMC of approximately 3220 t/yr.

The recent financial crisis, both in Greece and globally, is a determining factor for current consumption preferences, as it caused incomes to stagnate or even decline. Coupled with increasing oil prices in the following years, this has lead ever more households on Samothraki to be using fuelwood. This raises the question of the sustainability of the current collection practice. Since Samothraki's forests are already under pressure from overgrazing and resulting erosion, the additional human impact from fuelwood collection - especially illegal practices such as logging - must not be underestimated. This should be further assessed and - if need be - other practices, such as those discussed in the previous chapter, should be considered. The use of moderate amounts of local fuelwood should be regarded as preferable to the use of fossil fuels in the context of a socioecological transition on Samothraki. Nonetheless, a tipping point in local forest ecosystems could be exceeded which impedes forest regeneration and therefore could lead to a slow deforestation of the island. The effects of deforestation on the local climate and water cycle, soil erosion, biodiversity, etc. would be substantial.

Coming from different disciplinary backgrounds with a heavy emphasis on transdisciplinary work, which is also in the framework of the Summer School itself, our research team applied

different perspectives in our field work. While the research question focused on gathering data regarding consumption and extraction, for developing strategies and guidelines for future adaptation to sustainability goals, it is necessary to understand how the current energy metabolism has been shaped by cultural and economic factors and in consequence improve the likelihood of practical implementation of measures.

From a land use/agricultural perspective, practices of self-sufficient farming are still relevant as many people own land and/or olive trees. Several land-owners stated that they cannot give precise numbers as to how much land they own. They further did not have a clear forest management plan, hinting at a more practically oriented understanding of land use as opposed to following a paradigm of accounting. When building a model for a more sustainable future, possibly looking at concepts of circular economy, it is important to consider traditional ecological knowledge, craftsmanship and land use practices that might hold clues for a more ecologically and socially sustainable Samothraki. For lack of time these topics have not been investigated further. In the opinion of the research team additional efforts should be dedicated to these questions.

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Contact

Marina Fischer-Kowalski
marina.fischer-kowalski@boku.ac.at

Panos Petridis
petridispanos@gmail.com

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