A SOCIAL-ECOLOGICAL SYSTEMS ANALYSIS OF WATER SUPPLY GOVERNANCE ON SAMOTHRAKI, GREECE

by

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A SOCIAL-ECOLOGICAL SYSTEMS ANALYSIS OF WATER SUPPLY GOVERNANCE ON SAMOTHRAKI, GREECE

The island of Samothraki in the North Aegean Sea features astonishing water resources of pristine quality and high quantity. Contrary to what the condition of the water resources would suggest, the residents of Samothraki suffer from water shortages and incidents of contamination, as well as unsteady water provision to economic activities. Meanwhile, the natural water resource system starts showing signs of degradation. The situation is associated with inappropriate municipal water management within the frame of a collective action problem. The local municipality's inability to provide sufficient network coverage and quality control is facing resource-intense and hard-to-control surface water abstractions by individuals for agricultural purposes. Without a coherent understanding of the structures, dynamics and interdependencies underlying management decisions, the situation is likely to continue and cause social conflict as well as ecological harm .

Through the application of the Social-Ecological Systems Framework (McGinnis and Ostrom 2014), I first map out a wide range of variables connected to water management and analyse them according to their their relevance and interdependence. The results show that water mismanagement on the island is a much more complex issue than suggested until now, with strong symbiotic links between current informal and official, collective, individual and municipal institutions. I thus argue that the water supply on Samothraki is best understood as a complex social-ecological system.

In a second step I draw on insights from adaptive and decentralized governance approaches to evaluate the potentials of sustainable resource management inherent in current practices on Samothraki. I find that informal networks currently contribute most to the social-ecological system's sustainability and resilience, and embody the incubators of new approaches of sustainable governance.

YUNANISTAN SEMADIREK'TE Kİ SU YÖNETİMİNİN SOSYAL-EKOLOJİK SİSTEM ANALİZİ

Kuzey Ege Denizi'ndeki Semadirek adası, şaşırtıcı derecede bozulmamış kalitede ve yüksek miktarda su kaynaklarına sahiptir. Su kaynaklarının önerilenin aksine kullanılmasından dolayı, Semadirek sakinleri su kıtlığı, kirlilik ve bunun yansıra ekonomik faaliyetlerde su temininde sıkıntı yaşamaktadır. Bir yandan da, doğal su kaynakları sistemi bozulma belirtileri göstermeye başlıyor. Bu durum, toplu eylem sorunu (collective action problem) çerçevesinde uygun olmayan belediye su yönetimi ile ilişkilidir. Yerel belediyenin ortak su kullanımı konusunda yeterli ağ kapsamı ve kalite kontrolü sağlayamaması, kaynak açısından yoğun ve kontrol edilmesi zor olan yüzey sularının bireyler tarafından tarımsal amaçlarla alınmasıyla belediye ve ada sakinleri su kullanımı konusunda karşı karşıya gelmektedirler. Yönetim kararlarını alan yapıların altında yatan dinamikler ve karşılıklı bağımlılıklar hakkında tutarlı bir anlayış olmadan bu durumun devam etmesi ve ekolojik zararın yanı sıra sosyal çatışmaya neden olması muhtemeldir.

Sosyal-Ekolojik Sistemler Çerçevesi'nin uygulanmasıyla (McGinnis and Ostrom 2014), önce su yönetimiyle bağlantılı çok çeşitli değişkenlerin haritasını çıkarıyor ve bunları alakalarına ve karşılıklı bağımlılıklarına göre analiz ediyorum. Sonuçlar, adadaki suyun kötü yönetiminin, şimdiye kadar düşünüldüğü gibi mevcut gayri resmi ve resmi, toplu, bireysel ve belediye kurumları arasında güçlü simbiyotik bağlantılardan çok daha karmaşık bir konu olduğunu göstermektedir. Bu nedenle, Semadirek'teki su yönetim sisteminin en iyi şekilde anlaşılması için, kompleks sosyal ekolojik sistem olarak kabul edilmesigerekiyor.

İkinci bir adımda, Semadirek'teki mevcut uygulamalarda bulunansürdürülebilir kaynak yönetiminin potansiyellerini değerlendirmek içinuyarlanabilir ve merkezi olmayan yönetim yaklaşımlarından faydalanıyorum. Şu anda sosyal-ekolojik sistemin sürdürülebilirliğine ve dayanıklılığına en çok gayri resmi ağların katkıda bulunduğunu ve sürdürülebilir yönetimin yeni yaklaşımlarını bünyesinde barındırdığını görüyorum.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AG Adaptive Governance

AS Action Situation

A Actors

CAP Collective Action Problem

CAS Complex Adaptive System

CPRM Common-Pool Resource Management

CPR Common-Pool Resource

DPSIR Driving forces, Pressures, States, Impacts and Response

ECO Related Ecosystems

EC European Commission

EU European Union

GS Governance System

HCMR Hellenic Centre of Marine Research

IAD Institutional Analysis and Development Framework

IGME Institute of Geological and Mineral Exploration

IWRM Integrated Water Resources Management

LTER Long Term Socio-Ecological Research

MAB Man and Biosphere Reserve

PNAS Proceedings of the National Academy of Sciences

RBD River Basin District

RBMP River Basin Management Plan

RS Resource System

RU Resource Units

SEC Vienna Institute of Socio-Ecological Research

SESF Social-Ecological Systems Framework

SES Social-Ecological System

SGWS Samothraki Groundwater System

SNO Samothraki Nature Observatory

SWOT Strenghts, Weaknesses, Opportunities, Threats

S Social, Economic and Political Settings

UNESCO United Nations Educational, Scientific and Cultural Organization

WFD Water Framework Directive

XGWS Xiropotamos Groundwater System

YPEKA Greek Ministry of Environment, Energy and Climate Change

1. INTRODUCTION

As I am about to finish my thesis, an unusually severe cold weather front moving through parts of Turkey and Greece covers Samothraki, a small island in the North Aegean Sea and subject of my research, in thick layers of snow. I flip through the news headlines on my phone from a sunny spot in Vienna, Austria, with temperatures near 20°C - about 15°C higher than usually in mid February. Residents of Samothraki cannot enjoy the rare sight of snow with such ease.

Just a week in advance, the outbreak of a local gastroenteritis pandemic was announced by the local government. A rise in gastroenteritis cases had been observed already in mid-January, but no measures were taken as viral diseases usually peak during the winter months. Around the end of January, health workers informed responsible authorities of an abnormal rise in cases and suggested contaminated drinking water as a probable source. While repeatedly reassuring the public with references to the usual increase of viral diseases during winter[1], the Municipality of Samothraki issued microbial tests of domestic water resources. On 9th of February finally, residents were called to instantly refrain from using domestic water supplies for purely precautionary reasons, and informed that provision with bottled water was being organized [2]. By then, large parts of the population had already gotten infected.

The unfortunate event was the culmination of a series of water-related problems developing in the capital Chora since late autumn. Unannounced outages occurred, followed by an incident of turbidity and accompanied by unpleasant taste and colour. To all of the residents I could talk to, it was obvious that there were unresolved issues with the domestic water supply. In a statement via Facebook, even the mayor ultimately overlooking water quality controls admitted that there had been unresolved issues previously, just accredited the problem to the previous administration[3]. The question of "Why was the problem not investigated earlier?" stands in line with a range of questions which triggered my interest in water governance on Samothraki as an opportunity to learn from and contribute to small and big social-ecological transformations towards sustainability.

Samothraki, a small island in the North Aegean Sea, is home to outstanding freshwater resources both in respect to their abundance and high quality. Situated within a dry Mediterranean climatic zone, this unusual characteristic distinguishes it from other islands, is valued highly by locals and has

[1]Source (in Greek): https://www.e-evros.gr/gr/eidhseis/3/anastatwsh-sth-samo8rakh-gia-to-nero-meta-apo-kroysmata-Dgastrenteritidas-ka8hsyxastikh-h-dhmotikh-arxh/post42654, accessed 19.02.2021

[2]Source (in Greek): https://irineossamothraki.blogspot.com/2021/02/status-942.html, accessed 19.02.21

[3]See footnote 2

Figure 1.1. Samothraki Island with cloud formations on the Saos mountain range. Source: Athens Nature Journal, https://zogaris.blogspot.com, accessed 13.12.2020

been attracting visitors throughout history. The islands vast hydrological network features hot and cold springs, numerous streams, pools(so -called vathres), coastal wetlands, lagoons and groundwater aquifers, all of which contribute to the unique ecosystem of the island.

Despite its outstanding water resources incidents of impaired water quality occur, with the potential of causing major inconvenience - as recent events demonstrate. Regularly occurring water shortages furthermore prompt conflict amongst different water users, usages and other stakeholders. The island's water balance follows seasonal patterns with dry summers, which are oftentimes aggravated by periodically occurring droughts, and is increasingly troubled by extreme weather events which challenge the island community. However, these external circumstances are not to blame. Most problems originate from water mismanagement rather than an actual reduction in the volume or quality of the resource system (Skoulikidis et al. 2020). While this is a relief on one hand, it opens up a variety of new questions on the other. What are the causes of poor water management? What defines successful water management? Is the problem at hand one of insufficient resources or technology, or is it more complex? Is there a solution satisfactory for everyone ? In the face of changing future climatic conditions as well as upcoming demographic, socio-economic and political challenges, these questions gain relevance, as sustainable governance systems need to development to adapt.

1.1. Research Interest

In the process of a transition from traditional, agrarian to a modern, industrial society (Petridis et al. 2017), the community of Samothraki is in a position to direct change towards a desired trajectory. Aware of Samothraki's vulnerable, yet special position, as also the drawbacks of common

neo-liberal development trajectories, various actors on the island community have taken hands on creating space for deliberation on a sustainable future of the island. On various levels, sustainable visions are elaborated on, tested, established in practice, in a quest to steer Samothraki towards sustainable development trajectories. Since 2007, local ecological activists and international scientists work together in an interdisciplinary civic-scientific cooperation to work out pathways towards a sustainable transition. As one relevant compartment, characteristics of Samothraki's hydrological network have been studied intensively by researchers of the Samothraki Nature Observatory (SNO) in collaboration with locals and Summer School students (Skoulikidis et al. 2014; Skoulikidis et al. 2020; Pollakowski et al. 2019; Fischer-Kowalski et al. 2020b; Lampou et al. 2016). However, so far the studies' main focus lay on the quality and quantity parameters of the freshwater resource system. Recent works, eg. Lampou 2012 and Skoulikidis et al. 2019, give valuable insights in regards to socio-economic pressures on water resources and weak spots in water resource management. However, an extensive investigation of societal interactions within the water supply system has not yet been undertaken. The water supply of Samothraki can be conceptualized as a Social-Ecological System (SES). It features complex dynamics and is characterized by society-nature interactions. The SESF, developed based on Ostrom's Institutional Analyses and Development Framework, provides a systematic approach to cover social as well as ecological variables of the system and facilitates the analysis of their interdependence. Drawing attention towards the emergence of governance institutions, this process guides the researcher in diagnosing weaknesses and potentials of a sustainable SES governance. However, as a framework alone cannot provide a consistent theory that guides further steps and re-anchors research in applicable, testable and verifiable approaches. I therefore use the results of the SESF analysis for a discussion of sustainable resource governance, based on the theory of collective action and the approaches of adaptive governance and co-management and polycentricity which developed out of collective action theory.

This study therefore aims to deepen the understanding of the dynamics underlying water management through the approach towards the situation as a social-ecological system. Further, concepts of resource governance which promote the development of a sustainable social-ecological system were investigated and applied to the situation.

1.1.1. Research Questions

For this, the following two research questions are identified:

RQ 1 : Which relevant aspects does the social-ecological water supply system of Samothraki constitute of and how do they interrelate?

RQ 2: Which potentials and challenges can be identified within the SESin regards to sustainable governance?

In order to answer RQ 1, a variety of social and ecological variables including different spatial and temporal scales, as well as the relationships and feedbacks between the system components need to be investigated. This can be achieved through the framing of freshwater supply on Samothraki as a complex social-ecological system. Thus I apply the SES Framework to get an informed account of all the variables which come into play and apply its core diagnostic tool, the Action Situation (AS), to three selected interactions within the system to extract a more situated analysis. Together with an overall analysis of the system variables' interactions, the results of the SESF analysis inform my discussion on potentials and challenges of sustainable governance. Drawing on literature on collective action in Common-Pool Resource Management (CPRM), adaptive governance and decentralized governance approaches, I lay out principles of sustainable resource governance to then analyse the SESF outcomes accordingly (RQ 2). In order to differentiate between narrowly defined and a wholesome, transformative sustainability, I review relevant divergences in sustainability research and locate my working definition of sustainability within transformative and emancipatory approaches. Insights from the growing social-ecological research on the island further enrich my perspective on sustainability (Petridis et al. 2017; Fischer-Kowalski et al. 2020a). Furthermore, a glimpse into the past of water governance got its own single chapter, as the memories shared by one interviewee provided relevant insights as to how institutions have changed, but were at the same time situated too specifically to submerge in other chapters. I finally combine results from the SESF with perspectives gained from the sustainability literature with a governance diagnosis of the SES into a discussion on the future direction of Samothraki.

1.2. Positioning

Positionality in science is based on the assumption that normative and theoretical views as well as the societal background of researchers matter, as they inform the researchers perspective, facilitate or hinder their work, and thus are reflected in their research. The concept has evolved in emancipatory post-colonial and feminist studies from the necessity for a deeper understanding of the political, social and historical context in which scientific work is undertaken ((Vanner 2015)). The reflective exercise aims at raising the researchers' awareness for their entanglement in systems of power, as "no spaces without power exist" (Wittmayer and Schäpke 2014). In transformative sustainability research approaches, participatory research and the role of local actors are if high value. Scientists transcends their realm of knowledge, resources, infrastructure, and status to encounter local expertise and perspectives outside of institutionalized science, to enter a co-production of knowledge. However, as researchers' carry the characteristics of their status with them, their position remains privileged, though often undisclosed. Fritz and Binder 2020 calls to "unveil the ways in which the funding body, researchers, and practitioners exercise instrumental, structural, and discursive power over (i) actor selection and (re-)positioning, (ii) agenda setting, and (iii) rule setting" within a research process. Especially in transdisciplinary sustainability research settings, in which "ideas of societal change" set

the research agenda, but , "critical enquiries into power dynamics both within and stemming from [transdisciplinary and sustainability] practices have been scant" (Fritz and Meinherz 2020). This is of special relevance when the background of the researcher (German) and the area of study are entangled in a history of power inequality (manifesting in military occupation, economic suppression, labour migration and more recently, 'configurative'[4] power). For the perspective or interest of the researcher informing the study might be biased or at odds with local perceptions, but nevertheless find support due to different power structures available. I therefore want to shortly sketch out the background and coming-about of my work: I am a German student at a Turkish university, who approached an Austrian institute involved in sustainability research on a Greek island, Samothraki, with the request to work on a master's thesis within the frame of this research. The collaboration originated from former encounters between scientists (as tourists) and local environmental activists, and the research funding is largely organized by the major institutions involved. However, the research largely draws on the contributions and efforts of the locals involved (see Fischer-Kowalski et al. 2020b). My studies for this thesis were financially supported by my family and enabled through the work and effort provided by local networks. If I graduate, I will gain a moderate scientific title partly based on this research. So far, the study is designed to be accessible to different readers. In order for it to support the crafting of sustainable water resource governance, however, a rework may be necessary.

1.3. Thesis Outline

After this short introduction to the research area, framing of the research interest, and personal positioning, I will outline the theoretical basis which I work with: sustainability science, social-ecological-systems and environmental governance. I proceed according to the hourglass-principle, starting with introductions to the respective theoretical genealogy before narrowing down to the specific concepts in use throughout this work. Then I present the main methodological instrument, the SESF,through which I sort and analyse the manifold variables of water supply governance on Samothraki. This chapter has two focal points: the SESF operationalisation, ie. how the theoretical framework was applied to the SES under study. Here I explicate which variables were used, dropped, or focussed on. The second focal point is the data acquisition, in which the type of literature reviewed is outlined, followed by conceptual foundations and practical implementations of the interviews conducted. Then I move to the main thesis' main part: The SESF application. In the first three tiers (resource system, governance system, and actors), relevant variables and aspects of the water supply system are described. In section 4.4, 'focal action situations', three examples of interactions between above mentioned subsystems are given. The variable interdependencies and relevancies are subsumed in 'outcomes'. According to Mar Delgado-Serrano and Ramos 2015, they are evaluated in terms of socio-economic and ecological performance, while Petridis and Fischer-Kowalski 2016 emphasis on socio-ecological tipping points is echoed in subsection 4.5.2.7 on the system's vulnerability.

[4] term borrowed in this context from Eleni Kotsira

Chapter 5 is an excursion to former institutions of water governance. As interviews were difficult to obtain, the basis for this chapter is mainly provided by one elderly woman formerly living on Samothraki. I therefore decided to include this account of historical governance institutions as a stand-alone chapter, to be referenced to, but lacking in detail when compared to the description of current water supply SES. Following this excursion to the past, I recur to the theoretical background outlined in chapter 3.3 to analyse potentials and shortcomings of current governance institutions in regards to sustainable governance of complex SES. In the following discussion, I provide an outlook to the possible implications of the analysis and connect the situation on Samothraki with similar contexts and research.

2. THEORETICAL FRAMING

This study is situated in fields of research and theory-building, which co-evolved dynamically in recent years: Sustainability Science, Environmental Governance and Social-Ecological Systems Research. Each of these fields encompasses a variety of approaches and schools, of which those I work with are outlined in the sections below. First, however, I want to point out the fundamental concepts and principles these fields have in common, namely: *Systems thinking*, an understanding of everything as interconnected, emphasizing "connectedness, context and feedback" (Berkes et al. 2003), and focussing the researcher's attention to questions of boundary, scales and variable relationships; *an understanding of sustainability as value-driven*, acknowledging that the perception of what is desirable to sustain is generated through values, perspectives, and interests, generating a normative definition of sustainability which in turn informs research, policy and transformative action, in contrast to a value-free perception of sustainability as any system's ability to sustain itself, and *a strong inter- and transdisciplinary approach*, an understanding of social-ecological problems as 'owned' by the whole society, transgressing disciplinary boundaries and the science-society divide. Deliberation and collaboration between various actors is seen as indispensable for the construction of sustainable solutions.

Although these shared principles do not necessarily imply a common world view, point of departure, or lineage of scientific development, they allow me to form a set of complementary theories which this thesis is built on.

2.1. Sustainability Science

Sustainability science has emerged over the past two decades as an umbrella term for research which is (1) situated at the intersection of natural and social systems and (2) committed to contributing to a transformation towards sustainability (Kates 2011a; Partelow 2016). Scientific research connecting a social-ecological perspective with the need for active transformation can be traced back to the 19th century (Pulver et al. 2018)(see 2.2), while the concept of *sustainability* has been used increasingly since the 1980s, largely in co-evolution with the "sustainable development" discourse (Bettencourt and Kaur 2011). The idea of a sustainability science reached its current momentum only in the 21st century. Novel to its approach is the large-scale adoption of a purpose-driven research agenda across various disciplines, schools and methodological approaches. Faced with the realisation

that policy and science so far failed to successfully intervene into the global climate change trajectory, sustainability science aims not only at understanding, but also transforming the relationship of society and the environment. This conceptualisation also includes a transformation of science, moving away from a division by discipline and bringing the schism between the academia and the society through a prioritization of common goals. To this end, various participatory, transdisciplinary and purpose-oriented scientific approaches are developed within the diverse sustainability science community.

While I draw on it for the purpose of this work, the use of sustainability science as a general, overarching term is controversial (Clark and Dickson 2003). On the one hand, the term might imply an understanding of sustainability science as a distinguished scientific discipline. This interpretation is not unreasonable, as it was a distinct research community which promoted the term sustainability science from 2002 onwards (Clark and Dickson 2003; Kates 2011a; Kates 2011b). Five years later, the Proceedings of the National Academy of Sciences (PNAS) provided the growing community a "room of its own" when it started publishing a journal of the same name (Clark 2007), with others following. Meanwhile, degree programmes on Sustainability Science building on the theoretical foundations developed through this process are offered at various universities. With a scientific community, journal, teaching and a core agenda, the notion of sustainability science as an academic field some suggest it incorporates everything necessary to constitute a discipline (or at least scientific field) on its own (Fang et al. 2018; Spangenberg 2011; Komiyama and Takeuchi 2006). Others reject this notion, stating that the field has not yet reached sufficient maturity in terms of development of core concepts and theories (Clark and Dickson 2003; Osinski 2021). On the other hand, the proclamation of Sustainability Science took place in close relation to a re-conceptualisation of sustainable development(Clark and Dickson 2003; Kates 2011a). Sustainable development however represents but one of various approaches integrating the two aspects mentioned in the beginning, social-ecological interconnectedness and commitment to transformative action. It is for this reason that Clark offered "the science of sustainability" as an alternative, which conveys the notion of multiple sciences addressing a common theme (even if he and his colleagues nevertheless settled on Sustainability Science) (Clark and Dickson 2003).

I argue that sustainability science can be conceptualised as a *paradigm* for scientific endeavours which catalyse to societal transformation processes towards sustainability. As a way of doing science which inevitably transforms science in itself (Spangenberg 2011) and thus is fundamentally different from the reductionist character of scientific disciplines. The trajectories of transformation seen as desirable largely depends upon the norms and goals set. Sustainability so far captures "a multitude of norms, values and objectives underlying various streams of environmentalism"(Osinski 2021). Below, I shortly discuss different conceptualisations of sustainability, and outline those which constitute fundamental contributions to sustainability science as applied on Samothraki.

2.1.1. A Working Definition of Sustainability

Curiously, despite carrying such normative function, the notion of sustainability is seldom clarified in academic papers: Reviewing studies on sustainability, sustainable development and sustainability science, only 5-10% of studies were found to include an explicit definition of these terms (Salas-Zapata and Ortiz-Muñoz 2019; Fang et al. 2018). All the while a definition not uncalled-for: Researchers across the board criticize the vaguely defined, elusive and ambiguous use of the term (Osinski 2021). Without further definition, the term risks being absorbed by the contested but still dominant conception of sustainability as adjacent to economic development. While economy as a system of production, supply and distribution of goods and services is indispensable for human society (Friend 1992), the superordinate position accredited to economic development in sustainable development leads to the continuation of an economic paradigm, "whereby economic growth and exploitation economics act as primary drivers of resource management" (Santillo 2007; Haberl et al. 2011). The conceptualisation of sustainability dominant in this context is a situation of balance between the economic, social and ecological realms or subsystems, also referred to as the triple bottom line or "people, planet, profit" (Osinski 2021). This conception of economic development as desirable in itself disguises the need for a paradigm shift is not only within the economy[1], but also regarding the role of economy within social-ecological systems. Although various re-definitions of sustainable development, eg. as the "progressive evolution or 'growing up' of human society as a whole" (Santillo 2007) seem appealing, a clear shift towards social and ecological systems' sustainability as the driver for economic strategies is necessary (Petrosillo et al. 2015; Leach et al. 2018). In terms of framing, the triple bottom line notion of sustainability is often presented as a static balance of resource use and resource or ecosystem reproduction, an achievable and desirable goal which informs the political and scientific agenda (see eg. (Komiyama and Takeuchi 2006; Salas-Zapata and Ortiz-Muñoz 2019)). The underlying notion is that human resource exploitation must remain within the threshold of resource reproductive capacity supported within a human-wise meaningful timespan (rendering fossil energy finite). This argument resembles the concept of maximum sustainable yield, according to which the amount of a resource, eg. fish, to be harvested sustainably, can be calculated given the carrying capacity of the ecosystem and the reproductive rate of the fish. Failing to account for the complexity (see 2.2) of the system, reductionist approaches and fixed-rule statements were largely proven unsuccessful when applied in real-life situations (Petrosillo et al. 2015; Marshall 2015).

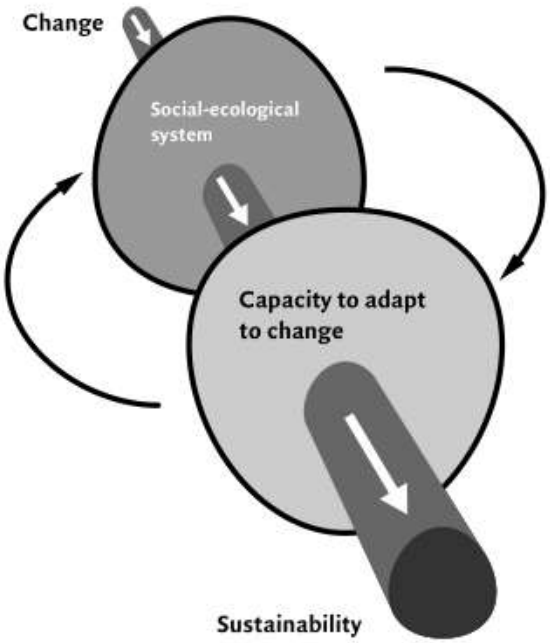
In contrast to the perception of a situation as sustainable under certain conditions, I outline sustainability as an organizational principle of human action guiding eg. research, policy, and activism. While a clear formulation of the final destination of the trajectory towards sustainability is helpful in carving out the general direction to proceed, it provides little guidance on how to get there. Drawing on approaches in political theory, Miller describes the universalist approach as encouraging "widespread agreement, but [not translating] substantively to the level of individual behaviour changes nor conflicts with more contextual notions of what is [...] desirable" (Miller 2013). To this

[1] eg. degrowth, ecological economics or sharing economy

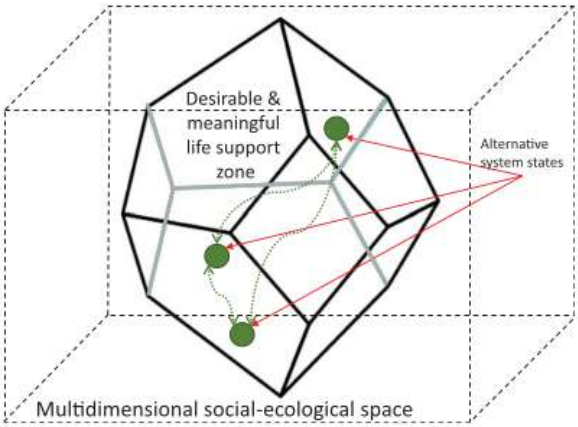
end, the procedural conceptualisation of sustainability aims to answer the questions of 'what?' and 'where to?' but also to the question of 'how?', providing guidance not only for the general direction of movement or where to place the next step, but on how to use the body in order to be able to walk. This leads to a complex challenge: Combining an understanding of the need for a radical, socio-metabolic transition with the procedural, adaptive process of carving out tangible pathways of transformation according to local specifications and time frames (Miller 2013), see figures 2.1a, 2.1b.

Taking into account all of the above, I propose the following working definition of sustainability: Drawing on a holistic understanding of social systems as intrinsically nested within the global ecological system (Santillo 2007) and acknowledging the dynamic interdependence of social and ecological systems, sustainability is "the long-term maintenance of desirable and meaningful life support systems which are biophysically, culturally and socially determined" (Leach et al. 2018). This conceptualisation is intrinsically anthropocentric, as the human perspective defines what characterises a desirable life support system. As also within the human species, different perspectives can reach to different conclusions, I further add the following specifications of sustainability as: (1) *situated*: What 'desirable and meaningful' bio-phyiscal, cultural and social systems constitute of in detail will vary in different contexts and therefore must be subject to discussion, making sustainability a "plural and politicized concept"(ibid.). (2) *democratic*: The sustainability of the global SES affects all human and non human life on earth, current and future. While not all of society took equal part in creating problems of unsustainability, all of society 'owns' them (Wittmayer and Schäpke 2014). A democratic sustainability puts forward the claim of deliberation and participation in decision making being be accessible to everyone affected, actively removing constraints to accessibility. Not only is sustainability - if understood as organizing concept of a desirable future - bound to value, thus requiring discussion of different views. It is also due to the characteristics of SESs that the "full range of knowledge and skills needed for environmental governance" (Berkes 2010) can only be developed through collaboration of a multitude of groups and agencies, an argument reinforced by increasing complexity of future challenges. Furthermore, democratic governance is found to have managed Common-Pool Resource (CPR)s sustainably over long periods of time(see 2.3), and (3) *emancipatory*: However situated, the long-term depletion of resources and services crucial for humankind's life support system is by no means desirable nor meaningful in any context [2]. As it is widely agreed on that the growing dysfunctionality of humankind's life support system, ie. global climate change, is due to a socio-metabolic regime driven by the capitalist principles of growth and accumulation (Pichler et al. 2017; Leach et al. 2018; Feola 2020), the need for uncoupling society from capitalist economics becomes imminent to a transition towards sustainability. An emancipatory approach rises awareness for power structures supporting the current capitalist regime and actively promotes pathways decoupling the sustainability of SESs from sustaining an economy based on capitalist principles (Feola 2020; Petridis et al. 2017). Conceptualising sustainability thus requires the integration of temporal and spatial scale into our thinking (Santillo 2007), knowledge of biophysical, cultural and

[2] Somehold on to a definition of sustainability as the characteristic of any system capable of reproducing itself, granting equal value to an ecosystem which supports human (or other) life as opposed to one which does not (Santillo 2007)



(a) Sustainability viewed as a process, rather than an end-product, of a dynamic process that requires adaptive capacity in resilient social–ecological systems to deal with change. Source: Berkes et al. 2003



(b) A schematic representation of a social–ecological systems perspective on sustainability showing systems variation across multiple social and ecological dimensions, but staying within a desirable and meaningful life support zone. In this figure, the dimensions are notional and situational, to be determined by scale or context. Source: Leach et al. 2018

Figure 2.1. Sustainability Models

social systems and their interrelations, and deliberation on a common vision of those systems which is considered desirable.

Drawn from the above, sustainability then should provide a set of criteria, principles or questions which enable a complex understanding of the social-ecological systems at hand, support the identification of desirable societal and ecological vision, and derives from this actionable pathways the future (Salas-Zapata and Ortiz-Muñoz 2019; Miller 2013). This puts sustainability research at the heart of three-directional agenda: Firstly, the degree of complexity of social-ecological systems in terms of scales, feedbacks, non-linearity and uniqueness requires further research and calls for the dissemination of system knowledge from both academic and non-academic experts to other stakeholders in order to support informed deliberation and decision-making. Secondly, spaces of deliberation are required in order to elaborate situated perspectives on meaningful and desirable social-ecological system conditions. Thirdly, actionable and adaptive pathways of transformation from the current, unsustainable social-ecological regime to a sustainable one must be found and set out to. Partelow 2016 arranges this process in three stages of sustainable knowledge production: (1) System knowledge, “analysing and describing SES functionality”, (2) target knowledge, “developing meaningful goals and pathways for transitioning towards sustainable human well-being and ecological functionality” and (3) transformative knowledge, “guiding and facilitating practical mechanisms to operationalize goals and pathways”. Researchers, as Miller 2013 remarks, are “(only) one of the knowledge providers [in this process], but they also facilitate the exploration of sustainability pathways and actively participate.”

2.1.2. Transformative Sustainability Science

Rooted in a procedural understanding of sustainability, sustainability research, then, is transformative in that it "does not only observe and describe societal transformation processes, but rather initiates and catalyses them. Transformative science aims to improve our understanding of transformation processes and to simultaneously increase societal capacity to reflect on them" (Petridis et al. 2017).

Realising that scientific knowledge itself is not sufficient for the changes aspired by sustainability scientists, a 'transformative turn' (Horlings et al. 2020) in sustainability science promotes the engagement of scientists into process- and action oriented activities. These include for example communicative action (Berkes 2010), guiding collective learning and mediation (Pohl et al. 2010), and supporting or engaging in policy-making (Salas-Zapata and Ortiz-Muñoz 2019).

Such spaces promoting transformative research are conceptualised as transition arena, agora, communicative space, arena for dialogue or participatory space in transdisciplinary, action research, and participatory approaches respectively (Wittmayer and Schäpke 2014). Although transformative approaches differ in terms of focal questions, theoretical perspectives and methods, general principles facilitating the active engagement of science in societal transformation have been developed (Horlings et al. 2020). These include:

- The incorporation of civic-science collaboration to "define problems, desirable futures and immediate actions" in research project frameworks (Wittmayer and Schäpke 2014).
- The active inclusion of a variety of participants while offering different levels of participation, thus allowing for a great variety of perspectives on and contributions to the issue at hand. Careful selection guidelines based on "knowledge, competencies and worldviews, rather than on hierarchical power, representativeness or authority" (ibid.), encourage the involvement of 'radical' actors holding "transformative power", ie. the capacity to develop new structures and institutions, and those with the capacity to create new resources, ie. "innovative power" (ibid.). With regards to the intertwined dynamics of power in sustainability transformations as outlined above, special attention should be paid to actors with less prominent outreach as opposed to well established and elite stakeholders.
- Reflexivity. As no space without power exists (ibid.), the above awareness for power structures and interests includes the academia and researchers themselves as well (see section 1.2).
- The construction of a research process based on adaptive learning, in which the generated knowledge is "shared, contested and collectively re-developed" (ibid.) in societal spaces, ie by the society.
- Mediation: In order for transformative research to include a variety of actors and learn from the contributions of different viewpoints, researchers mus establish a " quality relationship to

and among participants", condensing, analysing and mirroring back the outcomes of deliberation, "following up on emerging contradictions and finding ways to address'undiscussables'" (Wittmayer and Schäpke 2014).

- Applying principles of transformative research means to embark on a long and versatile journey. The sustainability research on Samothraki is an instructive example of such attempt (see section 2.1.3.1).

2.1.3. Island Sustainability Science

Islands provide a unique research possibility for sustainability studies.Their physical isolation and geographical delimitation create relative clearly defined boundaries, allowing a greater understanding of driving forces and some degree of experimental control. Island sustainability studies make use of the model-like conditions to systematically analyse the interactions of human activities and the environment. The insights gained might be applied for wider sustainability science, as investigations on insular stock-flow dynamics within Industrial Ecology show (Petridis and Fischer-Kowalski 2016). For island populations, these very features create the challenging necessity of supporting life with limited resource availability and constrained by remoteness and isolation. While this lead to the development of specific cultural systems in the past, in the modern world of global capitalist relationships, islands are marked by heavy dependence on imports and handicaps to economic development. Resources for resilient water, sanitation, energy and waste management are often insufficient (ibid.)

Researchers in the field of island sustainability argue, that the characteristics and peculiarity of islands are precisely what makes them to "hotspots of biocultural diversity" (Singh et al. 2020). Including the surrounding ocean waters, the area which the 600 million inhabitants of islands depend on for subsistence equals one sixth of the earth's surface, which makes insular social-ecological systems a globally relevant potential driver of transformation towards sustainability(ibid.) Taking into account their peculiarity as well as their need to response to the challenges imposed by socio-economic vulnerability and climate change, islands have the potential of evolving into "hubs of innovation "(ibid.), putting them in a globally unique leadership position regarding sustainable stewardship and climate action.

An emancipatory approach towards island sustainability conceptualises islands as such. It rejects the notion of islands primarily as backward and vulnerable without falling into the "conspicuous sustainability"(Grydehøj and Kelman 2017) trap of promoting islands as progressive and sustainable solely for tourism marketing purposes (Grydehøj and Kelman 2017; Kelman 2019). Critically revising the common call upon island communities to find their economic niche within global markets in an attempt to overcome economic vulnerability, emancipatory island studies suggests that it might be exactly the condition of 'islandness' which could catalyse the escape from "'inappropriate' economic development" (Petridis and Fischer-Kowalski 2016). The emancipatory approach envisions islands as promising place fo radical social-ecological transformations to take-off (Singh et al. 2020).

Recent scholarship thus focusses less on the biophysical boundaries and remoteness, but conceptualizes islands as "simultaneously open and closed systems, insular and at the same time embedded within complex multi-relational systems" (Petridis and Fischer-Kowalski 2016). Their nonconformity in global market relationships is seen as a potent niche for the growth of sustainable alternatives to the current paradigm of the financialisation and commodification of nature (Petridis et al. 2017). Emancipatory island studies seeks “to reveal various possible and realistic alternative pathways to scrutiny, economic growth notwithstanding, contextualising sustainability and calling for people to make democratic choices” (Petridis and Huber 2017). Sustainability research on Samothraki is a practical example of such approach.

2.1.3.1. Sustainability research on Samothraki. The meanwhile firmly established social-ecological research on Samothraki first started when local activists concerned with the ecological state of the island opened up discussion with regularly visiting scientist from social, natural and socio-ecological science backgrounds. The following deliberation process on how to tackle environmental issues and setting the path for a long-term transformation of the island towards an ecologically and socially sustainable future resulted in an “ambitious research program, informing and informed by an alternative vision of local island development form the bottom up” Petridis et al. 2017. The idea of transforming Samothraki into a United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere Reserve (MAB) Reserve was the core agenda of the initial civic-science collaboration, taking shape in several years of participative socio-ecological research, feasibility studies, stakeholder discussions, and science-policy interactions. While the application of Samothraki as MAB is an ongoing process (Fischer-Kowalski et al. 2020a), the collaboration has “enhanced the robustness” of the local activist group *Sustainable Samothraki*, “a group of young locals sharing and promoting a vision towards sustainability on the island, advancing practical initiatives, organising information meetings, but also receiving training in several international meetings, thus becoming operationally part of a ‘family’ of practitioners committed to a vision of island sustainability. This has been instrumental in facilitating the local development process, but has also brought other scientists into the process, thus acting as a solid foundation for scientifically guided decision-making” (Petridis et al. 2017). Consequently, a strong transdisciplinary tradition developed on the island, acting as an “open linking-network among research groups visiting the island” (Lampou et al. 2016; Petridis et al. 2017).

While the research generally lies within SES thinking, the conceptual framework largely adopted draws on the concept of social metabolism developed by the Vienna Institute of Socio-Ecological Research (SEC). The socio-metablic model represents the interactions of social and natural systems through a stocks-and-flows approach (see 2.2). As long as the flows required for maintaining the stocks of each “sphere of causation” can be organized, the systems (and its various subsystems) can reproduce themselves (Fischer-Kowalski et al. 2020a). The model proved successful in identifying critical stocks and flows and their interdependence, leading to a deeper understanding of social and ecological tipping points of the islands SES. As one example, European Union (EU) subsidies were investigated as potential driver for over-grazing and consequent soil degradation on the island (Fetzel

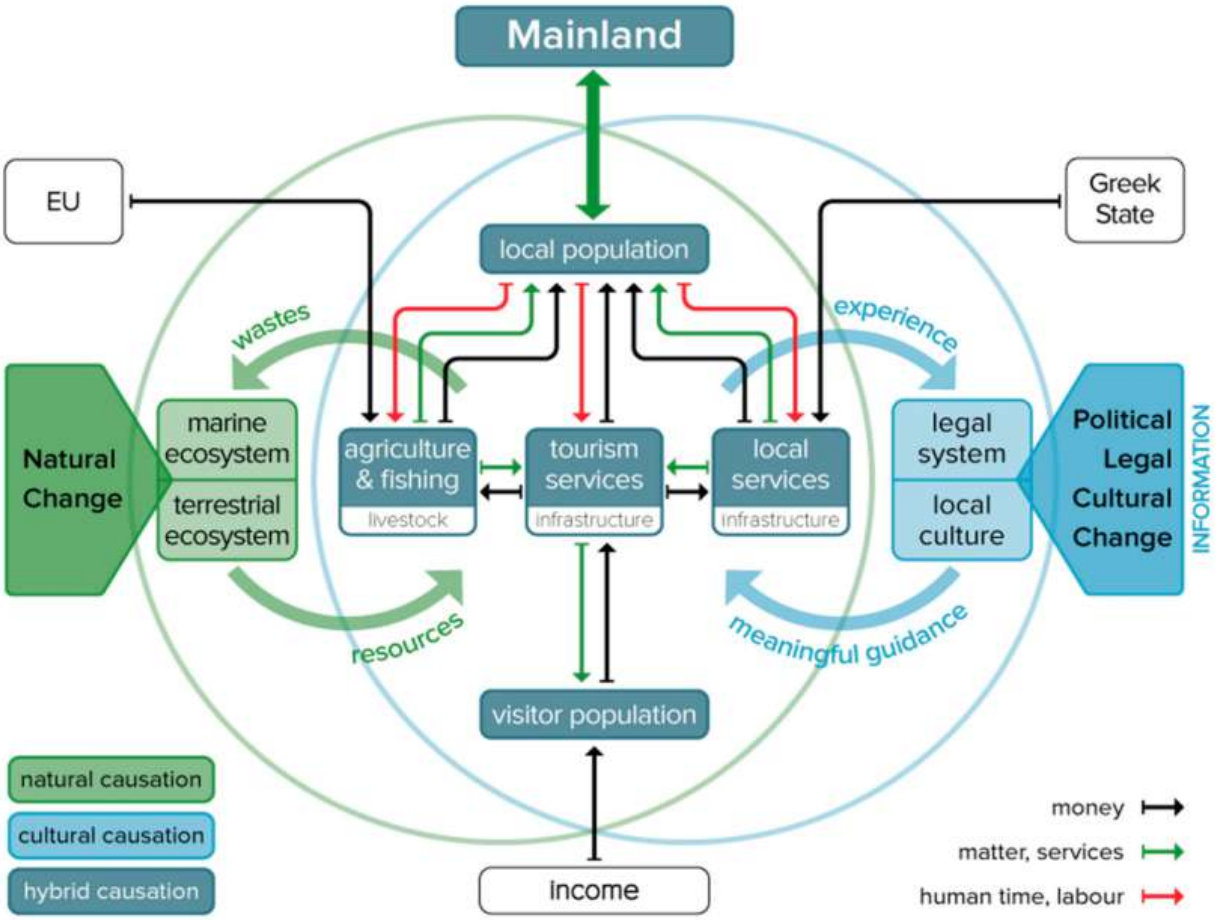


Figure 2.2. Sociometabolic system model for the relevant stocks and flows within and between the local society and its natural environment. Source: Fischer-Kowalski et al. 2020a

et al. 2018). Applying participatory methods, prevailing faulty assumptions regarding the causes of overgrazing could be dismantled and a civic-science program put in place for the restoration of pastures (Fischer-Kowalski et al. 2020a).

So far, research on Samothraki covers issues of waste management, land use patters, sustainable small ruminant farming, sustainable tourism, health care, local diets, subsistence, expansion of infrastructure, re-greening of land cover, forest regeneration and aquatic ecology[3]. It is employed through a great methodological variety characterized by a vivid knowledge dissemination and deliberation between 'insiders' and 'outsiders', such as focus groups, summer schools including international students as well a locals, and participatory fieldwork with stakeholders (Petridis and Fischer-Kowalski 2016).

The Hellenic Center of Marine Research (HCMR) is conducting studies on water quality, water budget and water use on the island (Skoulikidis et al. 2020) since several years. The research agenda initially focused on ecological assessment of the freshwater quality (Skoulikidis et al. 2014; Eidinger et al. 2016). In 2013, the SNO was initiated as a collaboration between the Hellenic Centre of Marine Research (HCMR) and Samothraki Municipality, connecting ongoing research within various frame-

[3]See sustainable-samothraki.net

works (eg. Long Term Socio-Ecological Research (LTER), MAB, Natura200, various national and European monitoring programmes) with participatory and transdisciplinary approaches on the island. Through this diverse collaboration of research, further characteristics of Samothraki's hydrological network were studied intensively, including water availability, variability and water balance integrating need, actual demand and availability (Pollakowski et al. 2019; Fischer-Kowalski et al. 2020b; Schoder et al. 2016). A recent research interest regards the source of Samothraki's vast freshwater resources. It is assumed that a part of the island's water budget stems from condensation of cloud formations accumulating at the peak of the island, a natural process which could be at risk through the planned installation of a 36 turbines wind park on the island (Skoulikidis 2018).

Studies on the characteristics of the freshwater resource system have been of immense importance for outlining and understanding basic biophysical flows of the water metabolism on the island, as described in detail in 4.1.2. In order to understand possible trajectories and transition pathways, "one needs to account for biophysical flows, but also understand the social structures that support these flows" (Petridis et al. 2017). In this context, Petridis and Fischer-Kowalski 2016 pose the following questions relevant for social-ecological research on Samothraki:

> What is the role of shared beliefs and collaboration? How is collaboration established, and what causes it to disintegrate? How does a functioning division of labor come into being, and how can it be governed? What role does a feeling of shared identity and 'specialness' play within the island population? In this context, the findings of Ostrom are highly relevant. What appear to be key conditions for the sustainability and resilience of island communities? What, on the other hand, triggers collapse? What are the implications for the future of Samothraki? ibid.

Skoulikidis and colleagues, experienced in Integrated Water Resources Management (IWRM), have given valuable recommendations regarding water management in a recent publication Skoulikidis et al. 2019. However, the socio-economic and societal interactions underlying water management have received little attention so far. In juncture with the questions formulated at the onset of transformative sustainability research on Samothraki, understanding these components of the water supply SES form the point of departure for the following thesis.

2.2. Social-Ecological Systems

Societal and natural systems have long been conceptualised as separate and at times opposing entities in Western thought. Enlightenment theories further dichotomized this relationship, setting the foundation for the distinction of 'natural' and 'social' disciplines in Western scholarship (Berkes et al.

2003). Likewise, attempts to (re-)integrate natural and societal aspects into models of larger systems can be traced back to 19th century discussions on the interconnections of society and resource systems , by theorists such as Marx, Malthus, Spencer, and Kropotkin (Berkes et al. 2003), (Pulver et al. 2018; Barry 2007). According to Colding and Barthel 2019, the first explicit definition of a social-ecological system was made by the Russian microbiologist B.L. Cherkassii in 1989 (ibid.), became known as a concept of public health and psychology studies, and only entered into environmental sustainability science in the 1990s (Stojanovic et al. 2016). Whereas Singh et al. 2013 trace the concept of *socio-ecological systems* back to 1984 in the field of LTER, where it is used consistently until now ibid. It becomes evident, that the term, similar to *sustainability*, cannot live up to the diversity of the field, and while semantic as well as theoretical differences exist, in many cases both terms are simply used interchangeably "because of the lack of a formal, contrasting definition in common practice"Stojanovic et al. 2016 [4]. However, various predecessors of social-ecological models in use today developed in the context of intensifying discussions on the drastic dimension and complexity of industrial societies' impact on ecosystems [5], the growing popularity of a systems approaches and the rise of environmentalist discourses since the 1970s, resulting in a rich proliferation of frameworks in the past two decades (Pulver et al. 2018; Binder et al. 2013). Next to the socio-metabolic model (see 2.1.3.1), those include, amongst others, human ecosystem framework, resilience, integrated assessment of ecosystem services, vulnerability framework, coupled human-natural systems, and social-ecological systems framework (Pulver et al. 2018)

The baseline of SES approaches is that social and ecological systems are interconnected in complex ways, co-evolving interdependently in a whole, dynamic social-ecological system (Berkes 2017; Leach et al. 2018). In contrast to the triple bottom line approach, in most SES models the economy is treated as a subsystem of the social realm instead of as a system meaningful on its own: "A social-ecological systems perspective on sustainability would suggest an even more integrated and dynamic vision of these three dimensions, moving towards the notion of society (*including the economy*) and ecosystems as inseparable and co-evolving" (Leach et al. 2018, emphasis by author)

Following the notion of a *dynamic system* sustainable over time rather than one desirable final *state*, a SES perspective acknowledges variability as inherent to sustainability, turning the question to the range of variability which a system can deal with (ibid.). This moves the focus of guided action away from "interventions which aim to decrease variance in order to achieve system stability and predictability" (ibid.) and instead towards outlining the "multiple social, ecological and social-ecological thresholds beyond which the system would risk undesirable and often irreversible changes" (ibid.), or socio-ecological tipping points (Fischer-Kowalski et al. 2020a).

[4] In this work, I mostly use the term *social-ecological*, which is more closely associated with the journal *Ecology & Society*(Stojanovic et al. 2016), a relevant resource for the development of the concepts I draw from. *Socio-ecological* is used only in reference to SEC-specific models and research.

[5] eg. following publications such as Rachel Carson's *Silent Spring* in 1962

The notion of a SES as a dynamic system resonates with the conception of Complex Adaptive System (CAS). *Complex* denotes the high number of variables and interconnections a system constitutes of - it can be thought of as building complex, consisting of numerous elements and serving a multitude of purposes. *Adaptive* indicates a systems ability to learn, be it from experience or evolutionary processes (Levin et al. 2013). In contrast to simple systems, complex adaptive systems cannot be described through one single perspective or understood through one mode of analysis (Berkes 2017). Building complex interconnections, CAS create something 'greater than the sum of its parts', functional through "self-organization, connectivity, path-dependence, and emergent properties" (ibid.). Thus, CAS are characterizes by "scale effects, nonlinearities and tipping points, inherent uncertainty or unpredictability" (ibid.), as the case with global climate. Questions surrounding the functioning of such systems must take these characteristics into consideration.

Scale refers to spatial, temporal and jurisdictional scales, and level to a point within a particular scale. Governance issues connected to SESs, for example, usually encompass various jurisdictional scales and include a range of institutions on each, resulting in a multi-level, multi-scalar system "linking decision-makers horizontally and vertically"(ibid.). *Self-organization* implies that "some form of overall order arises from local interactions between parts of an initially disordered system" (ibid.), whereas *path-dependency* of systems describes their development, learning and adaptation drawing on or being the outcome of previous experiences. This applies to conscious changes as well as to evolutionary pathways. Future states build on current steps of development, which build on past steps, and the system cannot be reversed nor freed from its path-dependency. As depicted in figure 2.1b, different pathways may lead to sustainability. SES are *nested* in that they intertwine within each other. Subsystem incorporates various smaller systems, which in turn are interlinked across scales and levels. Various watersheds for example might be dependent on the same climatic regime but feed different estuaries, while water resource management along the estuaries might be nested within severl layers of governance - local, regional, national, international (Ostrom 1990; Berkes 2017).

2.2.1. The Social-Ecological Systems Framework

As mentioned earlier, various models and frameworks were developed with SES literature an applied research. The SESF originates from E. Ostrom's quest to understand under which circumstances communities would create collective institutions of sustainable commons governance. In a deductive research process, Ostrom and colleagues investigated a wide range of case studies, identifying social as well as ecological variables found to be relevant for the crafting or emergence of such institutions2.3.1). The resulting set of variables was further extended, revised and rearranged with respect to different focal points (eg. power relationships), resource systems (eg. urban development policy) or research questions (eg. policy analysis,) and incorporated it various frameworks (McGinnis and Ostrom 2014; Whaley 2018; Partelow 2018).

I draw on one of the revised Social-Ecological Systems Framework developed by McGinnis and Ostrom 2014 and visualized in figure 2.3. It strongly builds on Ostrom's Institutional Analysis and Development Framework (IAD) framework (see figure 2.6), maintaining the 'Action Situation'-centred structure, but aims at a more comprehensive understanding of social-ecological variables influencing the Action Situation SESs (ibid.). While the IAD focusses more on the procedure of institutions building, the SESF accounts for the complex embeddedness of that procedure in social and ecological subsystems with different spacial and temporal scales. On first sight, the SESF thus might seem descriptive and static, lacking in dynamic process. The creators, however, followed a "long tradition of using state variables and dynamic processes to represent how a complex system changes over time" (ibid.) The variables grouped around the Action Situation thus should be interpreted as "state variables in place at a given point in time" (ibid.)

The variables are clustered sets of terms and concepts which, similar to a sorting rack, guide the researcher in searching for an allocating the respective variables of the SES under study. The original framework contains an extensive number of variables, 53 in total, which have been collected and revisited through applied research of commons governance. The intention hereby is to give a researcher operationalizing the SESF an overview of all the variables which so far have been found relevant across cases, so that the researcher can chose those most relevant for their case (McGinnis and Ostrom 2014; Mar Delgado-Serrano and Ramos 2015). Leslie et al. 2015, for example, identified 13 variables linked to the likelihood of the emergence sustainable governance institutions in small-scale fisheries. Descriptive studies on the other hand may use all variables indiscriminately. While this is acceptable for purely descriptive purposes, "such use of the SESF raises questions because explanation requires the selection of variables appropriate for that purpose" (Thiel et al. 2015). The framework, if used diagnostically, must be tailored accordingly.

The framework therefore is flexible to, if not dependent on, situated adaptation, enabling the researcher to use existing variables or develop new ones along the way (McGinnis and Ostrom 2014). Proceeding from broad to specific, the SESF has been compared to the diagnostic process which medical workers apply when testing all known indicators for symptoms in order to reach to a diagnosis (ibid.). As such, it serves as a useful tool in identifying and systematizing relevant variables and their interconnections of the water supply system on Samothraki.

Although the SESF was developed out of a particular school of thought, the framework is constructed in a way to be universally applicable to SESs. Using a "metatheoretical language" (ibid.), it provides the basic tools for a descriptive and diagnostic study of SESs worldwide (ibid.). Therefore it does provide causal links or explanatory statements by itself, but provides the tools and perspective needed by any theory to understand the "basic working parts and critical relationships among the elements that are essential to consider when studying SESs" (ibid.). It is the theoretical approach chosen by the researcher which enables conclusions, causal explanations and predictions to be drawn. This allows the SESF also to be applied using different theories and comparing their outcomes.

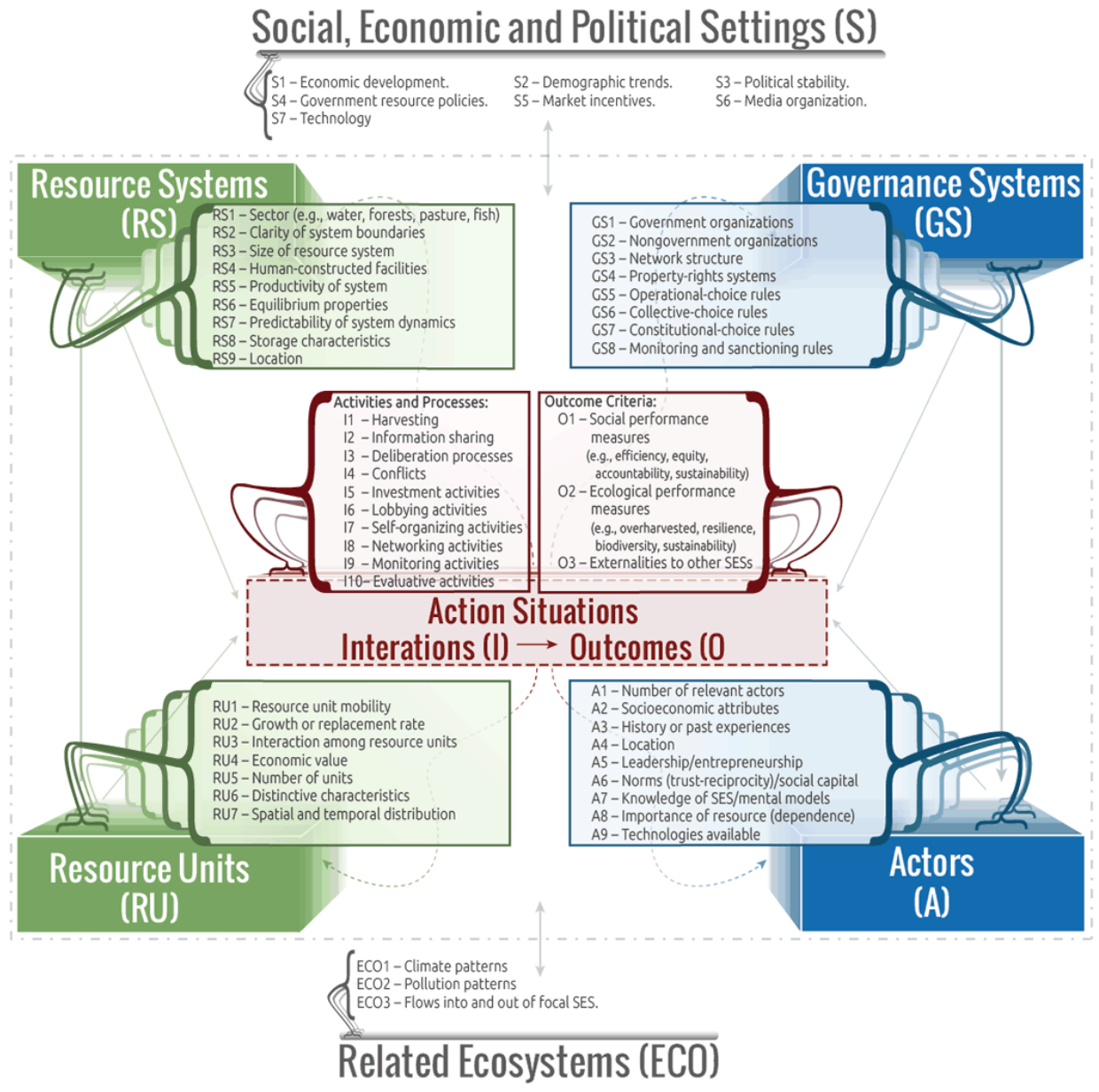


Figure 2.3. SESF Model as described by McGinnis and Ostrom 2014, adapted by Water Diplomacy. https://blog.waterdiplomacy.org, accessed 13.12.2020

As visible in figure 2.3, the SESF consists of four main tiers, Resource Units (RU)s, Resource System (RS)s, Actors (A), and Governance System (GS), which are embedded in the larger S as well as ECO. At the core of the framework are the AS. Action situations are determined by the relationships and influence the other variable shave on them. Social and ecological variables as well as their interconnections set the 'action arena', within which, through iterative decision making, lies the potential of crafting institutions: "Action Situations are where all the action takes place as inputs are transformed by the actions of multiple actors into outcomes" (McGinnis and Ostrom 2014). As the outputs feed back into the social and ecological systems supporting/effected by the action situation, one circle of decision making closes and changed social-ecological settings inform the next decision making circle. Conceptually based on those ongoing circles, the AS at the core of the SESF is its main analytical tool as also its most characteristic remnants of the game-theoretical foundations of Ostrom's IAD. Throughout a SESF analysis, researchers must "[identify] a set of focal action situations, [learn] how the relevant collective and constitutional choice arenas shaped their structures, and then [think] deeply about the processes through which those conditions have been (or might be) changed" (Cole et al. 2019).

2.3. Environmental Governance

The concept of governance is complex in itself. In encapsulates the system of how a society or a social body organizes itself - decision-making and deliberation processes, institutions, formal and informal rules, as well as the (re-)production thereof through rule-making processes, the crafting of institutions and the reinforcement of societal and power relations. For example, a water governance system " is the interconnected ensemble of political, social, economic and administrative elements that performs the function of water governance. These elements embrace institutions as well as actors and their interactions" (Pahl-Wostl 2019). Governance can describe how societies organize themselves or are organized. In any case, it is *social*, ie. bound to the relationships within a society/social body, its key assumptions or beliefs, and power. Understanding the key assumptions and power manifest in social relationships is not always evident, neither as the subject of those relationships nor as the observer. Michel Foucault for example famously drew attention to strategies of governance, which, "through the employment of power, knowledge, and discourse", create a situation in which "the subjects themselves are indeed willing to be governed" (Partelow et al. 2020). Awareness for less obvious exertion of power is key to a differentiated perspective on governance, acknowledging the various and at times ambiguous forms it can take.

In reference to SES research I will use *governance* in the notion of "a social function centred on steering human groups toward desired outcomes and away from undesirable outcomes" (Pahl-Wostl 2019 drawing on Young, 2013), thus adapting a normative as well as social definition of governance. *Environmental governance* is governance situated at the interaction of social and ecological systems,

forming an integral part of the SES (Berkes 2017). It is concerned with the development and management of ecological resources and services, "guiding the resource towards a desirable state and away from an undesirable state" (Pahl-Wostl 2019). Claudia Pahl-Wostl's definition strikes as very similar to Melissa Leach's definition of sustainability, see section 2.1. The 'environmental' in environmental governance is not to be understood as governance of the environment but as governance of/for sustainability. ibid. also stresses the participatory aspect of a normative sustainability approach in governance: "also highlights the normative character of governance as a societal function with a certain purpose. This purpose needs or should be negotiated among the various stakeholder groups involved."

Taking into account above definitions, the terms 'environmental governance' and 'sustainable governance' can be used interchangeably. I use 'environmental governance' throughout my thesis, again, adopting the term which most academic literature and journals informing my work use [6].

Which implications arise from the conceptualisation of SESs as complex, adaptive systems for environmental governance? How does environmental governance relate to the procedural conceptualisation of sustainability and the transformative, emancipatory claims outlined in section 2.1? The following paragraphs investigate the characteristics of such governance and presents two schemes developed through SES theory and applied research, namely adaptive co-management (2.3.2) and polycentric governance (2.3.3). Point of departure is Elinor Ostrom's work on collective governance of CPRs.

2.3.1. Foundations: Ostrom's Theory of Collective Action

Theories on the governance of SES trying to "understand how different governance processes or policies influence desired outcomes" (Partelow et al. 2020) co-evolved with discussions on sustainable resource use as early as in the 1950s (ibid.). Faced with the depletion of resource systems such as fish stocks or forests, and decreasing ecological performance of conservation efforts, questions on how to analyse, predict, and ensure the successful management of SES gained popularity in the 1970s (ibid.). In this context, commons - resource systems which are neither regulated through private ownership, nor through a powerful institution, but governed collectively or open public use - moved into the centre of attention. Redefined in an economic classification of goods and services as CPRs (see figure 2.4), commons are characterized by their high subtractability and low excludability, meaning that the extraction of one unit of resource critically reduces the amount of units available for future extraction or for extraction by others (h̄igh subtractablity). At the same time, individual resource users cannot easily be excluded from the resource system (l̄ow excludability).

[6] 'environmental governance' is used more commonly than 'sustainable governance' in *Ecology & Society* and *Sustainability*, as well as in academic literature in general.

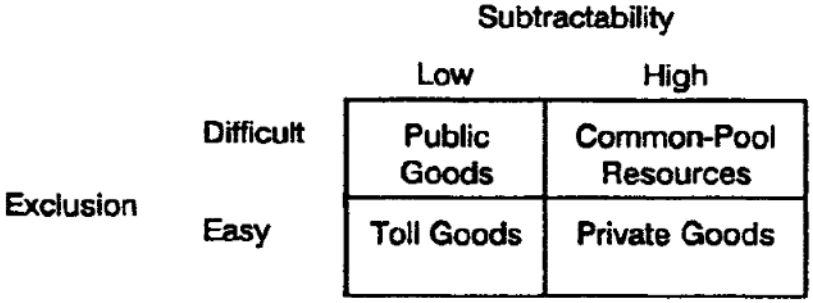


Fig. 1.1. A general classification of goods

Figure 2.4. Classification of goods according to E. Ostrom. Source: Ostrom et al. 1994

With CPR struggling to fit any of the then dominant modes of (environmental) governance, ie. governance through market mechanisms, powerful regulatory bodies or private property regimes (see section 2.1), the seeming lack of governance was widely agreed to determine the CPR's trajectory of environmental destruction. Elinor Ostrom, a trained neoclassical economist trying to "transcend the basic dichotomy of modern political economy"(Aligica and Boettke 2011), who was investigating the performance of multi-level public services and various CPR settings, intervened in this discussion increasingly influenced by the notion of the *Tragedy of the Commons*. The term was coined by ecologist Garrett Hardin, who argued that commons, if not effectively managed by the state or through private property, inevitably would face over-exploitation. The argument draws on a model of human agency as driven by short-sighted, profit-oriented and individualist goals, thus creating a contradiction between individual short-term benefits from and collective long-term maintenance of the resource at hand (Shiva 1987). Although Hardin's assumptions might rely on a under-complex model of human cooperation, his theory resonated well in the neo-liberal logic of that time (Shiva 1987; Dietz 2003). Confronted with various CPR systems and a variety of management settings throughout her work, many of which were successful, Ostrom pointed out that the *Tragedy of the Commons* was but *one* possible outcome of a Collective Action Problem (CAP).

In their most basic definition, "collective-action problems occur when individuals choose actions [...] in an interdependent situation" (Ostrom 2010). A situation is interdependent, when the outcomes of an individual's action, consequently also the choices an individual takes according to expected outcomes, are depend to a large degree on the choices and other individuals made. Such situations occur for example when the outcome of an individual action differs in relation to the number of individuals engaging in the same action, as demonstrated by Oliver et al. 1985 in respect to critical mass. In the context of CPRM, the problem of collective action is more often framed as a dilemma located in the very nature of cooperation. Cooperation arises when individuals consciously align or combine their actions according to a common goal, which *can only be realized through* the coordinated or combined individual actions. This leads to a situation, in which an individual's choice does not translate linearly into a specific result, but the result depends on the *accumulation* of individual choices made all the same. The degree of complexity inherent to such situations brings to mind the notion of *complex systems* in chapter 2.2. As in CAS, in CAP, too, multiple scales, feed-backs, and increase of relevant

variables add to the degree of complexity. While the prisoners' dilemma [7] arguable offers one of the most dramatic depictions of a CAP, an appropriate global reaction to climate change or an individual's contribution to 'flattening the curve' of a viral infection are examples of more complex CAPs. As do collectively managed resource system, in which users have to "invest time and energy to avert a tragedy of the commons" (Ostrom 2009), ie. to sustain the resource. Thus, sustainable governance is connected to the ability of resource users to engage in long-lasting collective action, that is, to craft institutions of collective governance.

Starting from this hypothesis, Ostrom set out to address the question of under which circumstances institutions of collective action emerge. Comparing numerous collectively managed irrigation systems, Ostrom came up with eight design principles of successful CPRM, see figure 2.5 (Ostrom 1990). In the following years Ostrom and colleagues, who, by now, made up a flourishing research community with a publishing journal, association and conferences dedicated to the study of the commons[8], further expanded the range of case studies investigated and further broke down the design principles into their structural, bio-physical and social components. Structural variables eg. consider whether decisions are repetitive or one-time, if participation is voluntary, the level of communication among actors and the number of actors involved; bio-physical variables include eg. the variability, predictability and productivity of the resource (system), and social parameters address norms (ie. fairness, solidarity), values, and past experiences (Ostrom 2010). Synthesizing a large number of case studies, a range of variables found to be relevant for the emergence of collective action institutions could be identified, as well as characterizes in terms of their influence on collective action, as illustrated by findings of a colleague of Ostrom's, Arun Agrawal, on the example of group size :

> Agrawal (2000), for example, posits a curvilinear relationship between size of group and collective action in light of his study of community forest regimes in India. If the group is very large, transaction costs and conflict may arise. If the group is too small, it is hard to generate the resources needed to engage effectively in collective action related to a forest. Thus, moderately sized groups are more able to solve these problems when related to the governance and management of many natural resources. ibid.

While adopting an inductive research design, Ostrom's fundamental approach towards collective action originated from the rational-choice theory inherent to neoclassical economics and game theory, whereby rational individuals consciously chose trade-offs between costs and benefits to meet their desired needs. Throughout her years of work, Ostrom revised this perception of drivers of individual choice, acknowledging the role of community values such as trust, reciprocity and reputation,

[7] A game-theoretical model in which two prisoners who cannot communicate with each other both are given the option to either testify and admit the crime they are accused of or to deny any statement. If both prisoners deny, they will serve a short time in prison before being set free. If both pledge guilty, they will both receive long sentences. If one, however, testifies and the other does not, the former will be set free immediately while the other will serve lifetime imprisonment.

[8] See https://www.thecommonsjournal.org/about/ accessed 21.12.2020

among other moral values (Ostrom 2003). From this she developed the concept of bounded rationality, according to which individual choices are basically rational(cost-benefit), but guided by moral values, learned norms and custom. Additionally, benefits are attributed to certain outcomes according to emotional states, which are subject the individuals perception. As Lara 2015 explains, Ostrom understands "individuals [as] bearers of extrinsic and intrinsic values, and of interests, but also of moral commitments that bind them to others". "The agent described by Ostrom is a subject with the autonomy to have ideas about the world, represent it, and be guided by these values. And since the subject has an internal world with complex ethical norms, he can use contingent strategies" (ibid.). Ostrom calls this extended behavioural approach towards rational choice *bounded rationality*. Under the assumption of *bounded rationality*, any theory trying to understand under which conditions certain choices are made, "must incorporate: '1. the way that participants acquire, process, represent, retain, and use information; 2. the valuation that participants assign to actions and outcomes; and 3. the processes (maximizing, satisficing, or using diverse heuristics) that participants use for selecting particular actions or strategic chains of actions in light of their resources'" (Ostrom 2005 in ibid.).

The bounded rational individual is sensitive to context. According to Ostrom, other than intrinsic values, norms, emotional states etc., it is the institutional arrangement which greatly influences individuals' choices. She argues that decision-making in market logic settings, eg., is highly predictive only due to the straightforward settings of market-based institutional arrangements (ibid.). This other major foundation of Ostrom's approach in based on institutionalism, a theory arguing that the structural conditions constituting the arenas of decision-making crucially influence the character and possible outcomes of an individual decision, as well as the emergence of specific institutions. Holding on to (bounded) rational choice theory, Ostrom thus smoothly synthesizes individual agency, ie. an actors potential to consciously and willingly take action with the goal of influencing his or her surroundings, with institutionalism, ie. awareness for structural variables shaping individual decisions.

Institutions, Ostrom explains,

> refer to the rules that humans use when interacting within a wide variety of repetitive and structured situations at multiple levels of analysis. Individuals who regularly interact use *rules* (or the absence of rules) designated by government authorities as relevant for situations of a particular type. They may also develop and enforce their *own rules*. Individuals interacting within a particular rule-structured situation linked to a specific environment may also adopt *norms* regarding their behaviour given the others who are involved and their actions over time. In light of the rules, and shared norms when relevant, individuals adopt *strategies* leading to consequences for themselves and for others. As individuals learn more about the outcome of their own and others' actions within a particular situation, they may change norms and strategies leading to better or worse outcomes for themselves and the relevant environment. Ostrom 2008a

CPR institutions

1. Clearly defined boundaries
   Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself.
2. Congruence between appropriation and provision rules and local conditions
   Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material, and/or money.
3. Collective-choice arrangements
   Most individuals affected by the operational rules can participate in modifying the operational rules.
4. Monitoring
   Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators or are the appropriators.
5. Graduated sanctions
   Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to these appropriators, or by both.
6. Conflict-resolution mechanisms
   Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.
7. Minimal recognition of rights to organize
   The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

For CPRs that are parts of larger systems:

8. Nested enterprises
   Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Figure 2.5. Design principles of sustainable common-pool resource management. source: Ostrom 1990

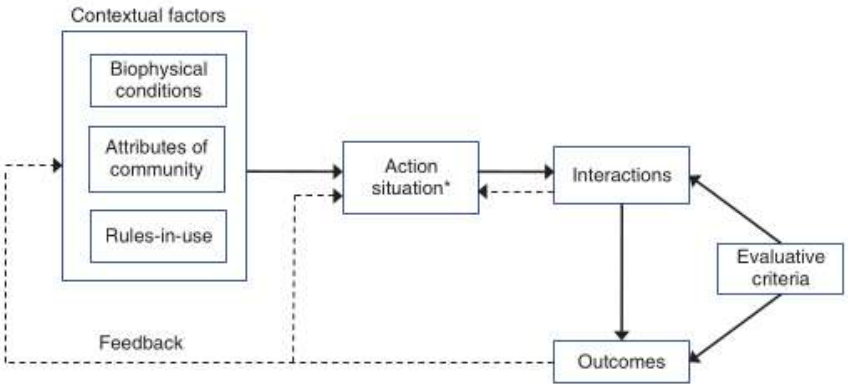


Figure 2.6. IAD Framework. Source: McGinnis and Ostrom 2014

This theoretical fundament together with the induced design principles constitute the core of Ostrom's *theory of collective action*. To test and to deepen the theory, Ostrom proposed a framework applicable in commons research, the IAD. The IAD locates the focal point of analysis within an'action situation' - the conceptual arena in which individuals, based on their processing of information, take decisions and produce outcomes (see figure 2.6). This allows researchers to analyse institutional settings in regard to their ability of supporting, facilitating or hindering sustainable resource governance in CPR situations, countering the notion of CAPs as inevitable catalysts of ecological devastation. The theory as well as the framework have received numerous revisions, regarding the assumed relationships between variables, the number of variables to be considered, as well as the application or operationalisation of the framework. One of the most notable changes since the original formulation of the design principles might be the recognition of mutual trust, reciprocity and reputation as important drivers of collective action (Ostrom 2010). The IAD, has since widely been used to analyse and to facilitate the crafting of sustainable governance institutions (Prateek and Carr Kelman 2016), was politicized, criticised (Whaley 2018), and served as blueprint for the SESF used in this work.

2.3.2. Adaptive Governance for Complex System

Ostrom's theory of collective action and the respective frameworks are very well designed to assess, identify and analyse institutional settings, explaining why self-organized CPRM works in some settings and in others does not (Partelow et al. 2020).

Directing attention to those variables which have the potential of promoting or hindering collective, sustainable resource governance, the approach offers guidance as to where to locate potential points of leverage. It does not, however, provide a coherent tool for the development of situated governance strategies (Prateek and Carr Kelman 2016; Partelow et al. 2020).

Furthermore, the point of departure of collective action theory were and are relatively homogeneous, small-to-medium sized communities which govern resources in relatively well defined SESs (Berkes 2017; Partelow et al. 2020). In contrast, most of today's sustainability governance has to ad-

dress multiple stakeholders, might span various governance regimes (property-right, state-regulared, community-based) and respective institutional levels, and account for more complex feedbacks, taking collective action theory to its limits (Berkes 2009; Ostrom and Cox 2010). I therefore draw on the "toolbox"(Partelow et al. 2020) of governance theories developed in vicinity to commons scholarship in order to reach actionable conclusions regarding sustainable water governance on Samothraki.

Since the emerge of social-ecological research, scholars argue that modes of SES governance which wants to account for the non-linearity, uncertainty, and diversity encountered in CASs have to adopt complex, adaptive systems thinking (Schoon and Cox 2018; Berkes 2017; Dietz 2003; Marshall 2015). Adaptive governance does so by drawing on "governance across levels, adaptive approaches that incorporate learning, and collaborative approaches to assist with learning in a world characterized by accelerated environmental change" (Berkes 2017).

At its core, adaptive governance is about the ability of governance systems to learn and adapt to changes. As such, adaptive approaches been applied where ever institutions of governance survived changing environments. As Berkes et al. 2000 argues, "traditional knowledge may be holistic in outlook and adaptive by nature, gathered over generations by observers whose lives depended on this information and its use. It often accumulates incrementally, tested by trial-and-error and transmitted to future generations orally or by shared practical experiences" . The evolutionary character of adaptive approaches connects to Ostrom's research focus on long-lasting CPRM regimes: "Essentially, Ostrom's analysis presumed that long-lasting communities had gone through a selective process as a basis for inferring that the resultant institutional traits have important adaptive qualities" (Schoon and Cox 2018). Assuming that "we are now living in a no-analogue world" (Steffen et al. 2015 in Marshall 2015), increasingly moving beyond the 'Holocene frame of reference' in which social-ecological institutions emerged, adaptivity becomes even more crucial for future environmental governance (ibid.).

The foundations adaptive governance draws on were developed in natural resources management, conservation ecology, resilience thinking and the institutional analysis and governance of commons scholarship discussed above (Hasselman 2017; Chaffin et al. 2014). In the 1970s, adaptive management strategies developed at the intersection of natural resources management and resilience scholarship, both as a solution for dealing with increasing uncertainty in natural resources management and as an attempt of putting resilience thinking into practice (Hasselman 2017; Chaffin et al. 2014) Adaptive management is based on learning through iterative testing or modelling of different conservation strategies, involving a participatory planning process to develop joint definitions of success and failure, and ongoing monitoring of the system in order to gain information to feedback into adapted decision-making. Through ongoing information feed-back it builds a robust, circular management process capable of navigating through the unpredictability inherent in the variability and constant co-evolution of complex SESs (Hasselman 2017). This approach proved successful in domains thus far governed by prescriptive 'command-and-control' practices, eg. fisheries, logging, or national park conservation.

The concept of ecological resilience emerged in the context of studies on ecological population dynamics in the 1960s and early 1970s (Bousquet et al. 2015). It was introduced to the larger SES research community by C.S. Holling in 1973 as the capacity of a system to maintain its fundamental structures when faced with disturbances: "resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling 1973 in Chaffin et al. 2014. Resilience research aims at understanding strategies which allow systems to deal with change while maintaining their 'system identity', ie. its fundamental structure/relationships and crucial functions (Berkes 2017). It investigates those characteristics of systems, which enhance its capability to absorb or buffer shocks, disturbance, and stress on the one hand, as well as a system's capacity to transform and adapt towards a new 'domain of stability' (Chaffin et al. 2014). From its outset in ecology, resilience thinking has gained popularity in social-ecological science as a tool in conceptualising dynamic stability, adaption and transformation (Berkes 2017). Resilience has by now become a core concept of analysis of SES, resulting in a diverse body of theoretical and applied research (Chaffin et al. 2014). Major aspects constituting a resilient SES have been found to be diversity, redundancy, connectivity, learning, adaptivity, self-organization, complex thinking, participative and polycentric governance[9]. (Bio)diversity serves as a good example of a SES characteristic enhancing resilience: High biodiversity of species offers ecosystems a greater buffer to react to rapid changes, with a greater variety of existing organisms and subsystems out of which new, adapted forms of life and interaction can grow without disrupting crucial ecosystem functions. As Berkes 2017 points out, same applies to institutional crafting, a perspective gained through Ostrom's work: "new institutions come about more readily if there is a diversity of existing institutions. Such diversity and abundance of options provide a built-in ability to buffer change or to adapt to change. Nevertheless, until change actually occurs, there is no easy way to determine beforehand if the system can cope with that change or adapt" (ibid.). Pilgrim et al. 2009 goes a step further in advancing the understanding of societal and ecological diversity as intrinsically interlinked. emphAdaptive capacity is another concept closely related to resilience. Perturbations in SESs trigger coping responses in as far as the respective organism, ecosystem or community is capable of absorbing or coping with the change. Once this capacity is exceeded, adaptive capacity - "the ability of the social-ecological system to learn and to adjust its responses to the impacts of external drivers and internal change" (Berkes 2017) determines the systems success in responding to the perturbation without losing its 'system identity and main functions'.

While resilience thinking supported the development of adaptive approaches in form of experimental management strategies, the thus also triggered research questions regarding societal and organisational requirements of resilient SESs. These are largely answered through the work on *adaptive governance*. In contrast to the narrow focus on outcomes (eg. ecosystem services, resource provision) in adaptive management, adaptive governance widens the perspective to "the social contexts that enable adaptive management [which] help to identify and avoid barriers to governance transformations at a scale larger than the management of specific resources" (Chaffin et al. 2014)

[9]Source: https://applyingresilience.org/en/the-7-principles/, accessed 21.12.2020

In SES research, the term was coined through a publication of Dietz 2003 co-authored by Elinor Ostrom, in which the authors made a case for the integration of uncertainty and an anticipation of change, especially if it seems unlikely to occur, into the institutional design of governance:

> Institutions must be designed to allow for adaptation because some current understanding is likely to be wrong, the required scale of organization can shift, and biophysical and social systems change. Fixed rules are likely to fail because they place too much confidence in the current state of knowledge, whereas systems that guard against the low probability, high consequence possibilities and allow for change may be suboptimal in the short run but prove wiser in the long run. ibid.

The same authors provide a range of examples of success and failured of 'robust' governance and subsume them to deduce five requirements of adaptive governance in complex systems:

(1) *Information* about social-ecological system variables, their relevance and interactions, scaled appropriately according to the problem or decision at hand and available in a way which is accessible to the respective target group or stakeholder. (2) *Dealing with conflict*: acknowledging conflicting interests and underlying asymmetries of power, different perspectives and world-views, as well as the constructive potential of antagonism, while promoting participatory conflict resolution. (3) *Rule compliance*: in order to work with rules, a reasonable degree of compliance must be in place. Compliance is brought about through sanctions, be they subtly sewn into social relations or formally enforced mechanisms, "those who impose them must be seen as effective and legitimate". Sanctions must be feasible and effective in terms of effort spend on implementation. Incentives for compliance in combination with sanctions are crucial for their success, but are not considered sufficient on their own. (4) *Provision of infrastructure*: Seemingly obvious but often overlooked according to the authors, the infrastructure available determines to a great part the available choices. This applies to technological, physical, as well as institutional infrastructure. (5) *preparedness for change*, as outlined in above quote.

The authors also identified principles which facilitate these requirement being met, thereby breaking down general concepts into smaller, more actionable guidelines of adaptive governance. The principles are depicted in figure 2.7 with the arrows indicating to which of the five requirements they contribute.

Proceeding from this first outline, SES scholarship has investigated and applied basic principles in adaptive governance, deepening some aspects and adding others (see Chaffin et al. 2014 for an extensive overview of developments in Adaptive Governance (AG) scholarship), the following of which I want to touch on shortly:

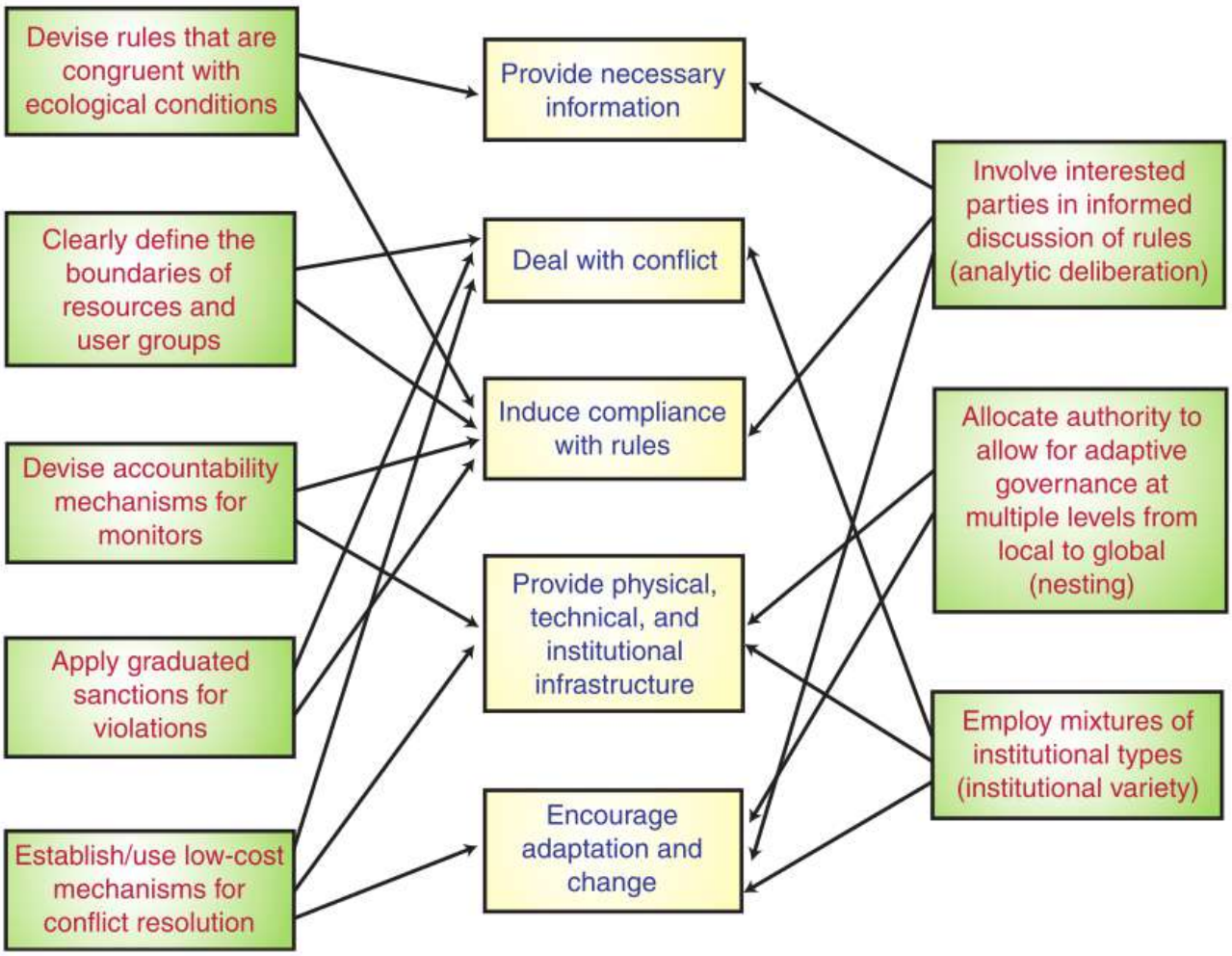


Figure 2.7. Requirements of Adaptive Governance in Complex Systems. Source: Dietz 2003

Learning: Although playing a prominent role in the conceptualisation of AG, Berkes 2017 emphasizes the need of AG approaches to work out and foster mechanisms of learning, suggesting a practice similar to the circles of experimental learning developed in adaptive management. Furthermore, learning needs to be collaborative in nature in order to fulfil its adaptive potential. Thus, ibid. promotes a high degree of participation and the development of 'problem-solving collaborative networks'. According to Folke et al. 2005, each activity in AG must be seen as a chance to learn and adapt. This requires a collective understanding of policies as ongoing learning experiments that need to be monitored, evaluated, and adapted. Adaptive governance therefore also requires formats of learning which encourage stakeholders to understand new policies or management strategies as opportunity to improve. Hypotheses, implementation and results have to be well-defined and closely connected so that they are accessible for deliberation and evaluation (ibid.). Huitema et al. 2009 point out to the need to anchor learning in the broader social context addressed by AG, in contrast to the "technocratic variant" of learning in adaptive management relying exclusively on experimentation and adaption. This happens through community capacity building, increasing communication, collaboration and trust (ibid.), but also through the development of "personal traits" (Folke et al. 2005) which encourage learning. Individual, social, institutional and organizational learning are important mechanisms of building knowledge and skills on a societal level. Different forms of learning can be enhanced through explicitly design tools, eg. addressing mental models on an individual and integrating analytic deliberation on collective levels. A variety in formats of knowledge dissemination supports such learning processes in matching the needs of the actors involved (Berkes 2010; Partelow et al. 2019).

Participation and Redistribution of Power: As learning processes have to be participatory, so do all other processes of decision-making and governance. Apart from participation and equal access to power forming desirable 'social outcomes' (see 2.2.1) in themselves, enabling societies to implement equality and self-determination, it is the combination of various actors and perspectives which is crucial for the governance of any system to master complex settings and changing conditions, as "knowledge for dealing with social-ecological system dynamics, resource abundance at various scales, trends and uncertainties, is dispersed among local, regional, national and international agencies and groups" (Berkes 2010). As Folke et al. 2005 points out, it is the diversity of personal traits and backgrounds which, when interacting, create "rapid and large change". Broad participation furthermore builds up a "collective memory of experiences with resource and ecosystem management [which] provides context for social responses and helps the social-ecological system prepare for change" (ibid.). Revisiting the notion of transformative power in section 2.1.2, participation and devolution or rather redistribution of power become a relevant requirement for radical change to even be possible, as historically powerful actors are likely to use their position to reinforce structures supporting their interests (Cleaver and Whaley 2018). Devolution of power is a frequently recited claim within AG literature, which calls for decentralization of competence and supporting local and regional actors in building sufficient capacity to solve problems at a level according to its scale - similar to the subsidiary principle. In the implementation, however, devolution of power is prone to reinforc-

ing power structures which render the approach of adaptive governance dysfunctional (Berkes 2010). Redistribution complements the devolution of power, stressing the vital importance of empowering disadvantaged actors for adaptive governance (Cleaver and Whaley 2018).

Devolution/redistribution of power and participation across scales call for modes of governance which do not centre around a single body, but integrate a variety of institutional settings and nested and connected clusters of levels of governance (Chaffin et al. 2014).

2.3.3. Co-management and Polycentric Governance

Developing out of commons research, co-management is also denoted as the 'fourth ideal' of governance regimes, next to government-, market- and community-based approaches (Whaley and Weatherhead 2014). It initially described the sharing of governing power between a community of natural resource users and a central government, or their respective local institutional arrangements (Berkes 2009; Ostrom and Cox 2010). Early analyses of co-management emphasized "the development of adequate levels of trust between participants and institution building both at the local level and between levels of organization" (Whaley 2018). Over time the understanding of co-management advanced to include more complex arrangement between multiple sources of governance, merging with discussions on polycentric governance (Ostrom and Cox 2010). Work on co-management however continued to develop, drawing attention to "how different management tasks are organized and distributed, concentrating on the function, rather than the structure, of the system" (Carlsson and Berkes 2005). Matured in its understanding of the institutional arrangements, system linkages and dynamics of shared power of governance between self-organized, informal and more powerful, central structures , the approach contributes significantly to the effectiveness of adaptive co-management, complementing the latter's experimental learning and problem solving capacity (Whaley and Weatherhead 2014)

Polycentricity was developed parallel, beginning with Vincent Ostrom's observation of the comparatively higher performance of semi-autonomous units in political and administrative metropolitan area-governance. Multiple over-lapping, seemingly redundant centres of decision-making generated better managerial outputs than centrally governed units (Partelow et al. 2020). The units all shared some degree of autonomy and took each other into consideration "through processes of cooperation, competition, conflict, and conflict resolution that can lead to self-organizing tendencies if general rules provide appropriate incentives and constraints" (Whaley 2018). V. Ostrom characterized this system as a governance strategy and named it polycentricity. The network character intrinsic to polycentric governance is important to point out here: The existence of multiple local and semi-autonomous decision-making centres alone does not qualify a governance regime as polycentric. A certain degree of networking must be in place in order to promote interactions which constitute a polycentric governance system, such as communication, cooperation or collective conflict resolution (Carlisle and Gruby 2019).

E. Ostrom and Parks introduced polycentricity to the field of natural resource management and SES. Here, too, the theory was deduced from observation. In this case, E. Ostrom found that “robust institutions governing common-pool resources tend to be ‘organized in multiple layers of nested enterprises’(Ostrom 1990 in Partelow et al. 2020)”. Seeing that polycentric systems performed well in terms of resilience and collective action, she argued that adopting polycentric governance could offer even a solution for many CAPs, even for the the unsatisfactory international dealing of the global climate crisis (Ostrom 2008b). Relying on a multitude of units and diversity of institutional settings, polycentric governance is better able to adapt when faced with social or environmental change, provide good fit and mitigate risks of institutional failure of one unit of governance (Chaffin et al. 2014; Carlisle and Gruby 2019).

A common analysis of early scholars studying polycentricity was the unwillingness of many actors, including governance researchers, to acknowledge the contribution of decentralized networks of power which constitute the governance system. This is attributed to cultural and‘expert’ bias, due to which groups within polycentric governance “ are invisible to those who cannot imagine organization without rules and regulations issued by a central authority [...] Many scholars consider the very concept of organization to be closely tied to the presence of a central director who has designed a system to operate in a particular way” (Ostrom 1999 in Marshall 2015). In fact, the redundancy of governing units is often seen critical, posing a risk of over-fragmentation, ineffectiveness, and ambiguity regarding competences and responsibilities. However, it is exactly this abundance of decision-making centres which characterizes polycentricity. Folke et al. 2005 points out in this context, that the advantages of polycentric governance can only be harnessed if the knowledge produced through collective learning is accumulated into a ‘collective memory’: “A collective memory of experiences with resource and ecosystem management provides context for social responses and helps the social-ecological system prepare for change.” (ibid.) Polycentricity consequently matches to a high degree the requirements formulated in adaptive governance research: “Theoretically, an AG system requires a structure of nested institutions (complex, redundant, and layered) and institutional diversity (a mixture of market, state, and community organizations) at the local, regional, and state levels, connected by formal and informal social networks” (Chaffin et al. 2014)

3. METHODOLOGY

In the following, I outline how I operationalise the SESF for describing the water supply SES on Samothraki. First I reflect on the purpose of applying the framework. Then I present the tiers and variables used and their respective particularities as referred to in section 2.2.1. In section 3.2, the methods of data collection used to gain the relevant information are outlined: literature research, semi-structured interviews with selected informants, and observations in the field. Finally I touch on limitations in data collection and research design.

3.1. Operationalising the Social-Ecological-Systems Framework

As discussed in section 2.2.1, the SESF is a versatile tool used to describe, diagnose, and compare social-ecological systems. Within the scope of this thesis, my focus lies on the first of those functions. Revising the steps of transformative sustainability research discussed in section 2.1.3.1, I aim to understand the social-ecological structures that support the water supply SES, as a crucial step for future (participatory) research (Mar Delgado-Serrano and Ramos 2015).

In order to gain comprehensive understanding of the SES, I use the tiers and second level variables suggested by the revised framework (see figure 2.3) as orientation for a diagnostic process, 'checking' the suggested variables for 'symptoms', ie. for salient patterns and for their relevance to the SES outcomes (Partelow 2018). As the aim is not to contribute to theory-testing or building, but enhancing understanding of a single-case study, I do not apply coding to make the study comparable. The variables and basic structure of the SESF serve more as a guide in proceeding through a complex case study than a strict check-list.

Considering the above, I made the following adaption(s) to the framework:

- Integrating the sub-tier variables Related Ecosystems (ECO), RU and RS into one overall tier, RS. This is, because I only consider one resource, ie. water, which has very similar characteristics when considered as unit or as system. Whenever relevant, a distinction is made clear, eg. regarding recharge dynamics of different aquifers or different spatial distribution of surface and groundwater. Categorizing groundwater and surface water as different RUs of the same RS might be sensible for future studies, as both subsystems feature different dynamics and are

faced with different pressures. For this first overview however I chose to treat the water resource system as one whole. The tier ECO was integrated into RS, too, as the RS's boundary is quite well defined through the island's shore and already includes overlapping ecosystems. The only in- and outflow considered are precipitation and evapotranspiration, as well as the influx of humid air from the surrounding ocean, which, unavoidably, are covered as part of the description of the RS anyway. The same holds true for climate patters.

- Similarly, I combine the tiers Social, Economic and Political Settings (S) and GS to one nested cluster. Through the adoption of strongly decentralized policy approaches on higher levels of polity, such as the river basin-oriented water management of the EU, local and supranational policy developments intermingle. As larger scale economic and political developments overlap with various sub-variables from the GS tier, I decided to relax the division between the two tiers.

- Furthermore, I omitted or changed some variables and added others. For example, in the main tier A, I changed to suggested sub-tier variables (see figure 2.3) to variables which address more specific aspects of the society on Samothraki. A complete list of original SESF variables used in the following description and of those omitted or changed can be found in the annex 8.

3.2. Data Collection

In order to 'fill' the structure provided by the SESF with relevant content, I used three ways of data collection: (1) review of published academic as well as grey literature, including policy reports, news outlets and social media; (2) semi-structured interviews conducted on the phone or through the internet, (3) recapitulation of observations during former visits to Samothraki, especially during the Summer School in June 2019. The heavy reliance on secondary data and literature review was not intended, the initial research design foresaw engaged field research with the aim of including a much larger scope of qualitative, primary data than could be realized in the present thesis. But with three planned field research trips cancelled due to Covid-19 and another one due to lack of funding, the research was adapted accordingly. The limitations of remote research are touched upon in section 3.3.

3.2.1. Literature Review

Since more then ten years, transdisciplinary sustainability research is being undertaken on Samothraki, the transformative and participatory approach of which is outlined in section 2.1.3.1. Researchers affiliated with the SNO and HCMR have contributed greatly to the study of the water resources on Samothraki, connecting the socio-ecological research with previously conducted studies on aquatic

ecology on Samothraki and bringing the resources, skills and experience required to understand the island's complex hydrological network.

The HCMR researches could to some extend draw on hydrological studies part of a long-term research project by the Institute of Geological and Mineral Exploration (IGME), in which hydrological five drillings and 40 springs were examined hydrogeologically and some of them revisited repeatedly in the 1980s (Vergis 1984, 1986, 1993; Tsanaktzis 1990; Romaidis et al. 2008, 2010, see Skoulikidis et al. 2019) Furthermore, Romaidis (2003, 2006) and Romaidis and Favas (2010) undertook various hydrogeological studies for the municipality of Samothraki and the IGME. In 2005, Vouvalidis et al. 2005 reconstructed the creation of the hydrological network through an extensive geomorphological study (Skoulikidis et al. 2014). Ecological and social-ecological assessments were conducted by Gritzalis 2006 (biological monitoring), Vardoulakis (2011) (Environmental Impact Assessment) and Lampou 2012 (biochemical and hydromorphological assessment, benthic macro-invertebrate and ichthyofauna samplings, IMPRESS, DPSIR and SWOT analyses). The latter was first to systematically consider socio-economic parameters next to ecological ones through the Strenghts, Weaknesses, Opportunities, Threats (SWOT) and Driving forces, Pressures, States, Impacts and Response (DPSIR) methods. A lagoon system was identified and characterized by Catsadorakis and Paragamian 2007. Finally, extensive ecological assessment of four sub-basins including biological, chemical, physical and environmental parameters was conducted by Skoulikidis et al. 2013 and extended by Skoulikidis et al. 2014.

In 2013, a formal cooperation was signed between the HCMR and the municipality of Samothraki, initiating the SNO as a "linking-network among scientists and local community"[1]. Its objectives are long term environmental monitoring, natural resources and biodiversity protection, enhancing local community sustainability and environmental education. Furthermore, the SNO's website consolidates a wide range of research results related to the aquatic ecology of Samothraki, providing a good overview and connecting related research projects such as national LTER and the Samothraki MAB. Meanwhile, the attention of research was drawn to the phenomenon of high N values in the streams of Samothraki, leading to the installation of automatic hydro-meteorological equippment on the island[2], long-term hydro-meteorological and hydro-chemical monitoring of the Fonias basin (see, eg. Pollakowski et al. 2019) and the extensive investigation of controls of the water's chemical composition (Skoulikidis et al. 2020). Regarding water management, early publications provide little description or assessment. The thesis by Lampou 2012, as well as the findings of summer school participants Schoder et al. 2016 and Özkan et al. 2020 consider water management, providing some tentative suggestions. However, in a recent report, Skoulikidis et al. 2019 offer a coherent account of current water management practices, their weaknesses and future management suggestions in compliance with IWRM as required by the Water Framework Directive (WFD).

[1] See: http://samothraki-observatory.hcmr.gr, accessed 13.12.2020

[2] see http://samothraki-observatory.hcmr.gr/sample-page/objectives/, accessed 13.12.2020

Since the onset of the civil-science cooperation between the SEC and *Sustainable Samothraki* more than ten years ago, the body of social-ecological literature on Samothraki is growing steadily[3]. It contains journal articles, project reports, posters, master theses and documentation from the international summer schools taking place regularly since 2012. Broadly speaking, literature from this body informed three major aspects of my work: Publications featuring a strong sociological perspective and qualitative data, such as Petridis 2011, Petridis et al. 2013, Skarp et al. 2016 or Petridis and Huber 2017, provide information on societal variables such as moral values, perspectives on sustainability or traditional cooperation patterns. Secondly, analyses of the island's social metabolism provided the relevant socio-metabolic and demographic data, eg. material and energy consumption, waste production, stocks in use, regenerative flows and capita fluctuation. Works covering these aspects include Xenidis 2012 (includes a comprehensive historical research), Petridis and Fischer-Kowalski 2016, Fetzel et al. 2018, Baierl 2019 and Fischer-Kowalski et al. 2020a. Thirdly, literature on the character of the sustainability research itself, such as Fischer-Kowalski et al. 2011, Petridis and Fischer-Kowalski 2016 , Petridis et al. 2017 and Fischer-Kowalski et al. 2020a informed insights on participatory and transformative science in theory and practice, see also section 2.1.3.1.

Non-academic literature used include official documents, such as the River Basin Management Plan (RBMP) of the Thrace River Basin District 2013 and its 1st review 2017, both commissioned to the European Commission (EC) by the Greek Ministry of Environment, Energy and Climate Change (YPEKA) and available on their respective websites[4]. Of great importance are the Operational Programmes, which the Municipality of Samothraki started issuing from 2014[5] onwards, covering the periods 2013-2014 (Municipality of Samothraki 2013) and 2014-2019 (Municipality of Samothraki 2016). The Operational Programmes are the basic strategic document for developmental and policy activities of the municipality, providing an account of the current status as well as plans and visions for the near future. They include data on demographic changes, strategic assessments, and the municipality's proposed vision for the future. Similarly important were publications by the Municipality of Samothraki via their website https://samothraki.gr/, such as documentations of council meetings or announcements of water related construction work. Additional grey literature includes blog post, local news websites and Facebook. As many political parties, civil society groups and public bodies use Facebook posts as a means of communicaiton and networking, it was useful tool to identify topics of dispute, access political commentary, discover relevant actors and keep track of activities.

3.2.2. Semi-Structured Interviews

Originally, the thesis was planned as a field-work intensive study, significantly relying on observations and primary data. For this purpose, interviews with a variety of stakeholders, relevant actors and experts were envisaged. As the Covid-19 pandemic and related travel restrictions made it difficult

[3] see http://sustainable-samothraki.net/research/publications/, accessed 13.12.2020

[4] https://ec.europa.eu/environment/water/participation/map_mc/countries/greece_en.htm and http://wfdver.ypeka.gr/en/management-plans-en/, both accessed 21.12.2020

[5] https://samothraki.gr/2014-03-31-08-17-38/, accessed 31.12.2020

and unreasonable to visit Samothraki, reaching the level of engaged fieldwork necessary to find and arrange interview partners was out of question. Thanks to the informal networks which grew through the transdisciplinary and participatory design of past research on Samothraki, I could reach out to some but not all intended interview partners. Generally, those offering to participate were already involved in or familiar with the sustainability research on Samothraki, and some actively working towards a sustainability transformation. Attempts to arrange interviews with other relevant stakeholders[6] and experts[7], eg. municipal workers, farmers or various other water users, as planned originally, failed.

The interviews were conducted via telecommunication, through Skype, Zoom, Viber or phone calls, in English and German. Of the five interviewees, two were former or current researchers, four former or current residents, two residents engaged in community work, societal change and ecological activism, two former users of irrigation channels and two current users of PVC pipes for irrigation of their gardens of cultivation plots. The interviews were held as semi-structured interviews, in which the researcher sets up a rough guideline to follow during the interview, while allowing sufficient flexibility for the interviewee to elaborate on issues they consider relevant to the topic(Cox 2020). The interview guide (see annex 9) was made based on the SESF's wide range of social-ecological variables considered constitutive for SES governance outcomes on the one hand and knowledge gained through literature review, visits to the island and previous talks. The interviews were transcribed and analysed through to the SESF variables. The transcribed interviews can be found in the appendix (see appendix 10).

3.2.3. Visits to Samothraki

Participating in the 6th International Summer School of Aquatic and Social Ecology on Samothraki, I had the possibility of engaging in hydro-ecological research on site and getting to know (at least to extend) the network supporting a transformative sustainability agenda on The presence of the island's unique ecology left a lasting impression which cannot be translated into words easily. Numerous discussions amongst students, tutors, and locals contributed to an overall orientation and wholesome understanding of the issue as much as the actual field-work of taking stream discharge and physico-biochemical measurements (the results of which are summarized in Özkan et al. 2020). Some of the pictures used in this thesis were part of an attempt to document the different ways in which water access is being managed on the island. While the image of abundant PVC pipes used for water abstraction in-midst a near-pristine environment still carrying visible marks from the 2017 flood might not be easy to transmit through written work. This thesis however is an attempt to account for some of this image's complexity.

[6]The term stakeholder, originally coined in economics as someone who has a stake in something, is now widely used in socio-ecological research for individuals, groups or organisations who are interested in, involved or affected by a particular project or action toward resource use'(Krupa 2016)

[7]Expertise is not limited to people of academic background (Karvonen and Brand 2012) but refers to any person with an extensive knowledge of the water supply system and related aspects

3.3. Limitations

Scarcity of data constrains the scope of this work significantly. Initially conceptualised as case study comparing historic and current water supply, strongly integrating the perspectives of a variety of water users, the travel restrictions put in place frequently during the time of research required me to rely mostly on secondary data. Although it is increasingly used with secondary data only (Partelow 2018), the SESF was initially selected as main tool for this research because of its ability to process and arrange a large variety of primary data. It enables the researcher to investigate the variables constituting a social-ecological system at a comprehensive yet detailed level. Resorting to data compatible with remote research brought along various restrictions: While the hydrological network, water availability and water quality are relatively well documented through the extensive work done by SNO and HCMR researchers, little information is available regarding societal aspects of water management. Such include, eg., an understanding of water governance institutions, related power structures and societal functions, societal implications on water use patterns and dependency on the resource, or also stakeholders' perspectives on current practices. While some general information can be found in social-ecological research conducted so far, none investigates water governance specifically. I therefore rely strongly on the perspectives of local informants while having very restricted means of reaching out to possible interviewees. Not knowing any Greek I relied on English or German speaking informants and literature published in these languages. Most of the early hydrological studies on Samothraki were published in Greek, and were difficult to retrieve even for Greek scholars (Skoulikidis et al. 2019). Regarding non-academic sources, machine translation supported my initial research of grey literature, relevant parts of which were then translated by a study colleague.

As further outlined in section 4.3, there is a strong 'insider' vs. 'outsider' narrative amongst long-established residents of Samothraki, with residents being considered 'outsiders' even if they are living or have lived for a long period of time on Samothraki, which brought about the humoristic but kind term 'neo-locals'. All of the interviewees who contributed to this research are considered 'outsiders' or 'neo-locals' to various degrees, having moved to Samothraki at some point in their live, having left the island for work or studies on the mainland/abroad, or being long term foreign visitors. Cooperation and information exchange is highly present within these groups, whereas 'old' locals are less open and communicative (see section 4.3). The interviews conducted within this research, especially under the condition of telecommunication, relied heavily on the interviewee's willingness to communicate and support my work. The qualitative analysis is consequently likely to be biased towards the perceptions of those groups of actors who are more open, supportive, and already engaged or interested in a sustainability transformation. This unbalanced representation is countered only by openly taking into account the respective background of informants and sources.

4. APPLICATION OF THE SES FRAMEWORK

In the sections below, I follow the outline presented in section 3.1 to construct the SESF and fill it with content.

4.1. Resource System

In order to understand relevant controls of Samothraki's freshwater resource system, general geological, topographic and climatic conditions are outlined first, followed by a more detailed description of size, quality and basic recharge dynamics of springs, streams, and groundwater aquifers.

4.1.1. General Conditions: Geology, Topography and Climate

4.1.1.1. Geology. Samothraki is the result of tectonic pressure regimes of the Late Jurassic (Koglin et al. 2009). Continuous tectonic uplift movements cause it to rise by about 2 mm/yr (Skoulikidis et al. 2020). Its central part consists of magmatic rock of Late Jurassic and Miocene origin, the former type forming ophiolite and the latter granite rock, covering 31% and 26% of the island's surface respectively. Volcanic rocks cover 8% of the island's surface east and west of the magmatic units, and an Upper Jurassic - Lower Cretacrous clastic metamorphosed sedimentary basement is found around Chora, covering 3% of the island's surface (ibid.). Much younger Pliocene-Quaternary sediments, created through physical weathering, erosion and clastic deposition, cover 32% of the island's surface mainly in the west. Quaternary deposits are also found as scree, talus cones, and alluvial fans in the steep parts of the island and steam valleys (ibid.).

4.1.1.2. Topography. The uniqueness of Samothraki's water resources is strongly connected to the islands topography. About 100 km north-east from Mt Athos (2033 m asl), 100 km south of the foothills of the Rhodope mountains and less than 150 km north-west of Mt Ida in Turkey, the island's peak Fengari is one of the highest elevations in the region. Covering only 178 km² in area, about 17 km on the north-south and 28 km on the east-west axis, but reaching an altitude of 1611 m asl at its highest point, Samothraki is a "mountain in the sea" (ibid.) taken up nearly entirely of the Saos mountain range. The mountain range's slopes descend directly into the sea on the island's south-east, with a narrow margin of more even land surrounding the mountain in the north-east and hilly

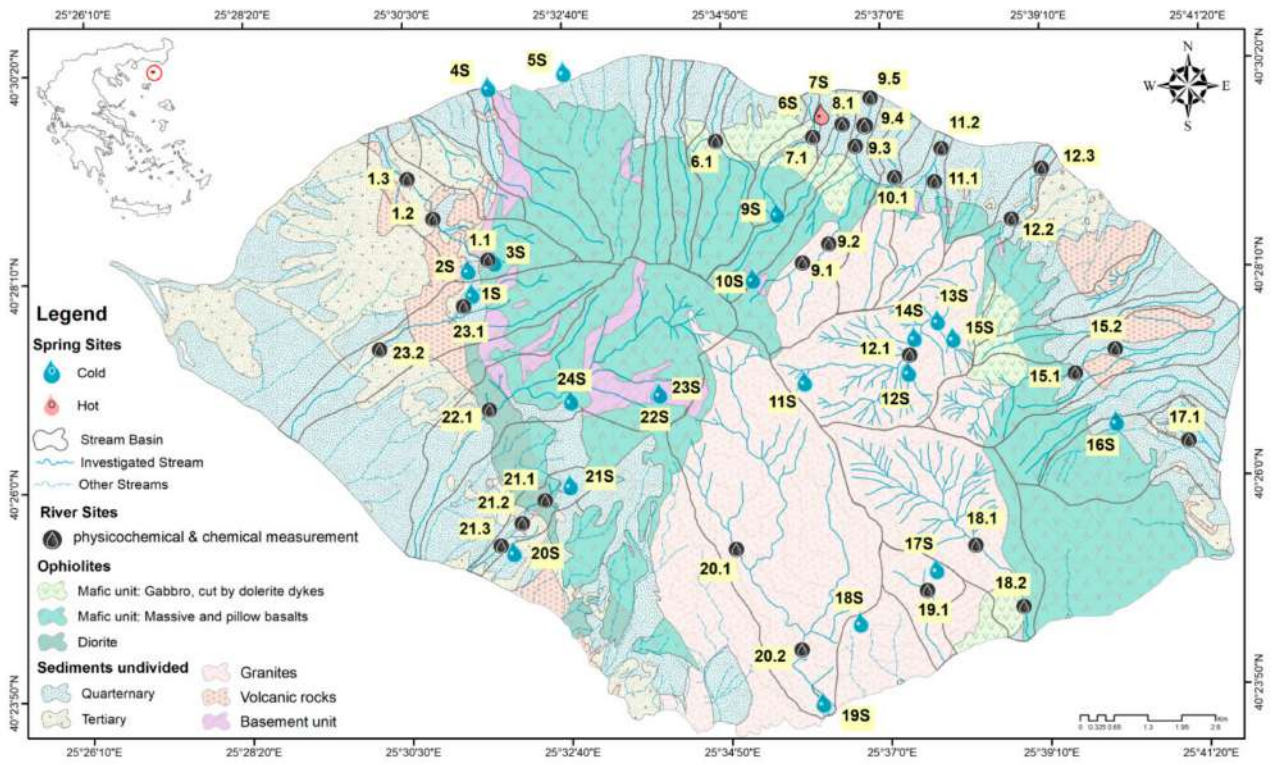


Figure 4.1. Geological Map of Samothraki with Points Examined by Skoulikidis et al. 2020. Source: (Skoulikidis et al. 2020)

countryside in the south-west. Only in the west do larger planes extend (see figure 4.3). The island thus consists of mostly steep terrain, with an average slope above 30% (Panagopoulos et al. 2019).

4.1.1.3. Climate and microclimatic conditions. Close to the Thracian land-bridge, between the South-east Balkans and the Black Sea, Samothraki is situated in a climatic region characterized by dry summers and humid, continental winters (Skoulikidis et al. 2020). The particular topography of the island, however, creates two microclimatic regimes: A Mediterranean climate regime in the lower, mainly south-western part of the island, and a humid, mountainous climate regime dominating the Saos massive. The Köppen-Geiger classification (see figure 4.4) three sub-zones are present on Samothraki: Csa - hot-summer mediterranean, Csb - warm-summer Mediterranean and Dsb - humid continental (Beck et al. 2018).

Significant data on local climatic conditions is quite recent, as the island's first meteorological station only started operating in August 2008, placed at 90 m asl south-west of Chora[1]. It's ombrothermic chart for the period of 2008-2012 is shown in figure 4.5. A second meteorological station measuring climate conditions at Koufouklio, 800 m asl, has only been installed as recent as September 2018 (Skoulikidis et al. 2019) by the SNO. Until then, the lower station of Chora has been used as a reference for the whole island, therefore not capturing microclimatic peculiarities. Older data can

[1](Source: http://meteosearch.meteo.gr/stationInfo.asp, accessed 13.12.2020)

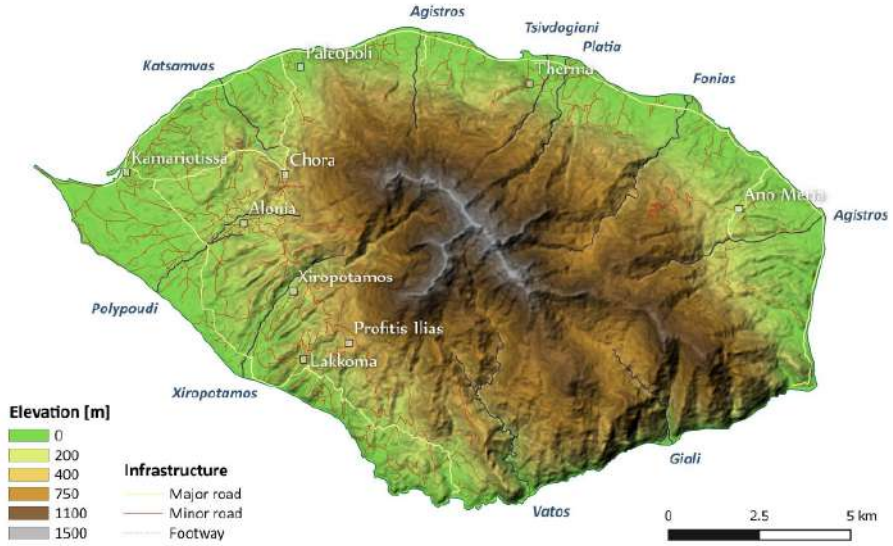


Figure 4.2. Digital Elevation Model of Samothraki. Source: Löw 2017

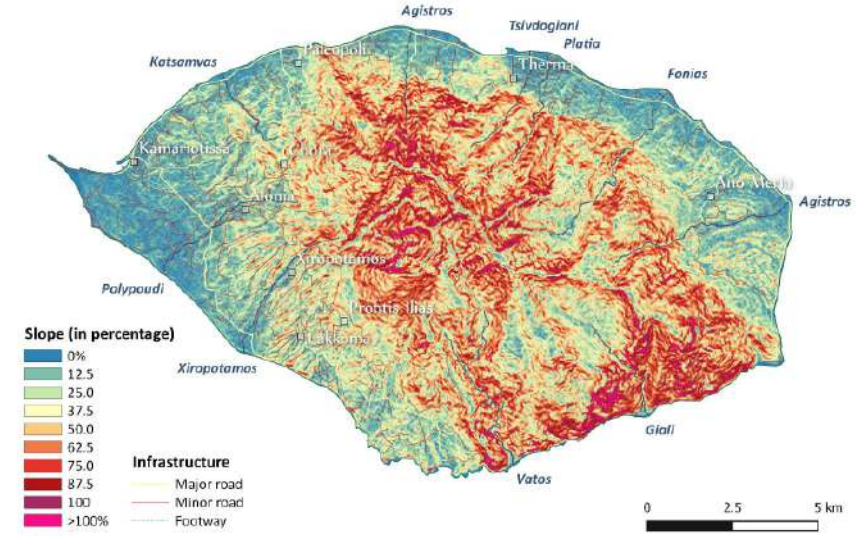


Figure 4.3. Slope-map of Samothraki. Source: Löw 2017

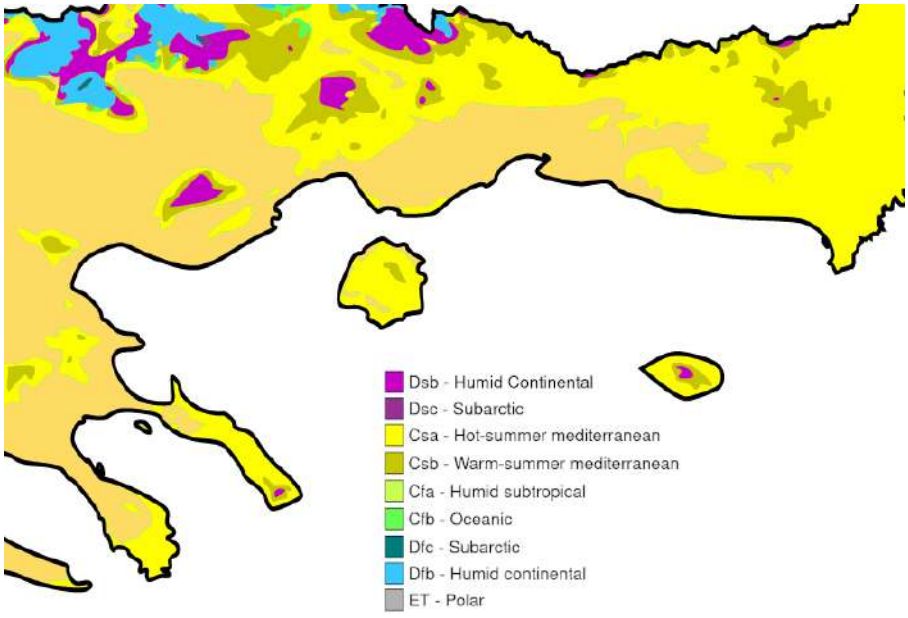


Figure 4.4. Regional Climate Zones. Source: http://www.gloh2o.org/koppen/

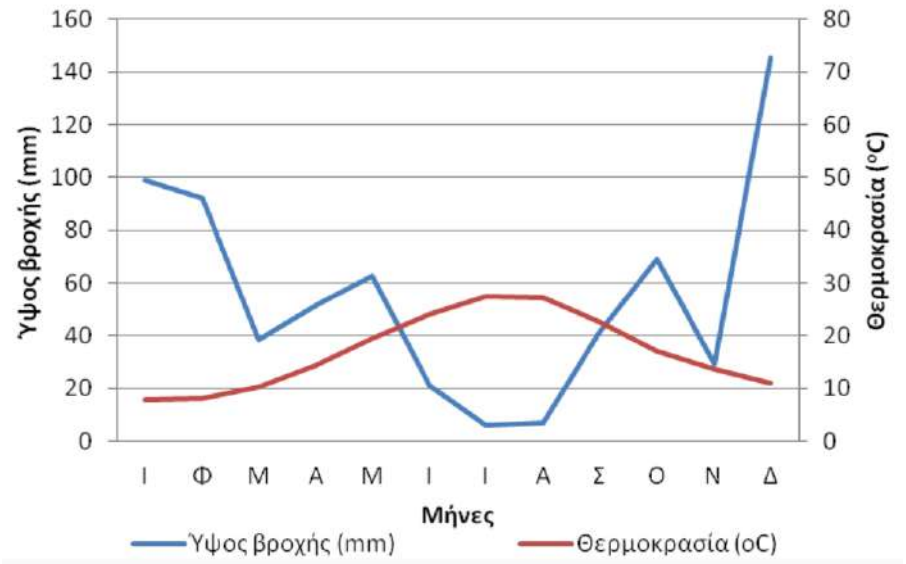


Figure 4.5. Ombrothermic Diagramm of Samothraki 2008-2012. Bue line indicates rainfall in mm, red temperature in °C. Source: Lampou 2012

be found nearest at the meteorological station of Alexandroupolis, which provides long-term series since 1901 (Pnevmatikos and Katsoulis 2006) [2].

The annual average temperature on Samothraki is estimated at 15-16 °C, with July and August being the hottest and December to February the coldest months. Sharp fluctuations in temperature occur during the day and over the year (Municipality of Samothraki 2016). For 2019, the Chora meteorological station records a mean annual temperature of 18 °C, with monthly means of more than 25.5 °C from June to August and less than 9 °C in January and February. Maximum and minimum temperatures were 36.8 °C in June and -3.9 °C in February[3]. In general, winters in the mountains are cold (frequently below 0 °C). The peaks, of which several exceed 1,400 m asl, are frequently covered by snow during winter and spring, much in contrast to other Aegean islands (Skoulikidis et al. 2020). Snow layers can reach up to two meters (Municipality of Samothraki 2016). Mean annual precipitation at the Chora station is registered at 707.4 mm for the time period of 2008 - 2017(Skoulikidis et al. 2019), while during the relatively dry years 2018 and 2019, mean annual precipitation was recorded at 527.8 mm and 621.9 mm respectively (see figure 4.6).

If measurements from Koufouklio station are taken into account, however, much higher mean precipitation values for the whole island are likely the case. In the hydrological year 2018/2019, three times as much precipitation was registered at the higher meteorological station as at the one in Chora, namely 1.582 mm in contrast to 584 mm. The difference is particularly high during winter, while both stations recorded similarly low total rainfall during from June to September 2019, namely 52 mm at the lower and 62 mm at the upper station (Skoulikidis et al. 2020).

[2]Until today the mainland meteorological station of Alexandroupolis is frequently relied upon for climatic data and meteorological forecasts.

[3]http://penteli.meteo.gr/stations/samothraki, accessed 10.12.2020

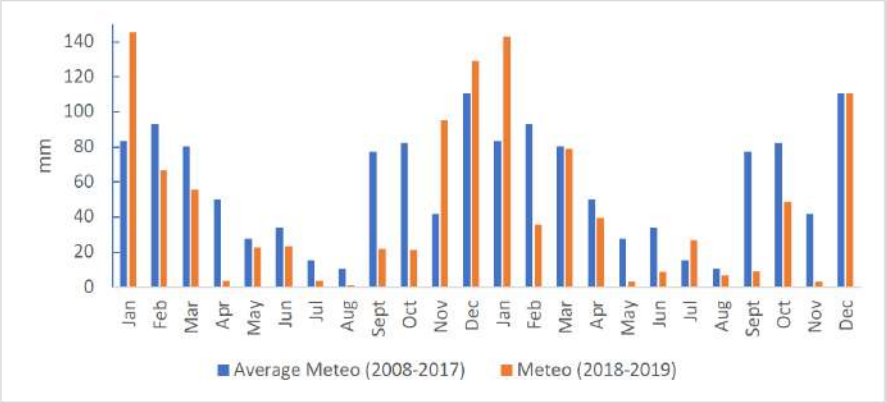


Figure 4.6. Monthly Precipitation From 2018-2019 as Compared to Average 2007-2017 Values, Chora. Source: http://penteli.meteo.gr/stations/samothraki/, accessed 31.12.2020

These differences alone demonstrate how different the climate regimes on Samothraki are. The different microclimate is caused by the sudden rise in altitude and connected decline in temperature: Humid and warm air masses are blown from the sea into the mountain heights, where the water vapour which they carry condensates. The resulting cloud and fog formations are characteristic for Samothraki (see figure 1.1) During the night, when temperature drops further, water droplets form on the surface of the mountains' rocks and vegetation, infiltrate shallow aquifers or accumulate in surface run-off. This process is assumed to contribute largely to the water balance of Samothraki, as a study in the period 26 August - 24 September 2019 registered an average 60% increase of nightly discharge in comparison to day-time values at the Fonias stream. The Koufouklio meteorological station also records significantly higher humidity than the 90 m asl meteorological station, with nearly a third of the measurements registering >95% humidity (Skoulikidis et al. 2020) as in contrast to the average 70% estimated for Samothraki (Municipality of Samothraki 2016). Water level measurements of Fonias, which discharges the basin in which the meteorological station is located, confirmed a correlation of higher stream discharge and higher air humidity occurring during night(Skoulikidis et al. 2020). While further research under way to quantify the phenomenon, the existence of perennial streams despite low precipitation, high humidity measurements in the mountains, higher discharge of streams during the night, the chemical composition of mountainous streams, as well as local knowledge and ground proofing support the assumption (ibid.).

4.1.1.4. Climatic trends. Due to the complexity of global climatic feedbacks and high spatial variability in response to changes, it is difficult to project the impact of climate change on a local scale. Current climate change projection models are usually of a coarse spatial resolution which makes it difficult to derive valid statements for small but complex units as islands are[4]. In addition to that, Samothraki exhibits peculiar micro-climatic dynamics, which are under study only since recently. The knowledge acquired thus far does not yet allow for projections of the distinctive local responses to climatic changes.

[4]For these reasons, the project SoclImpact aims to provide climate change impact studies for a range of participating islands, see www.soclimpact.net/the-project/ (accessed 13.12.2020)

Nevertheless, regional projections on climatic changes provide a general understanding of trends and are insightful regarding regional and supra-regional controls of the local climate. Past climate trends in Greece show a 0.4 to 0.6 °C temperature increase especially during the summer period, a significant reduction in precipitation, and increase in extreme weather events such as floods, droughts and wildfires since the 1990s compared to the internationally accepted reference period of 1979-90 (Publishing 2013). According to the Ministry of Energy and Climate, these trends are to continue. Temperature is projected to rise by 3.5 - 7°C by the end of the century, with daytime temperature projected to increase more sharply (by 6 - 7 °C) in the north of Greece. Average sea levels are expected to rise by 0.2-2 m by 2100 (Ministry Of Environment And Energy 2018). In a 2011 climate change impact study of the Bank of Greece, Samothraki is included in the Northern Aegean climatic zone based on climatic and geographic considerations. Climate projections for this zone show an increase in average temperature from 16.19 °C (16.37 °C) to 19.23°C (20.56°C), decrease (increase) of total annual rainfall from 500.7 mm/yr (481.8 mm/yr) to 532.2 mm/yr (451.3 mm/yr) and decrease of humidity from 73.52% (71.35%) to 72.73% (68.94%) from the 1962-1990 average until the end of the century under a scenario of a 620 ppm (850 ppm) CO2 concentration in the atmosphere(Bank of Greece 2011)[5].

Long-term data series of the meteorological station Alexandroupoli shows increasing precipitation values, which could also be attributed to normal climatic oscillations (Pnevmatikos and Katsoulis 2006). Pollakowski et al tested precipitation and temperature values from 1979 - 2014 for statistic trends. They found average temperature to increase significantly from about 15.5 to 17 °C. Precipitation increased slightly in volume and variability, with a more sharp increase of both volume and variability in summer and autumn. (Pollakowski et al. 2019).

The variability of results reflect the difficulty in making meaningful statements regarding local climate change impact projections. Next to rising temperatures, above data strongly points to higher variability of precipitation and extreme weather events. This will pose additional stress to the island's aldready visible vulnerability to sudden heavy precipitation events and droughts. Although rise in sea-level cannot be estimated based on current data, the vulnerability of coasts is expected to increase with physical and biochemical alterations of marine hydrological systems and due to extreme weather events. Groundwater resources in vicinity to coastlines are projected to be more susceptible to saltwater intrusion, thus increasing the risk of saltwater intrusion (Ministry Of Environment And Energy 2018). Projections made so far on a regional scale thus translate into an intensification of most of the current local pressures identified above.

[5]The small differences in climate parameters of the reference period for the different emission scenarios are due to the fact that climate parameters are estimated on the basis of different sets of climate simulations for the different scenarios.

4.1.2. Freshwater Resources

4.1.2.1. Springs. There is some extend of variability regarding the exact number and location of springs due to technical issues, differences in nomenclature and missing or inaccessible data. The Institute of Geological and Mineral Exploration (IGME) identified and examined 40 springs as part of a long term research project in the 80s, however, not all springs were continuously studied. Another hydrogeological study on springs was published in 2006, the respective data of all IGME studies is included in the HCMR's reports (Skoulikidis et al. 2014), (Skoulikidis et al. 2020), (Skoulikidis et al. 2019). For reasons of language and accessibility, I rely on the HCMR's account of the data. Additionally to the different studies not using consistent nomenclature, the Municipality uses a different coding system for the springs which they exploit. Coordinates are sometimes missing or faulty. Although th HCMR put great effort in identifying the respective water sources and abstraction points, some unclarity remains.

Of the 42 cold springs registered by IGME in low and middle altitudes of the island, 33 (IGME) or 35 (RBMP) are located within the magmatic rocks of the island. These springs are fed by aquifers residing in the cracks and fractures in the rock caused by tectonic movement (see section 4.1.2.3). The majority of the springs are contact springs located in ophiolitic rocks at their intersection with Quarternary deposits of low water permeability, followed in number by fracture type springs emanating from granitic and volcanic rocks, and some overflow springs also draining ophiolitic rocks. According to IGME, the mean annual discharge of springs originating from ophiolitic rocks ranges between 0.65 and 19.5 l/sec and shows little seasonal variability. Mean annual discharge of springs originating from granitic and volcanic rock ranges between 0.1 and 6.5 l/s. (Skoulikidis et al. 2019; Municipality of Samothraki 2016) At the western lowlands and connected to the Xiropotamos Groundwater System, 9 contact springs have been identified by the IGME with a mean annual discharge ranging from 0.5 to 15.1 l/s. In addition, two hot springs have been registered by IGME. Their source is assumed to be a geothermal groundwater reservoir, which is fed by rainwater which permeates through deep fissures in the volcanic rocks to depths of more than 2000m. Chemical analyses and the fluctuation in flow and temperature indicate intrusion of sea water in the groundwater reservoir and a mixing process with water of shallow aquifers and surface water during the hot water's journey to the spring source (Municipality of Samothraki 2016). The SNO investigated 21 cold springs and 2 hot springs. The georeferenced and studied springs, along with those identified by IGME and those exploited by the municipality, are shown in figure 4.7.

According to their hydro-chemical measurements, springs can be clustered into two distinct hydrochemical types: 14 are categorized as calcium-hydroge-carbonate type and 9 as sodium types. Thermal springs belong to a sodium-sulphate geothermal subtype. Cold spring water is of paramount quality, generally characterized as soft, with low solute concentration and poor in metals. Concentrations of heavy metals, nitrate and ammonia are below drinking water standards, and the examined spring waters surpass bottled spring waters of Greece and most other European countries in low totally dissolved ion (TDI) values. Samothrakian spring water might have the lowest mineralisation of

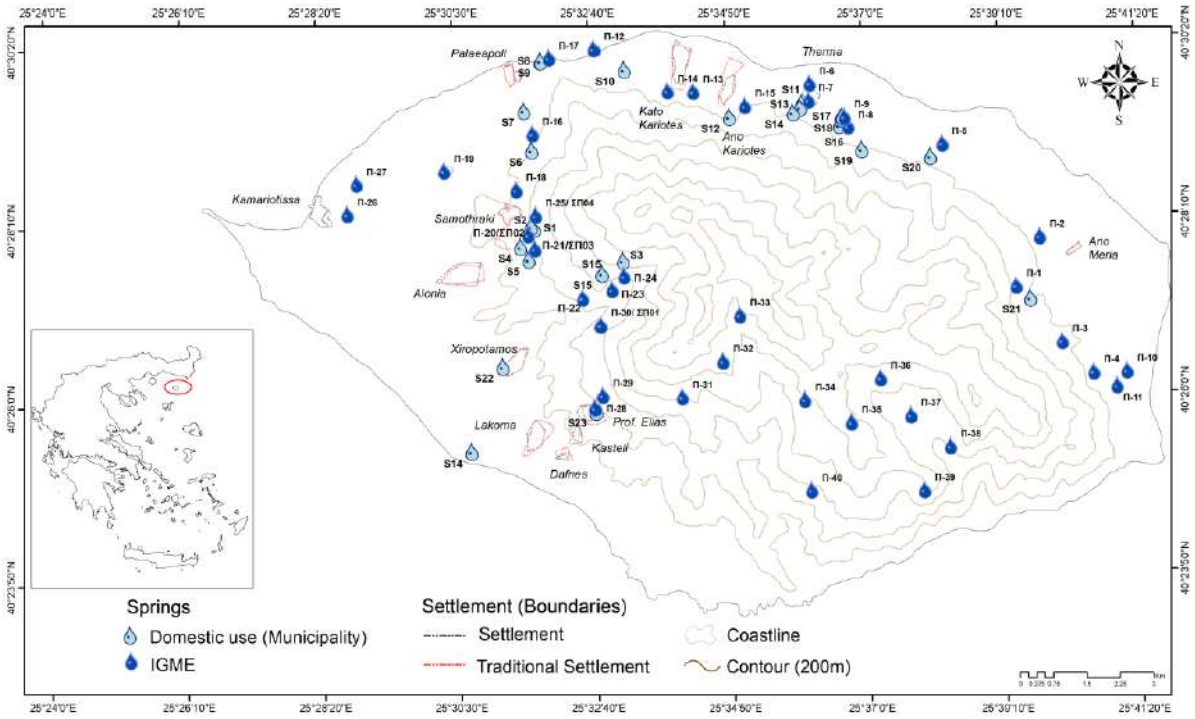


Figure 4.7. All Registered Springs of Samothraki. Source Skoulikidis et al. 2019

registered European potable spring water (Skoulikidis et al. 2019). Exceptions are the spring Dafnes, which has an exceptional composition of high alkali ion, sodium, bicarbonate, sulfate and nitrate concentrations and shows salt formations at its outlet, and the Paleapoli spring, which shows signs of saltwater intrusion. The thermal springs are highly mineralised, featuring high sodium, chloride and manganese levels, making them an appropriate source for therapeutic use (ibid.).

4.1.2.2. Streams. The numerous streams radiating outwards from the central heights are considered as the main element of the island's surface run-off. Running waters are classified as streams due to their low order and small basement size. The majority of streams discharges an area of less then 10 km², thus being classified very small, whereas Xiropotamos and Vatos are classified as small with a basement area of 10 - 100 km² (Skoulikidis et al. 2020).

A total of 23 main basins with perennial or intermittent flows have been identified on Samothraki, of which 16 have been investigated thoroughly in regard to physical and biochemical parameters, covering a catchment area equivalent to 56% of the island's surface. The remaining area is drained by ephemeral or episodic streams (ibid.).

Of the examined basins, roughly two thirds extend on weathering resistant rock of low permeability in the central mountainous part of the island. These streams basins are characterized by a high relief ratio (average drop in elevation per unit length of river), steep slopes and high percentage of granite in the river bed. One third of examined stream basins covers recent Plio-Quaternary sediment formations, predominantly in the western part of the island and some minor streams in the east. These basins are marked by a low slope and relief ratio. While most of the basins are of elongated

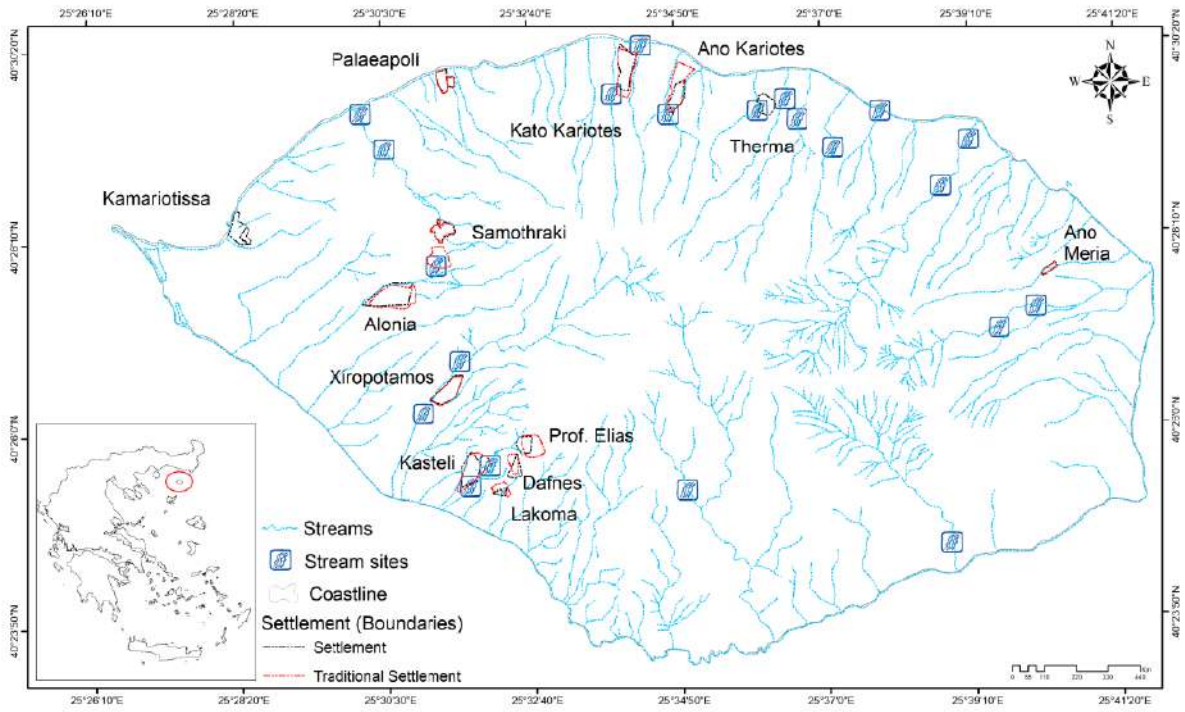


Figure 4.8. All Stream Discharge Measurement Sites of Skoulikidis et al. 2019. Source: Skoulikidis et al. 2019

shape with parallel drainage patterns and few tributaries, the upstream portions of larger basins (eg. Fonias, Giali and Agkistros) extend into plate-form basins with many small tributaries, resulting in a maximum drainage density (average 3.52 km-¹) of that streams. Fonias (lit. *the Killer*) is the stream with highest discharge, with conservative long term measurements estimating an average run-off of 0.26 m³/s. Draining a basin of only 99.7 km², Fonias shows one of the highest specific discharges (discharge per unit area of upstream watershed) across Greece(Skoulikidis et al. 2020).

The mean annual discharge of all investigated streams (see figure 4.8 for discharge measurement sites) has been calculated at 62.82 hm³. Due to the inaccessibility of two streams, Giali and Vatos, the exploitable annual stream discharge is calculated at 49.43 hm³ (Skoulikidis et al. 2019).

Similar to springs, streams, too, show remarkably low mineralisation. Streams also showed a slight enrichment of Chlorine and Silicate compared to mainland streams, which is usual for lotic island waters, with lower ion concentrations than other islands, however. Streams are similar to springs in most physicochemical variables, major ions, and nutrients, except for higher water temperature and lower ammonium concentrations than springs. Streams are more homogenous regarding their hydrochemical types, with 29 examined stream sites classified as calcium hydrogen carbonate type and only one, Kremasto, as a sodium sulphate geothermal subtype. Regarding nutrient concentrations, average nitrite, phosphate, and TP values match reference values and ammonia close-to-reference values, resulting in 90% of the examined sites being categorized as high quality status. Good or moderate quality status often is due to nitrite concentrations,which vary considerably between different sites, with high values found in higher altitudes, indicating non-anthropogenic sources. Exceptions are Katsambas and Lakoma streams, which are of lower quality due to the discharge of untreated

municipal waste waters (Skoulikidis et al. 2020). Xiropotamos is an exception as well, exposing high PO4 values when running low, which most likely originate from settlement and livestock wastewater as well as agricultural activity (Lampou 2012).

4.1.2.3. Groundwater aquifers. Samothraki is home to two aquifers: One cracked groundwater aquifer covering 3/4 of the island's north, east and south, called Samothraki Groundwater System (SGWS) and a smaller, alluvial aquifer in the western part called Xiropotamos Groundwater System (XGWS) (Ministry of Environment & Energy, Special Secretariat for Water 2013) (see figure 4.9) The SGWS covers 66.3 km² with a maximum length of 11 km, maximum width of 8 km and a thickness of about 35 m. The aquifers inhabit the fractures, cracks and fissures in the otherwise impermeable magmatic rocks which are caused by tectonic activity, or form in ravines filled with weathered rock material. They discharge to numerous springs which substantially contribute to Samothraki's surface run-off (Skoulikidis et al. 2019). The XGWS covers 26.6 km² according to the RBMP and 14 km² according to IGME, with a maximum length of 8 km and maximum width of 5 km (Ministry of Environment & Energy, Special Secretariat for Water 2013), (Skoulikidis et al. 2019). According to ibid., the IGME estimates depth as up to 15 m. The sedimentary aquifer is fed by 9 contact springs, of which those with highest discharge are Panagia Mandalo and Ano Panagia (II-30 and II-29 in figure 4.7) (ibid.). Additionally, water from the cracked Samothraki groundwater system is assumed to feed into the XGWS (IGME in ibid.).

According to IGME, groundwater tables reach their annual minima in autumn, about one month after minimum precipitation and run-off (ibid.). Pumping tests, where the hydraulic properties of an aquifer are estimated based on the response of the water-level to controlled withdrawal, could not be conducted because of frequent use of the aquifer for irrigation needs. According to the RBMP of Thrace, the average annual supply of the SGWS is estimated at 19.8 hm³ and the average annual supply of the XGWS at 1.14 hm³ (ibid.).

4.1.2.4. Quantification of water resources available for freshwater exploitation. According to the HCMR researchers, total annual discharge of springs and streams and the annual supply of groundwater aquifers add up to 79.13 hm³ as Samothraki's total available water resources. This is in accordance with earlier estimations of Schoder et al (Fischer-Kowalski and Petridis 2016), while the RBMP's estimation of 90 hm³ is considered too high (Skoulikidis et al. 2019)

4.1.2.5. Other water bodies. In addition to the water resources outlined above, Samothraki is home to lagoons, coastal wetlands, and a unique marine ecosystem, which contribute to the island's biodiversity and essential ecosystem services (Sustainable Samothraki 2011). Coastal Wetlands are formed at the outflow of some streams, including Agkistros, Fonias, Polypoudi, Xiropotamos, Vatos and Giali. They are a result of the rivers turning westwards before entering the sea due to frequent north-east winds and wave movements. High stream discharge in winter and spring however tends to straighten

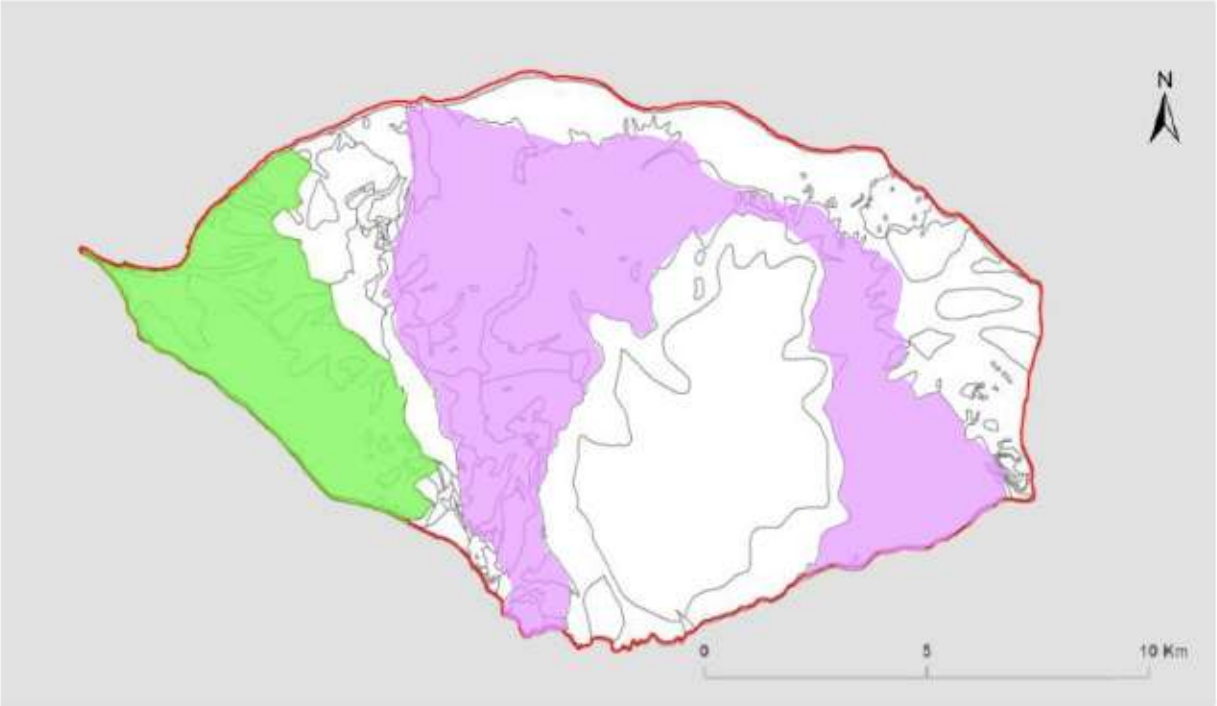


Figure 4.9. Aquifers of Samothraki: XGWS (green) and SGWS (purple). Source: Ministry of Environment & Energy, Special Secretariat for Water 2013

the river outflows, leaving behind the previous branches (Christos Anagnostou in personal communication with HCMR researchers) (Skoulikidis et al. 2019). Several lagoons are documented on the coastline of Samothraki, of which the biggest is St Andreas lagoon. These lagoons create favourable habitats for migratory bird species and used to be relevant fishing grounds which got abandoned over the years (Sustainable Samothraki 2011). Marine hydrology, although is not considered in this study, two feed-backs which interact with the island's freshwater system should be pointed out to. The effect of vapour stemming from sea water condensing in the mountain's heights has already been elaborated on in 4.1.1.2. The influx of freshwater into the coastal waters through Samothraki's numerous streams, on the other side, contributes to the existence of a unique marine ecosystem (ibid.).

4.1.3. Human Constructed Water Supply Infrastructure

4.1.3.1. Municipal water supply. According to the municipality, all settlements on Samothraki are provided for with domestic water through the network installed and maintained by the municipality. The system also provides hotels, camping areas and buildings outside of settlements (Municipality of Samothraki 2016; Skoulikidis et al. 2020)

Water is mainly provided by tapping a total of 17 springs (18, according to Skoulikidis et al) in the vicinity of the settlements (see table 4.1 and figure 4.11). During the dry summer period, when springs run low, stream water is abstracted additionally and mixed with spring water. For two settlements, Alonia and Kamariotissa, groundwater resources are being used additionally to cover water demand

Table 4.1: Municipal Springs and Drillings according to the Settlements they serve. Terminology adopted from the Municipality. Source: Skoulikidis et al. 2019

Spring	Map code	Settlement
Vrysia 1	S1	Chora
Vrysia 2	S2	Chora
Varades	S3	Chora, Alonia
Sotiros	S4	Chora, Alonia
Ag. Giorgos (not operational)	S5	Alonia
Ag. Theodoros	S6	Kamariotissa, Paleapoli
Kopsi	S7	Kamariotissa, Paleapoli
Skra (Axios 1)	S8	Kamariotissa, Paleapoli
Skra (Axios 2)	S9	Kamariotissa, Paleapoli
Vasilikos	S10	Vasilikos
Voutiros	S11	Kato Kariotes
Kapias	S12	Ano Kariotes
Therma	S13	Therma
Milia	S14 (north)	Therma
Askamnes	S15	Therma
Road towards summit Fegari (pump)	S16	Therma
Pathway towards summit Fegari (pipe)	S17	Thema
Svotana	S18	Pera Therma
Grigorakis	S19	Pera Therma
Ag. Antonios	S20	Varades
Kandour (Kardies)	S21	Ano Meria
Terzis' mill	S22	Makrylies, Xiropotamos
Panagia Mandalou	S23	Xiropotamos, Lakoma, Profitis Elias, Kasteli, Dafnes
Macrylies beach (well)	S14 (south)	Lakoma
Sklavouna	D1	Alonia
Lagada (Trypa)	D2	Kamariotissa

during summer (Skoulikidis et al. 2020; Municipality of Samothraki 2016). Another drilling and connected 40 m³ tank are under construction, which will provide the smaller towns of Profitis Elias, Kastrelli, Dafnes and Seli with domestic water [6]. Some springs provide several settlements at the same time and some settlements are supplied by several springs. An overview is given in table 4.1.

The supply system's infrastructure consists of cisterns at he spring outlets, pumps where the source lies lower than the settlement (as the case for Paleapolis), pipelines to transport the spring water to the settlements, tanks which serve as reservoirs in closer vicinity to the settlements (as the case for Kamariotissa), the distribution network inside of the settlements and water meters for each individual housing unit.

The spring water is fed into cisterns right at the spring outlet, from where it is channelled through closed pipes into the distribution system. This makes it difficult to access the actual spring outflow of several springs (see figure 4.10). Consequently, total discharge of springs used by the municipality cannot be measured for discharge (Skoulikidis et al. 2019).

[6](Source: https://statusradio.gr/2020/10/erga-axiopoiisis-ydrogeotrisis-profiti-hlia-samothrakis/, accessed 13.12.2020)

Figure 4.10. Cistern Installed at Spring Outflow. Source: Skoulikidis et al. 2019

The cisterns fulfil the purpose of levelling the unsteady spring water outflow. Automatised chlorination was installed after a water pollution incident (Skoulikidis et al. 2019), but is currently not in use since the water quality has been of exceptionally high standard again over the past years (Nikos Koutsouris, personal communication). Water quality is monitored on a monthly basis by the Municipal Water and Sewerage Corporation of the Region of Eastern Macedonia and Thrace in Alexandroupolis. Additionally, the Municipality of Samothraki and private users occasionally assign water analysis to the state or private laboratories.

As outlined in 4.1.2, the natural water resources used for domestic supply are of high quality. Skoulikidis et al consequently associate contamination to damaged water supply infrastructure, which may allow inflow of waste waters inappropriately disposed of in permeable septic tanks (ibid.). Stream water, while also of a quality suitable for human consumption, should undergo primary treatment (settling, filtration and disinfection) to prevent possible microbial pollution caused for example by animal cadavers (ibid.). A microbial contamination of drinking water occurred in July and August 2016. Measurements of microbiological parameters were not compliant with drinking water standards, probably due to waste water inflow (Skoulikidis et al. 2020). As the contamination occurred during the dry season, during in which stream water is used as an additional water source, a source of contamination in stream water cannot be excluded. In October 2020, according to claims of citizens, the drinking water supply of Chora was polluted by the intrusion of mud, causing turbidity of the tab water (Interview MP). The incident caused a dispute over how the problem was caused and who to hold responsible, with some blaming the current administration and others the mismanagement during the years ahead. The chain of causation could not be followed from the distance. According

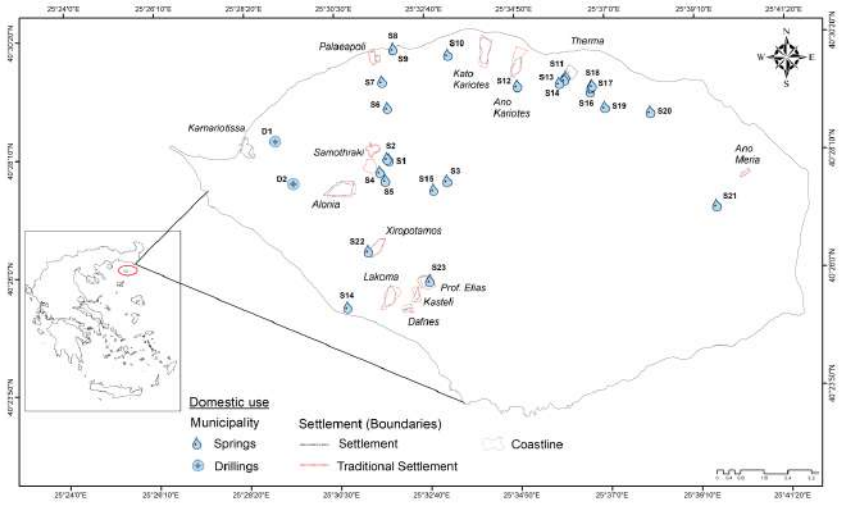


Figure 4.11. Spring Abstraction Points and Drillings Operated by the Municipality of Samothraki. Source Skoulikidis et al. 2019

to Interviewee Maria P., the problem is a symptom of a general short-termed and ad-hoc approach to problem solving (Interview MP).

Generally, the network infrastructure is in a bad state and urgently needs extensive repair works or full replacement. Several leaks allow water to escape and pose a risk to the water quality. However, currently only two water workers, of which one is an hydraulic engineer, are tasked with maintaining the whole municipal water supply infrastructure. There is a reportedly lack of expertise, human resources and financial means to guarantee reliable water supply. In addition, private or undefined ownership status of some of the lands which the pipes run on complicate access to the network and works on site (personal communication with Nikos Skoulikidis, November 2020), (Municipality of Samothraki 2016). Water outages occur regularly on the domestic supply lines in the dry summer months and less frequently during the rest of the year. Settlements in higher altitude suffer more frequently of disruptions in water supply. An exception is the harbour town of Kamariotissa, which faces shortages because its growing number of inhabitants force water demand to surpass available infrastructure. In the first half of November 2020, a total of five outages were announced by he municipality alone[7]. According to the municipal announcements, most outages were connected with water infrastructure repair works, technical issues, and disturbances caused by other construction works[8]

In addition to the two drillings providing domestic supply of two settlements, the municipality currently operates 16 drillings to meet irrigation demands (see figure4.12). Two more drillings exist but are not functional (Skoulikidis et al. 2019). After being installed by the prefecture, the drillings originally were managed by the farmers cooperative, as no regional equivalent of the body responsible for the management of public drillings, called Land Reclamation Agency (TOEB, acronym in Greek), was created. The municipality took over management of the drillings due to problems with the management (Municipality of Samothraki 2013). Related to Samothraki's aquifer formations, drillings

[7]Source: https://www.facebook.com/dimossamothrakis, accessed 13.12.2020
[8]Source: https://samothraki.gr, accessed 13.12.2020

show a high spatial distribution in the west of the island. The shallow aquifers in magmatic rock in the central and northern part of the island are not considered favourable for exploitation through drilling, and test drillings carried out in the northern part of the island to exploit aquifer formations within Quaternary sediments remained unsuccessful (Municipality of Samothraki 2016). Drillings in the western part abstract water from the alluvial sedimentary XGWS (see 4.1.2.3). The drillings are operated by the farmers individually and upon demand (Nikos Koutsouris, personal communication June 2019). Since 2015, electric hydrometers register the time of abstraction on cards through a system operated by a third party, a mainland company. The charges for abstracting water through the municipal drillings were recently increased from € 2.60 to € 2.10 per hour of water use. According to the former mayor Athanasios Vitsas, this system has substantially reduced water use from drillings(Skoulikidis et al. 2020). Some farmers on the other hand claim the software registering the abstraction times to be manipulated, charging too much (personal communication with Giorgos M., November 2020)

As stated in sections 4.1.3.1 and 4.1.3.1, currently, neither the domestic nor the irrigation hydrometers account for the total water use, creating a gap between the water actually used and the water use paid for according to the hydrometers. In domestic supply, users who do not use a hydrometer because their settlements are not covered by the modernised municipal network yet are charged an average fee of € 70. All other users currently without hydrometers are urged to apply for installation by the municipality. According to announcements made by the municipality, the payment fee for water bills is often times delayed, and some. As for irrigation water supply, former mayor Athanasios Vitsas estimated one third of the users to rely on unregistered surface water abstractions, which is supported by Salas-Zapata and Ortiz-Muñoz 2019's calculations (see section 4.3.6), while a few use water from registered private boreholes or surface abstractions, for which all the same no fee applies. A variety of irrigation systems is in use, including canals, pipes artificial rain, surface, drip and sprinkler irrigation as well as free flow. According to registered irrigation water use, sprinkler irrigation is used most often, providing for 89.3 acres of land, followed by surface and drip irrigation. This data is not sufficient to draw conclusions on the overall irrigation types, as it is only a fracture of the 7,329.1 acres irrigated according to the municipality (Skoulikidis et al. 2019).

Since more than 20 years, consecutive municipalities have worked on the implementation of a water reservoir fed by abstractions of Xiropotamos river in order to supply additional irrigation water to the farmers cultivating lands in the arid south-west of the island. Constructions for the infrastructure started in 2018, several years after a first design (1998), and budget (2012) were approved and a contract with a construction company signed (2013). The construction got delayed due to objections of a second bidder, objections filed by residents concerned about unsustainable water management and complications in the expropriation process, until the contract expired. A new contractor took over the project and meanwhile constructions are under way and due to be completed by the end of 2020. An irrigation network connected to the reservoir has already been set up. It is set at about 120 m asl, built of soil covered with water proof materials and has a capacity of 315.000 m³. The whole construction

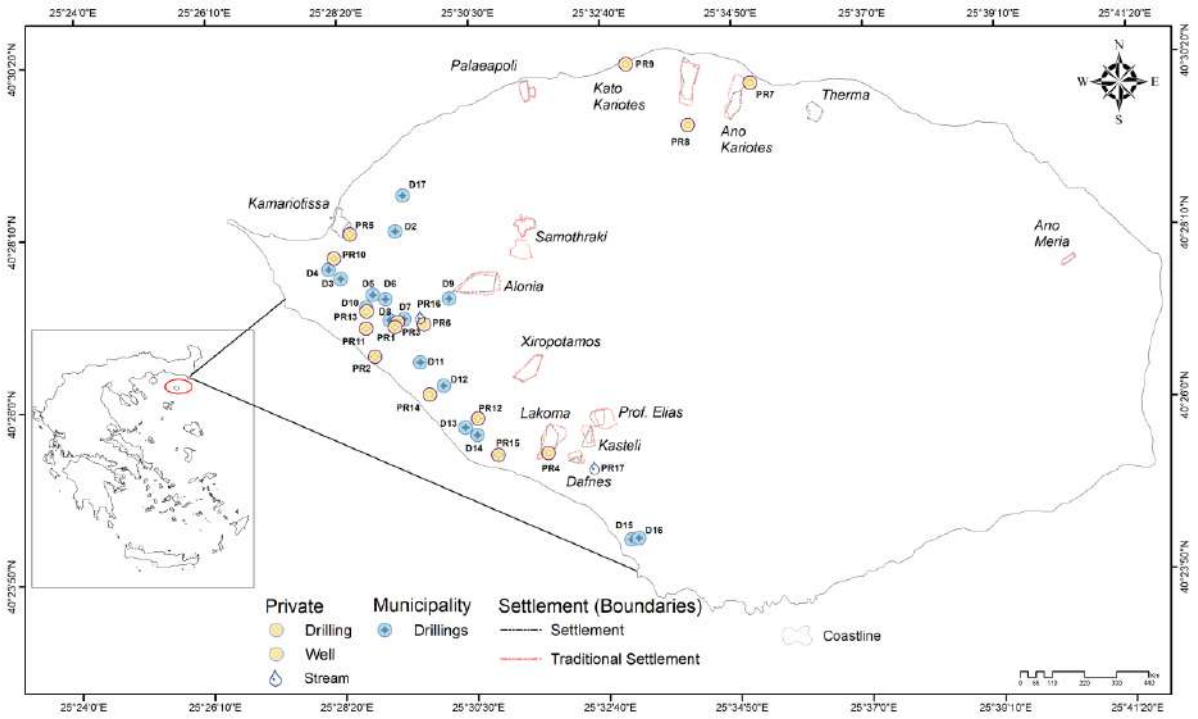


Figure 4.12. Municipal and Individually Licensed Abstraction Points for Irrigation Use. Source (Skoulikidis et al. 2019)

including a tank and flood protection installations requires the moving of 662.000 m³ of soil, filter and stone material in an area of 100.000 m². Water is extracted from the Xiropotamos stream 3km north of the reservoir at a rate of 20% of the stream flow through a 400 mm diameter polyethylene pipe as visible in 4.13 (Source: https://www.gnomionline.gr/limeno-deksameni-samothrakis/, accessed 13.12.2020)

The reservoir is a highly controversial issue. While some are promoting it as a solution to the irrigation demand of the planes below, others, including residents and scientists, criticise it as serving the wrong end of the problem and point to its risks and potential ecological long-term damage. According to Stamatis Zoragis, the Environmental Impact Assessment was made during the initial phase of the project, thus does not take into account relevant recent studies. The reservoir lies within a protected area, and the project does not sufficiently consider effects it might have on biodiversity, land cover and water balance. The project planning furthermore relies on the winter discharge values of Xiropotamos, a stream naturally desiccating in summer. The abstraction puts additional pressure to the stream, which could substantially harm downstream ravine ecosystems (Zogkrais 2020).

4.1.3.2. Historical water infrastructure. Innovative irrigation and drainage technologies developed within ancient civilisations living in the region of modern-day Greece, particularly in the Aegean (De Feo 2013; Valipour et al. 2020). Sophisticated irrigation networks are attributed to Minoan Crete, which pre-Hellenic Samothraki has been in contact (Girella and Pavúk 2019), and Samos, the most probable origin of Greek colonization on Samothraki (Graham 2002), is home to one of the oldest preserved qanat irrigation channels of Greece (Weingartner 2007). The oldest water infrastructure found on Samothraki is the fountain of Nike, the famous winged Victory of Samothrace, dating back

Figure 4.13. Constructions for Xiropotamos Reservoir. Source: https://www.gnomionline.gr/limeno-deksameni-samothrakis, accessed 13.12.2020

to the Early Hellenistic Period (323 - 220 BC). The statue stood in a pool of water, which was channelled through terracotta and clay pipes. Nike's right hand was found in one of these terracotta pipes nearly a century after the main parts of the broken statue had been found (Salviat 1956).

Fast forwarding to modern-day Samothraki, a network of mostly abandoned open channels strikes the eye. Their origins are not documented, but water supply infrastructure of this type has been widely used in the region (Angelakıs et al. 2020). The construction material of the channels was stone and clay originally , but all channels used in the more recent past have been reinforced with concrete. The system comprises of aqueducts, which run along river basins, connecting their headwaters with the lowlands, as at Xiropotamos basin (see figures 4.16 and 4.15). The same applies for some springs in high altitudes, as for example Sotiras. Close to (former) settlements and arable lands, a network of shorter channels provides water to individual users. At channel bifurcations, metal panels can be arranged to direct the flow of water (see figure 4.14).

Today, many of the channels run dry, and those carrying water are often not maintained well enough to provide a reliable infrastructure. Extreme weather events and soil erosion damaged many channels or covered them with debris through landslides. A major censure was the destruction caused by the flood in 2017. In addition, normal natural processes such as sediment transport and falling leaves clog the open channels and weirs, if not cleared regularly. However, some residents and farmers

Figure 4.14. Sluice gate. The position of the panels directs the flow to the lower channel.

still make use of the water supplied through traditional channels, predominantly for irrigation of gardens and small scale cultivations (Interview MP).

4.1.3.3. Individual water supply infrastructure. In addition to above mentioned current municipal and historical communal supply networks, individually owned or operated wells, drillings, spring- and streamwater abstractions contribute to the freshwater supply infrastructure. Farmers install boreholes and dig wells on their own properties, and it is a common practice to abstract stream water through individually laid, km-long PVC pipes. The volume of private water abstraction and the exact abstraction points are unknown due to insufficient documentation or investigation. According to law, private water abstraction must be applied for, licensed, and some information on the water source and use must be provided. However, so far only nine wells, seven drillings and two stream water abstractions have been registered, which does not nearly match the observations and estimations made in this regard (Skoulikidis et al. 2020). For two more licensed abstractions, the exact location and abstraction type are missing. Location of the licensed individual drillings, wells and stream water abstractions can be seen in figure 4.12.

PVC pipes as those visible in figure 4.15 are a major source of irrigation water supply. They are installed individually by water users for irrigation of gardens and small scale cultivation and large scale farming alike. Estimations indicate that only slightly over 10% of the irrigation needs are met through official channels (ie. the use of licensed individual and municipal water supply infrastructure), with the remaining demand assumed to be met through the installation of PVC pipes.

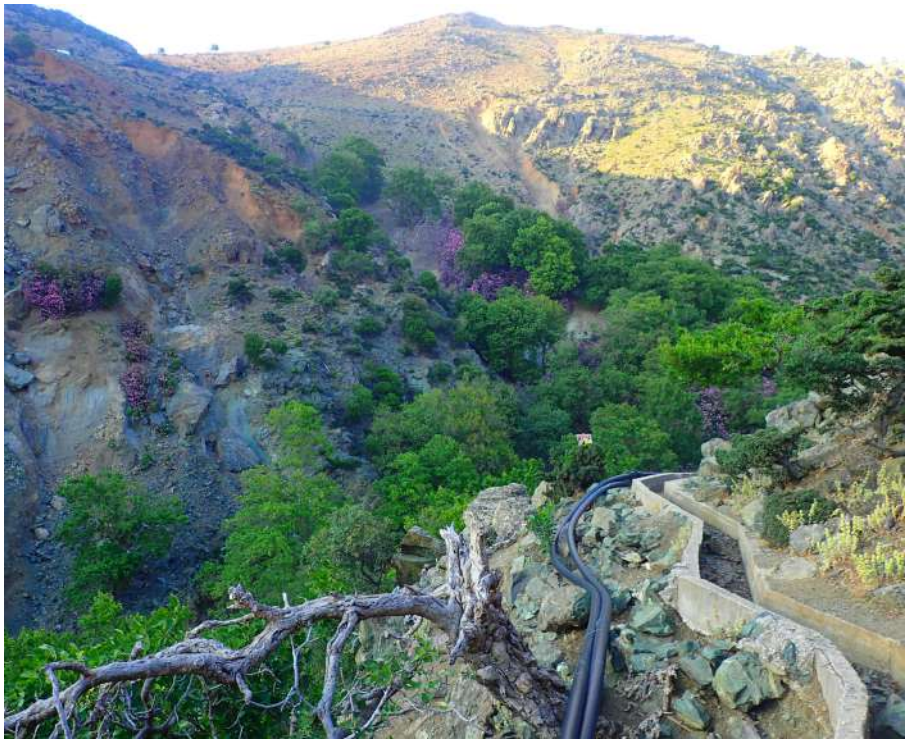


Figure 4.15. Individually Plotted PVC Pipes at an Abandoned Aqueduct, Xiropotamos Basin.

The former mayor Athanasios Vitsas estimated a 30% of all residents using those unofficial channels. The pipes are loosely laid and light, which makes their installation relatively simple. Several pieces are connected to form a pipe long enough to provide water from the desired source. Often, several pipes run next to each other and abstract water from the same point. At some places, cement is used to fix the pipe at the desired abstraction point, and various makeshift filtration systems are in place to prevent rocks and leaves from entering the pipes (Interview MP, also see figure 4.17). The pipes need frequent maintenance such as de-clogging, rearranging, repairing of small damages and replacing. Due to their loose installation, they are easily damaged or put out of place through heavy weather events and free-grazing ruminants. It also occurs frequently that pipes are deliberately removed or made dysfunctional by other water users (Interview MP).

4.1.4. Temporal and Spatial Variability

As precipitation and temperature vary greatly over the year, water resources likewise vary in quantity. The degree of variability changes according to the resource characteristics and time frame applied. Highest precipitation occurs in winter, which in addition with snow-melt results in high stream discharge until spring. In summer period, streams run low and many smaller ones dessicate up to a few kilometres upstream of their outflow. This is phenomenon is visible mostly at streams running through the sedimentary river beds in the western part of the island, such as Xiropotamos, literally, *The Dry River* (Skoulikidis et al. 2020). Due to their shallowness, the SGWS aquifers dis- and recharge quickly following precipitation patterns. The XGWS shows recharge dynamics with a months delay to precipitation events, which is attributed to its larger storage capacity and the extended recharge time through streams and infiltration. On a daily base, Fonias has shown higher nightly discharge,

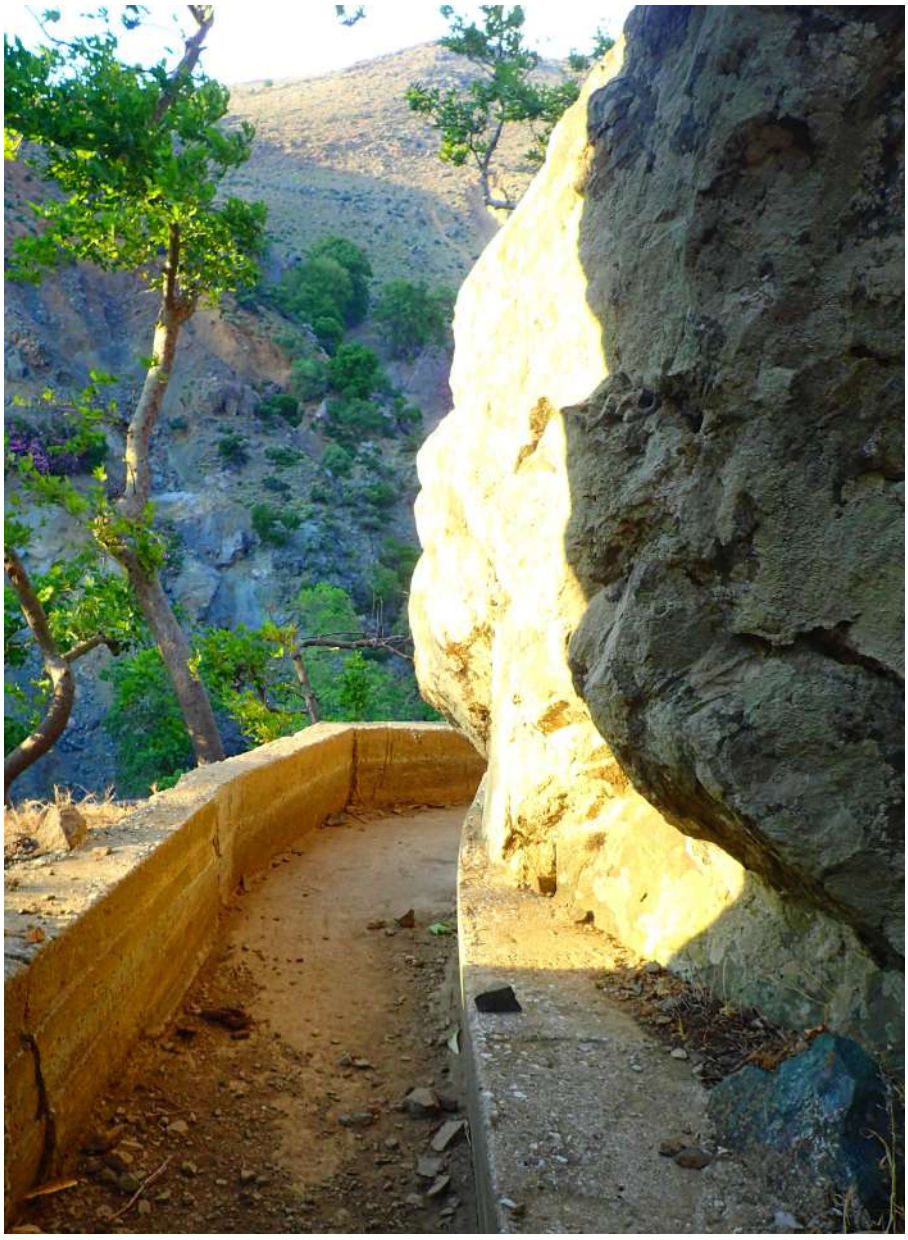


Figure 4.16. Abandoned Aqueduct at Xiropotamos Basin.

Figure 4.17. Improvised Filtration System.

which is likely to be applicable for other streams fed by mountainous springs as well (see 4.1.1.2). Additionally to seasonal and daily variations, exceptionally dry periods occur every couple of years. Skoulikidis et al. 2019 reports dry years in 2006 and 2016, and Pollakowski et al show low regional precipitation in the years 1989, 2000, and 2008 (Pollakowski et al. 2019). In the particularly dry 2006 summer, available water resources decreased to 50% of usual amounts, according to the mayor at that time (Skoulikidis et al. 2019).

In terms of spatial distribution, water resources are very unevenly distributed over the area of the island. The high density of streams in the steep northern flanks of Mt Saos create water rich ecosystems and make water readily available to local residents, while streams are less dense and tend to dessicate in the wide plains of the south (ibid.). In the south and south-west, on the other hand, lie the groundwater systems (see section 4.1.2.3) and the topography of the area allows for larger infrastructure projects, such as the Xiropotamos dam (see section 4.1.3.1) and facilitates the drilling of boreholes.

4.2. Governance System

The governance system describes the sets of rules, regulations and institutions, which determine resource management. These include formalised (eg. state laws) and informal (eg. traditions) rules, the regulations of rule-making (eg. who is involved in the creation of rules) and implementation of agreements (eg. through sanctions, rewarding, exclusion). In her work on institutional analysis, Ostrom differentiates between three levels of rules: Constitutional rules regulate how rules are created,

eg. who is involved in decision making and how rules are created. Collective-choice rules are those made within the arrangement designed by constitutional rules. They actually regulate social and social-ecological interactions, such as resource appropriation quotas, prices, and how non-compliance with rules is dealt with. Operational rules are the decisions put in practice in day-to-day actions within the frame set through collective choice processes (McGinnis 2011). This could for example be someone allocating resource units according to collectively decided upon factors. On all of those levels, formal and informal rules may come into play (Ostrom 2010; Ostrom et al. 1994). In the following I will outline policies, regulations, rules and agreements relevant to water management, starting from a larger frameworks of formal regulations and downscaling to the local context as I continue.

4.2.1. Historical Social, Economic and Political Context

Samothraki experienced dramatic political developments throughout history. Situated at a strategically significant spot in vicinity to Thrace and on the waterway between the Mediterranean and Black Sea, Samothraki resurfaces regularly in historic accounts, ornamented with myths such as Poseidon, Greek god of the seas, watching the battle of troy from it's mountaintop (Lampou 2012). While early trade can be traced back the Minoan culture (Girella and Pavúk 2019), Samothraki got known as a spiritual centre in ancient periods, renown especially for its mystic rituals devoted to the cult of Kaveiria which were eligible to everyone disregardful of class, wealth or nationality, thus including slaves and women (Fischer-Kowalski et al. 2020a; Cartwright 2016). Samothraki gained such importance that ambassadors of other Greek city-states were deployed to "[look] atfer the interest of their city at the site" (Cartwright 2016), continuing to attract "personalities such as Plato, Aristotle, Philipp II of Macedon, the Greek historian Herodotus and the apostle Paul" (Kalamboukidou-Paschali in Schwaiger 2017. The Sanctuary of the Great Gods, the famous statue Nike of Samothrace, as well as a subtle mysticism associated with the island are remainders from this past (Baldini 2012). After switching hands between various Hellenistic rulers, Samothraki was integrated into the Roman empire under which it was given the privileged status of a free city (Cartwright 2016), but declined in significance after the spread of Christianity discredited the ancient cult as "pagan ritual" by the 5th century CE (Schwaiger 2017). Under Byzantine rule, Samothraki was used as a place for exiles, experienced a dramatic decline of population and got ransacked repeatedly by pirates. To escape further attacks, the remaining residents moved inward and established today's capital Chora (ibid.) After a short rule under Genoese nobles named Gattilusi in the 15th century, which had Chora and Paleapoli fortified, Samothraki was conquered by the Ottoman empire in 1456 CE. In 1821, a local insurrection against the Ottoman occupation was answered with a massacre of large parts of the population (Fischer-Kowalski et al. 2020a; Schwaiger 2017), presumably aided by local collaborators (Interview GM). Only a few families survived by seeking refuge in the mountain range (Interviews GM and GK). Others were enslaved and only later returned to the island (Interview GM). The drastic reduction in population and livestock allowed the rehabilitation of pristine woodlands, which had been under stress from extensive pastoralism of the past century (Fischer-Kowalski et al. 2020a). In

the following decades, however, a flourishing charcoal export set off, exploiting the rich soils built by natural processes over a myriad of years. In 1886, a quantity of 1.6 - 2.3 thousand tonnes of charcoal were estimated to be exported per year. In the course, ancient forests were nearly completely destroyed and occasional fires caused by charcoal work accidents had burnt down some olive groves. Population recovered to 3000, and there were as many charcoal producers as farmers or livestock owners (Xenidis 2012). After the Balkan Wards, Samothraki came under Greek rule (Fischer-Kowalski et al. 2020a). Meanwhile, the decline of forests gradually slowed down the charcoal production, until it largely came to an end after World War II (Xenidis 2012). During the military dictatorship 1969-1974, Samothraki once again became a place of exile for political dissidents (Bernhardt et al., 2011 in (Schwaiger 2017)). As mentioned above, in the 1960s large scale emigration of labor-force set off in Samothraki as in other Greek regions, leading to a renewed decline in population, while the island underwent its transition from a mainly agrarian to the modern/industrial metabolic regime of society (Fischer-Kowalski 2020). Samothraki thus has been home to various distinct political, religious and cultural communities and experienced major political upheavals as well as different socio-economic regimes (Fischer-Kowalski et al. 2020a). After the World War II, with the population facing economic and political hardship, emigration to Western Europe set off in mainland Greece starting in the 1950s. The vice-versa movement of affluent Western Europeans to Greece, more easily accessible after the popularisation of cars, initiated mass tourism which soon became a relevant source of income. Although foreign tourists in search for untouched nature eventually discovered Samthraki, it by-passed the development of mass-tourism until today (ibid.). It's economy was largely characterized by subsistence until the 1990s (Fetzel et al. 2018), and at the onset of the transition from agrarian to modern-industrial society in the 1960s, money was no prerequisite to livelihood on Samothraki. The few shop owners then importing goods such as sugar, coffee, rice or fabric, offered them in exchange for local produce, such as charcoal, walnuts, and other agricultural products (Interview NK). A series of modernisations such as electrification and the construction of the first modern port in the 1960s set off the transition from a agrarian to modern-industrial society (Noll et al. 2019). The transition was accompanied by the economy developing from a local towards an import-based economy, the expansion of state services, including schools, health care, legal services and infrastructure, and the beginning of moderate tourism (Fischer-Kowalski 2020). Increasing pressure to participate in market economy as also the opportunity to work abroad set off a labor migration mostly to Germany (Interview NK, Fischer-Kowalski et al. 2011), while Samothraki slowly turned into a modest tourist destination (Fischer-Kowalski 2020). Next to income from abroad and gradually increasing tourist services, the European agricultural policy had a major impact on the socio-economic development of Samothraki: From the 1980s onward, the EU issued subsidies to support livestock farmers' lagging income. The first scheme of subsidies operating in the 1980s combined a per-head payment for livestock with a compensation for remote areas, resulting in growing numbers of small ruminants and pastoralism in many areas of Greece, including Samothraki (Fetzel et al. 2018), where their number rose to triple or quadruple of the estimated carrying capacity - 60,000 - 80,000 vs. 20,000 - with severe consequences for the ecology of the island (Petridis et al. 2017). Overgrazing is identified as the number one ecological pressure, showing severe adverse effects on land cover and erosion

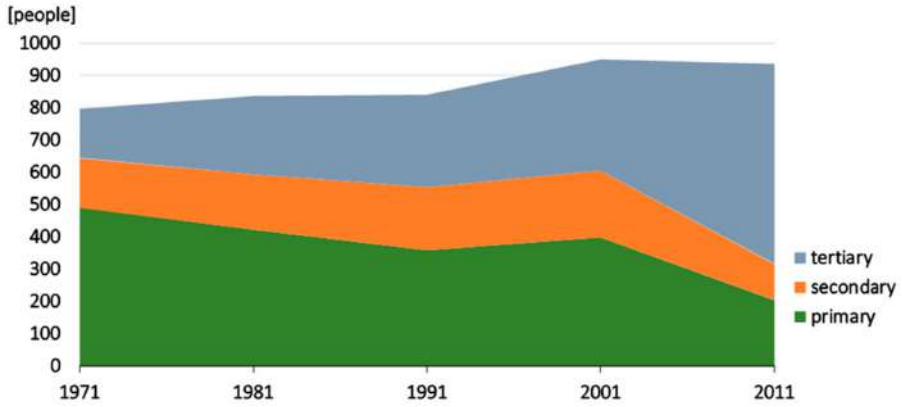


Figure 4.18. Economically Active Population by Sectors 1971–2011. Source: Fischer-Kowalski et al. 2020a

(Fischer-Kowalski et al. 2020a). Although the scheme got reformed and adapted to counteract those consequences, income generated from subsidies peaked at more than 5000,- € per receiver in 2017, and the common believe that up to 30€ of subsidies can be received annually on a per-head basis persists (Fetzel et al. 2018). Tourism and related services in the tertiary sector remained of moderate relevance and increased only gradually until the 2000s, when it replaced primary production as main employment sector within the 10 year period between the 2001 and 2011 census (see figure 4.18), correlating to tourist numbers by now more than doubling residents during high season (Fischer-Kowalski et al. 2011; Schwaiger 2017). The relatively slim secondary sector comprises of small scale production units, many of which are cooperations, such as a brewery, dairy, olive press, other food production and arts/handicrafts (Municipality of Samothraki 2016). The economically inactive population of Samothraki is significantly larger than the economically active one (1,775 to 1,084 in 2011), which is largely due to the age structure of the population (ibid.). Unemployment was 13.59% in 2011 (ibid.).

As in all of Greece, the economy is marked by the aftermath of the 2008 Euro-crisis, leaving Samothraki with significantly less tourists (Schwaiger 2017) and therefore reducing a main income. (Petridis and Fischer-Kowalski 2016; Schwaiger 2017). While of this year's census as well as on the impact of the ongoing pandemic on the economy is not available yet, but the drastic loss of income due to the near-total reduction in tourism in combination with an increasing dependency on tourism related service prefigures yet another long-lasting crisis.

4.2.2. Nested Resource Policies

Due to the relevance of the EU water management policy for the regional level of the member states, the following section sketches out the main pillars of the EU WFD as well as the Greek implementation thereof.

4.2.2.1. The European Water Framework Directive. On the European Level, the Water Framework Directive (WFD) is the fundamental pillar of water-related policy regulation. Following pressure from

the European Parliament to change its regulatory approach focussed on quality parameters, in the mid-90s the European Commission (EC) involved other political bodies and a variety of stakeholders in a consultation process on European water policy (European Commission and Directorate-General for the Environment 2003). As an outcome, the WFD presents an integrated approach to water governance which combines streamlining of legislation with decentralized governance, quality standards, ecological aims and economic needs while strongly promoting citizen participation. The directive entered into force in 2000 with the aim of reaching a good status of all European water bodies within 15 years. Member states committed to adopt certain national and regional governance tools in accordance with this goal, among which the most crucial one is the designation of river basins (RB) as the basic unit of governance, thus prioritizing hydrological boundaries to political ones, which is a crucial cornerstone of the WFD's conceptual restructuring. Another relevant aspect is the principle of cost recovery, which requires member states to develop a water pricing policy which covers environmental and resource costs, with the goal of providing "adequate incentives for users to use water resources efficiently" and holding various economic sectors accountable to the recovery cost of water services, including natural processes (ibid.). Furthermore, citizen participation and public consultation should be integrated in the national WFD adoption processes at all levels. The EC required members states to define the RB within three years of the WFD's implementation and develop strategic River Basin Management Plans (RBMP), which are to be revised every six years, until 2009. This process, however, has been delayed in different member states, including Greece. In general, WFD is challenging not only in regards to its ambitious goal, but also in adapting the specificities of each country's institutional framework to the requirements of the legislation. (Maia 2017; Zingraff-Hamed et al. 2020).

The Greek implementation of the WFD had a slow take-off, attributed in parts to the severe impact of the financial crisis following 2008 and a national restructuring and decentralization process, which started in 2010 and needed a re-clarification of responsibilities and competences (Podimata and Yannopoulos 2011). National law was harmonized with the WFD through 2000/60 Law 31199/2003 (Government Gazette 280 A / 09.12.2003) and Presidental Decree 51/2007 (Government Gazette 54 / A / 08.03.2007) (Source: http://wfdver.ypeka.gr/, accessed 13.12.2020). Greece defined 14, River Basin Districts (RBD) and crafted RBMP in 2010, which were assessed by the commission during the first assessment cycle (2009-2015). Second round RBMPs were adopted by the EC in 2017, but are not yet included in assessment, as they have not been reported on time (Kagalou and Latinopoulos 2020; EC 2019). Today, Greek environmental policy is largely in accordance with EU directives, while the lack of implementation is the "Achilles heel" of its effectiveness (Kagalou and Latinopoulos 2020). Problems with implementation are connected to centralized and hierarchical administration, missing systems thinking, lack of resources and expertize and the inexperience of both public and governing bodies in participatory processes (Kanakoudis and Tsitsifli 2014; Demetropoulou et al. 2010; Zingraff-Hamed et al. 2020).

4.2.2.2. Fragmented competencies of Greek polity. On the Greek national level, water protection was defined as a responsibility of the Greek state as early as in the 1911 constitution. Relevant regulations were maintained with minor modifications throughout the 1975/1986/2001/2008 constitutions (Farmaki and Tranoulidis 2018). Water governance was strongly associated with the central state power until a process of decentralisation in the 1980s and 1990s passed responsibilities and authority regarding water management to regional and local administrations. The transformation challenged the hyper-centralised Greek state administration and left behind a fractured, multi-level water governance with a high number of different competences and responsible bodies (Podimata and Yannopoulos 2011). After the 2008 Eurozone crisis, Greek parliament passed a law in 2010 which drastically reduced the number of local administration entities, while delegating more competences and power to the first and second triers of local governance, ie to municipalities and regional authorities. This general decentralisation process named *Kallikrates Reform* was intended to generate fiscal savings through the application of the economies of scale concept. It was at the time seen also as an opportunity to strengthen local and public involvement in questions of development, environmental issues and sustainable resource management through a bottom-up process (ibid.) However, the restructuring processes of Greek administration and governance created lack or ambiguity of competence in some areas. Regulations are not yet harmonized on supra-national, national and sub-national scales, causing delays as experienced with the application for a UNESCO Man and Biosphere Reserve on Samothraki (Fischer-Kowalski et al. 2020a). In accordance with the adaption of the WFD, various bodies were created to facilitate the implementation procedure. The National Water Commission is a inter-ministerial body responsible for policy-making on the national level. It determined the river basin districts and competent authorities and reports regularly to the National Water Council on the progress of Greek compliance with EU legislation in water governance. The National Water Council includes representatives of parties and organizations and the president of the Minister of Environment, Energy and Climate Change. Its role is to consult the Water Commission and conduct public consultations. Furthermore, a Special Secretariat for Water was created within the Ministry of the Environment and Energy to coordinate regional water management with the national level. It is responsible for the development and implementation of the RBMPs in collaboration with regional water authorities (Podimata and Yannopoulos 2011) [9].

Due to the new architecture of the Kallikratsi reform, responsibilities of water governance are split between central governance bodies and regional authorities. The former is charged with the formulation of policy and general management, while the local bodies are responsible for implementation of policy and strategic planning. In terms of Greece's political-organisational structure, River Basin District (RBD)s lie at the intersection of regional authorities and decentralized administrations. Seven state appointed Decentralized Administrations which are financially autonomous perform delegated/devolved state power in general governance issues, including the environment, and supervise the lower tiers. Lowest regional governance unit (first tier) are the municipalities, which form regional units and add up to 13 administrative regions (second trier). Both municipalities and administrative

[9] see also http://wfdver.ypeka.gr/en/, accessed 13.12.2020

regions are voted for through direct election (popular vote). The lower tier units exert a degree of self-governance, with the responsibility for regional planning and policy-making in accordance with national and European politics. Due to their orientation on river basins instead of political units, RBDs might intersect with various of those regional units and layers.

Samothraki is included in the RBD of Thrace, which coincides with the eastern part of the administrative region of Eastern Macedonia and Thrace. The RBD Thrace comprises of the regional units of Evros (which Samothraki belongs too), Rhodopes, Thassos and Xanthi, as well as 47.3% of the regional unit Drama and 36.2% of Kavala. It covers an total area of 11,234 km², including the Greek parts of the Evros and Nestos and the complete Filiouris and Xiroremata river basins. According to the RBMP of 2017, 14 Water Departments and 45 catchments have been identified within the RBD Thrace. The who islands Thassos and Samothraki are subsumed as one river basin, and three streams are included in the RBMP's evaluation of the rivers' condition. Two out of three are considered of 'good' ecological status and one (Fonias) of 'medium'. All three are considered of 'good' chemical status[10]. A note is made on potential risks for groundwater resources and the need for groundwater monitoring on Samothraki. Otherwise, the RBMP pays very little attention to Samothraki, and there are no suggested measures specified for the island(Fischer-Kowalski et al. 2020b).

4.2.3. Local Government Organisations

Municipal authorities are obliged to exercise their powers taking into account related national, regional and European policies. Their responsibility is, in coordination with other local or public authorities, to guarantee the availability of resources and their beneficial, efficient use and equitable distribution, adequate, qualified and efficient services in order to better serve residents, high quality environmental protection, protection of cultural heritage and the promotion of sustainable development of these areas (Europe 2012).

On Samothraki, the municipality with seat in Chora is responsible for all water related planning and water management. Whereas water services of larger cities are handled by delegated public companies, Samothraki as a municipality with less than 10.000 inhabitants is managed directly through the municipal administration (EurEau 2018). This means that the responsibility for provision of the inhabitants with domestic and irrigation water supply and sewerage lies with the municipality. The municipal administration consists of a number of collaborating organisational units, of which the Operational Services Unit (unit 2) and the Supporting Services Unit (unit 6) are tasked with different aspects of water management. Unit 2 is responsible for documentation of demographic, social and geographic data, planning and design of programs, conducting feasibility studies, and monitoring in the fields of economic and social development Implementation of planning objectives lies within the responsibility of the Supporting Services Unit. Within this unit, the Department of Technical Services and Quality of Life conducts all municipal technical works and collaborates with unit two in

[10]Source: http://wfdver.ypeka.gr/en/, accessed 13.12.2020

the design and implementation of related action programs. It is structured in sub-offices, of which the Water-Sewerage Office is tasked with the maintenance and expansion of water supply and sewerage infrastructure. The Office of Environment, Cleanliness, Green Areas and Civil Protection plans and proposes environmental programs, including those for the protection and management of water resources, mitigation of pollution, and monitors the implementation of protected areas in collaboration with other authorities (Fischer-Kowalski et al. 2020b). In accordance with the competences appointed to the local authorities through above mentioned decentralisation processes, the municipality of Samothraki crafted a local spacial plan, the Operational Programme (OP). With the ambitious aim of providing a strong positive vision of and proactively shaping the island's future amidst economic, demographic, and social constraints, it provides an extensive documentation of current issues and objectives in the social, economic and natural development of Samothraki. Regarding water resources and infrastructure, it promotes a rationalised and integrated water resources management. This includes the extension, repair and partial replacement of the current supply and sewerage network, the closing of monitoring gaps (through licencing of water abstraction and installation of missing hydrometers), reuptake of chlorination to guarantee water quality, clarification of ownership statuses, the establishment of artificial water reservoirs for irrigation, combat of illegal water abstractions, the establishment of or integration with protected areas, flood protection, and reduction of the soil erosion (Municipality of Samothraki 2016). As concrete projects, the OP names the continuation with the installation of sewage drains for the settlements of Kamariotissa, Chora, Therma, the Platia (municipal) camping, Profitis Elias and Lakoma. It also points out to the problem, that the Water and Sewage Office is currently staffed with two engineers, which is not sufficient to meet the service needs. Other resources like appropriate vehicles are missing as well.

4.2.4. Property Rights Regime

Much of Samothraki's land is under controversial ownership status. The ambiguity partly originates from the various influences Samothraki was exposed to over time (see seciton 4.2.1), including their respective land ownership regimes. Frequent changes in population contributed to the phenomenon as well, allowing those remaining on the island during a population decline to reconfigure ownership arrangements. This was the case for former residents returning to Samothraki after several years abroad to find their family's property being used and often also claimed by others in the meantime (Interview NK).

Before the transition to a modern/industrial society, a feudal landownership regime was in place. Most families only owned small plots of land, insufficient to cover their needs, and worked the fields of a land-owning upper class. These relationships only changed when the large-scale labor emigration in the 60s caused land prices to drop, while providing former land workers with the money necessary for land acquisition (Interview GK).

The traditional unit of privately owned lands is Kefalomandri, κεφάλι - μαντρί in Greek, indicating a plot 'big enough to serve the needs of 100 free-grazing ruminants' [11], which is about 30 - 60 ha in size depending on the geomorphology of the land [12]. According to the former mayor, the unit is in use until today, especially in the north 11. The phenomenon of unclear or ambiguous ownership of lands is much greater in the agricultural southern part of the island, where plots may be claimed by various livestock owners and farmers based on usage or maintenance thereof. Although co-ownership arrangements with the formal owners emerged in some cases, land ownership is by and large referred to as a cause of conflict and chaos. This even manifests in local humour: "If you want to find out whose property you are standing on", goes one joke, "build a fence. Many people will come and argue, but the one person outlasting all the others is the actual owner" (Interview GK). In the context of an ongoing cadastral process attempting to clarify the issue, however, all land which is not proven to be private, is declared public (Municipality of Samothraki 2016). Additionally, the rate of second home owners is increasing, as more and more property is sold to mainland Greek and European tourists (Fischer-Kowalski et al. 2020a; Municipality of Samothraki 2016). Consequently, much land and property is deserted during off-season periods.

4.2.4.1. Areas of nature conservation. Most of Samothraki's area is included in the Natura2000 network of protected areas for species habitat and breeding places conservation (see figure 4.19). Efforts are made to implement a further scheme and broaden the perspective of ecological conservation to social, cultural and economic activities. Even through the conservation areas do not comprise a property regime in themselves and do not change existing property regimes, they do offer a potential framework for resource management regulations based on area, which is why they are included in this section.

The Natura 2000 network was established to promote biodiversity through the protection of species and habitats. Natura 2000 zones foresee human use of the protected ecosystems to an extend which does not harm natural habitats and biodiversity. On Samothraki, Natura 2000 sites include various marine, coastal, terrestrial and riparian habitats, such as reefs, ancient oak and oriental plane forests, and numerous designated wildlife species of importance [13]. Knowledge exchange, organisational support and funding on research, management and development of the sites is available through the European Natura 2000 network (Kettunen et al. 2014). However, delays in Greek national administration resulted in the zone not yet being institutionalized. On a local level, management of the sites is missing. The municipality suggests a managerial body to be formed and assigned the task of developing a management plan for the protected area in order to realise its goals (Municipality of Samothraki 2016).

[11] Source: https://tangelonias.blogspot.com/2012/02/blog-post.html, accessed 31.12.2020

[12] A kefalomandri in a mountainous region with steep slope would have to be larger in size to sustain the same amount of ruminants than in the flat lands

[13] See also Samothraki's Natura2000 Factsheet, https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=GR1110004#6 (accessed 13.12.2020)

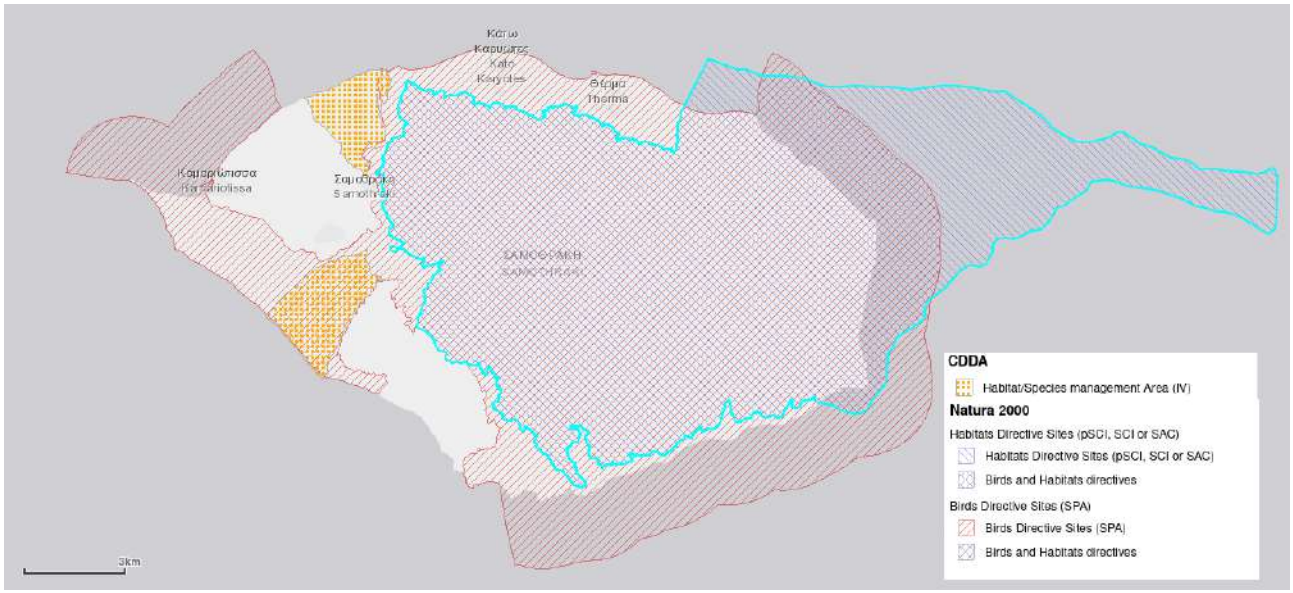


Figure 4.19. Designated Natura 2000 sites of Samothraki. Source: https://natura2000.eea.europa.eu/, accessed 13.12.2020

The existence of further *protection zones* around water abstraction points which serve domestic water supply is necessary for the protection of public health and foreseen by law. However, such zones are missing in Samothraki. In accordance with national legislation (laws 1650/86, 3199/03 and Ministerial Decision 51/2007) and also in accordance the requirements of the RBMP, protection zones could be implemented on Samothraki. Skoulikidis et al. 2019suggest fencing in order to protect them from free grazing ruminants and human activities, the use of septic tanks by individual households in the vicinity of these zones and a ban on agrochemical use for agricultural areas nearby.

In recent years, great efforts have been made by the municipality and researchers affiliated with Sustainable Samothraki, especially the Vienna Institute of Social Ecology, for the transformation of Samothraki to a UNESCO MAB. The purpose of MAB reserves is to combine the conservation of ecosystems with the sustainable use of ecosystem services. Within the MAB frame, social, cultural and economic activities are an integrated part of the reserve, so that traditional and new local sustainable practices are promoted under its framework. The application of Samothraki as a MAB was unanimously decided by the municipal council in 2011, but not accepted by UNESCO due to the missing Natura 2000 institutionalisation. With the civic-science cooperation continuously working towards the implementation of the MAB, however, its framework could soon be applied.

4.2.5. Rules-in-Use

Collective institutions of water use outside of municipal regulations are documented until recently, such as the small-scale, collective maintenance of channels which occurred around Chora until the great flood of 2017 destroyed much infrastructure (Interview MP) or a similarly small-scale collective scheme for allocating irrigation water to gardens at Kato Kariotes (Interview NK). However, I did not encounter any such arrangements during my research, nor did any of the informants know of collective action institutions. The remarkable high amount of unregistered abstractions is not governed by

collective choice, and are therefore covered as a cumulation of individual choice in section 4.4.1. Thus in the following section, the three levels of rules-in-use - constitutional, collective and operational - refer to municipal regulations.

4.2.5.1. Operational choice rules. As outlined in section 5, water was formerly managed through collectively deliberated and agreed upon informal rules and implemented through numerous operators. Operational choice rules, the "implementation of practical decisions by those individuals who have been authorized (or allowed) to take these actions as a consequence of collective choice processes" (McGinnis 2011), were relevant under such conditions, as the operators were entrusted with the power to chose from a range of available options, largely influencing the outcome (Binder et al. 2013). The municipal administration is officially responsible to carry out water management according to the rules set by the Municipal Council, national Greek law and the EU WFD. With automatized monitoring, low-maintenance water supply infrastructure and clearly set rules on water allocation and prices, operational rules play less of a role than formerly - in theory, at least. As described in section 4.2.3, two engineers employed by the municipality carry the responsibility of keeping the municipal water infrastructure functional on a daily basis. A task impossible to perform, given the desolate state of large parts of the infrastructure, and the urgent need for general reconditioning (see section 4.1.3.1). The workers thus have to chose priorities on a daily basis. Unfortunately, very little information could be obtained regarding their everyday working mode. Skoulikidis et al. 2019 describes the general water management, including the day-to-day operation, "ad-hoc", and one of the workers confirmed that fast and short-term solutions predominate their work (Nikos Koutsouris, personal communication, June 2019). The nature of water management choices on this level seems to stem from limited resources in terms of tools, labour force, and finances as well as a lack of strategic planning and long-term investments (Municipality of Samothraki 2016; Skoulikidis et al. 2019).

In contrast to the formal requirement of sanctioning, municipal administrations seldom check for unregistered water abstractions and hand out fines. Controls were announced by the municipality one to two times per year, sometimes in relation to water scarcity [14]. According to Marina Fischer-Kowalski, municipal administration workers and water users are too closely linked to each other to use sanctions as effective means pressure, as interpersonal ties govern decisions more than the rule of law does (Interview GK and Marina Fischer-Kowalski, personal communication November 2020). A municipal discussion on the 2014 water regulation seemed to go stalemate on the question of whether fees and fines on water (mis)use were legitimate in face of the quality of service provided. The inability of the municipality to guarantee a satisfying quality of water provision and maintenance, some argue, delegitimizes the use of sanctions against water users who find and implement a solution to the problem themselves (Municipal Council of Samothraki 2014). Judging by the Council's discussion as well as regular announcements issued by the Municipality14, it also seems to be common practice that water bills are not paid on time and deadlines to clear debts are prolonged repeatedly by the municipality.

[14]Source: https://samothraki.gr/, accessed 31.12.2020

4.2.5.2. Collective choice rules. As the executive power of the smallest unit nested within a representative democracy, the Municipal Council is empowered by its electorate to set local rules in accordance with the higher structures, ie. national Greek law and European legislature. Collective-choice rules in this context are perhaps best characterized as Municipal-Council rules. The Water Regulation, decided upon the Municipal Council in 2014, is a collection of the basic set of rules, various specifications or amendments were added through administrative processes and Council decisions over time. The Water Regulation identifies the duties and rights of the Municipality and water users, respectively. According to the regulation, the municipality is responsible for provision, maintenance, replacement and expansion of the water network "under consideration of the needs and available financial means". The regulation also defines priorities in the use of water, ranking domestic supply, including shops, as highest, followed by watering of livestock, industrial, manufacturing and tourist facilities, to the watering of gardens (Municipal Council of Samothraki 2014). Water users are not expected to actively participate in water provision or infrastructure maintenance. When applying for a (re-)connection to the municipal water services, users are obliged to provide their name and address, state the intended purpose of water use and pay a one-time installation fee (domestic supply includes all types of economic and private water use except large scale irrigation). The municipality installs a hydrometer at each connection to documents the amount of water used. Following the installation, users are obliged to pay the prices of water abstraction as determined in the Water Regulation (ibid., see section below) to the municipality, maintain the meter's intended use and report any abnormalities in supply or damage of infrastructure (ibid.). Water abstraction through any means other than the municipal infrastructure must be documented and licenced. The licencing process includes disclosure of the location of water abstraction, type (drilling, surface water abstraction), rough amount and purpose of water use. Privately owned and individually operated drillings are common, if also to a much lesser extend than surface water abstraction through PVC pipes (Skoulikidis et al. 2019). Detailed information on the quantity of water abstracted privately for any use other than agricultural irrigation could not be obtained, however. Agricultural water users can either use the municipality's drillings or register their own abstraction points. In the first case, they are obliged to purchase an electronic card in order to use the municipal boreholes. In the latter, farmers are obliged to undergo the same licencing process as for domestic water use. According to the regulation, water supply fees should to cover the costs of administration, maintenance and operation of the municipal water supply network as well as the depreciation costs of the invested funds. The water prices are made up one-time service fees and consumption rates, which are clustered according to user groups and increase incrementally with the quantity used. The prices for water consumption via the municipal pipe network are:

For domestic and economic service related use (houses, shops, workshop, accommodation):
€ 0.20 per m³ for a consumption from 0-40 m³
€ 0.36 per m³ for a consumption from 41-80 m³
€ 0.55 per m³ for a consumption of 81 m³ and more

For irrigation of plots, gardes, industrial and livestock use:
€ 0.20 per m³ for a consumption from 0-30 m³
€ 0.36 per m³ for a consumption from 31-60 m³
€ 0.55 per m³ for a consumption of 61 m³ and more

Furthermore, the following one-time fees apply regardless of use:
€ 250 for the first connection to the supply network
€ 125 for a reconnection to the supply network
€ 15 annual service fee

And the following fines:
€ 500 for the illegal abstraction of water (undefined whether this concerns unregistered connections to the municipal water supply infrastructure, manipulation of the water meter or unregistered surface water abstraction)

The regulation was implemented in 2015, but new rates are currently discussed due to extended economical stress (source: https://samothraki.gr) Prices for irrigation water abstraction have recently been adapted and are defined as follows:

€ 2.10 per kilowatt hour of abstraction, with the exception of the Alonoudia drilling
€ 1.70 per kilowatt hour of abstraction at the Alonoudia drilling
€ 25.00 as a yearly flat rate charge for use of the Alonia drilling
€ 25.00 costs of the electric card which is used to document the hours of water abstractions

According to the Economic Committee's calculations based on the number of farmers using municipal irrigation infrastructure and the hours of abstractions, revenues from above fees sum up to € 9,125.00 per year, nearly covering the expected expenses of € 10,940.00. The difference will be covered by the Municipality through re-allocation of extraordinary budget (Municipal Council of Samothraki 2021). The Council thus decided to subsidy the use of irrigation water with € 1,815.00 in consideration of the economic difficulties and complaints on irrigation water pricing (ibid.). As stated above, it is the water users' obligation to pay the respective fees and the municipality's right to make fine users in case of non-compliance to the regulation. However, sanctions are rarely implemented.

4.2.5.3. Constitutional choice rules. Constitutional choice rules are "the highest level of the rule hierarchy, determining who will take part in collective choice decision-making processes" (Ostrom et al. 1994; Rahman et al. 2017). On Samothraki, it is the Municipal Council who decides on water

related regulation. Rules regarding the constitution of the council are set by the electoral law of the Third Hellenic Republic, which in turn relies on the state constitution, legislature, and draws on the concepts of citizenship, state power and representative democracy more generally, the discussion of which exceeds the scope of this work. Nevertheless, Greek national law determines the election periods, regulates who is eligible for election and defines the boundaries of the electorate. There is no formal power to change these constitutional rules at the municipal level of governance. The municipal administrations of Greece are elected for every five years on the same occasion as the European Parliament elections. The electorate constitutes of citizens older than 18 years. On Samothraki, 3,993 eligible voters were registered for 2019 (including diaspora, see Fischer-Kowalski et al. 2020a), of which 48% or 1,954 participated in the last election. The administration of a municipality consists of the mayor and the municipal council, the members of which are, like the mayor, elected via popular vote, with 3/5 of the seats allocated to the party winning majority and 2/5 distributed to the other parties proportionally to their election results (Europe 2012). Council members form committees, such as the executive, economic, and quality of life committee. Additionally, deputy mayors are appointed by the mayor to head the committees and assist or consult the mayor in various issues. The number of municipal council members and deputy mayors depends on the size of the electorate (ibid.). Samothraki has 17 council members, of which, other than the Mayor Nikolaos Galatoumos, five are members of his party Ενωτικό Κίνημα Σαμοθράκης (Unity Movement of Samothraki), seven, including the former mayor, members of Δημοτική Ενωτική Συνεργασία Σαμοθράκης (Municipal Cooperation of Unions Samothraki) and four members of the relatively new party Σαμοθράκη 2020 (Samothraki 2020) (https://samothraki.gr/2011-04-02-07-24-10/ accessed 13.12.2020).

Apart from the act of election, participative elements on the municipal level are foreseen (but not required) by Greek law (ibid.). For example, the municipal administrations may additionally call for citizen assemblies and local referendums. Also, communities of more than 300 inhabitants may be represented by community presidents who consult and inform the municipal administration on local matters (ibid.). The implementation of these measures is recommended, but remains voluntary, and thus depends on the willingness of local administrations and/or the community's vigour in claiming their right to participate. According to my research, none of the above possibilities have been used so far on Samothraki. Apart of running for and working as mayor or municipal council member, direct political participation of citizens therefore seems to be limited to the act of voting. A trend all over Greece, growing focus is put on citizen consultation and stronger communication through e-governance on Samothraki as well(Municipality of Samothraki 2016). Social media platforms are vividly used by the municipality, political parties and citizens alike to express opinions and promote or criticise specific agendas. A just as relevant, but more mediate and long-term way of shaping the political agenda and the degree of citizen participation therein are various non-governmental initiatives working on aspects of the political, economic and social organisation of Samothraki, as presented in section 4.3.5.6. Such informal channels may increase the diversity of opinions, perspectives and policy suggestions taken into account. But they do not provide the political power of exercising decision making, let alone the changing of constitutional rules.

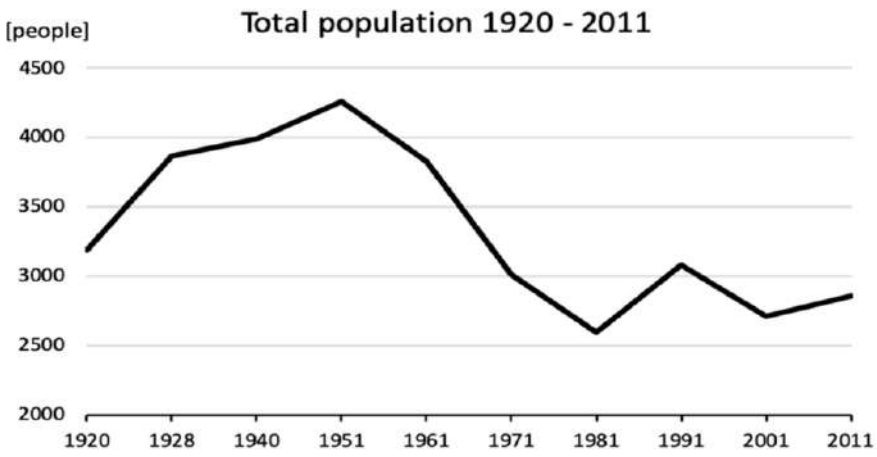


Figure 4.20. Population of Samothraki 1920-2011. Source: Fischer-Kowalski et al. 2020a

4.3. Actors

In this section, I provide information on the societal background of relevant actors and characterize the relevance different social and professional groups have in terms of water governance.

4.3.1. Demographic Background

Samothraki has a total population of 2,859 at the last census in 2011. The population declined drastically from a peak of 4,258 residents in 1951 to , mainly due to above mentioned labour migration (Xenidis 2012; Fischer-Kowalski et al. 2020a), and the current administration is concerned about a further decrease in resident numbers (Municipality of Samothraki 2016). There is a small but growing portion of non-permanent residents, registered mainly in Chora and Kamariotissa (ibid.), consisting of Samothracian and foreign second home owners (Interview NK, ibid.). The population is ageing, with the ratio of population older than 65 years to population younger than 15 being 1.55, compared to 0.91 for all of Greece. In 2011, the most represented age groups were 15 - 29 years, followed by 60 - 74 and 30 - 44 years (see table 4.21), thus people in their mid-twenties and thirties likely constitute the largest age group today. For 100 person in the productive age of 16-64, there were 47.2 persons younger or older (dependency ratio of 47.2), and the rate of replacement of persons leaving productive age by persons entering productive age was 80%. The development intensified recently, but is not new, as the decrease in primary school children of 43.4% since 1981 shows. The most dramatic drop however occurred from 2001 - 2011 (- 34.8%) (ibid.). Gender distribution differs by 6.5% percent from an equal distribution, with only 43.5% female as compared to 56.5% male residents (ibid.).

The two main factors shaping Samothraki's society have already been laid out in previous sections: Insularity, the awareness of relative isolation, remoteness and the precarious uniqueness of being an island community and the resulting development of distinctive coping strategies, societal traits

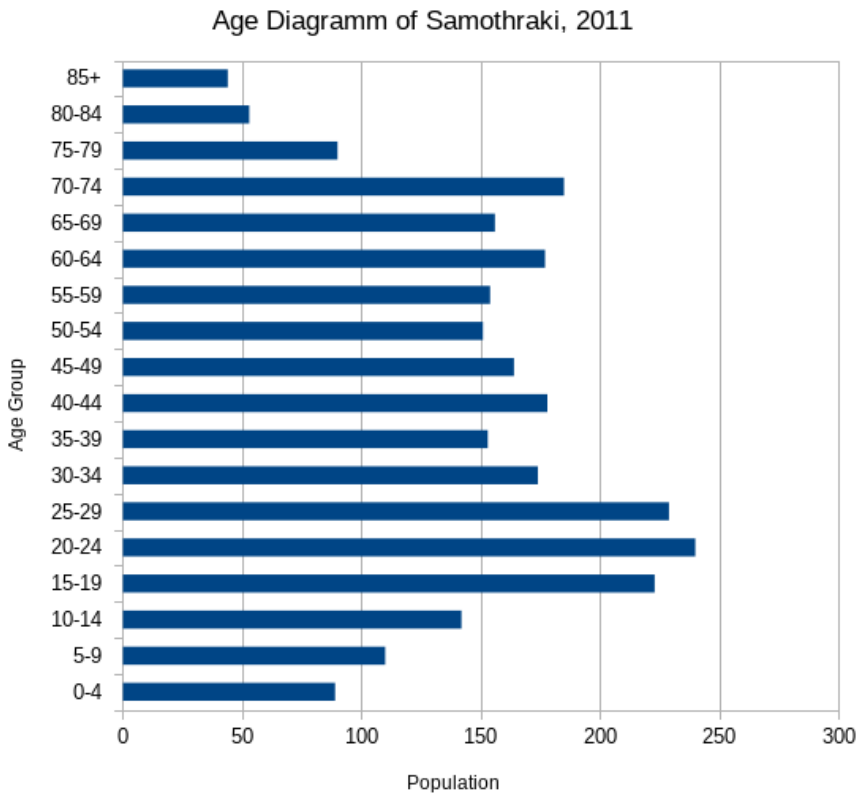


Figure 4.21. Age Diagram of Samothraki. Data Source: (Municipality of Samothraki 2016)

and culture (see section 2.1.3), of course is relevant on different levels. Another major role plays the socio-metabolic transition from an agrarian to a modern-industrial society which Samothraki is going through (see section 4.2.1), the further path of which is not yet settled. As both of them combine, sometimes at odds with each other, a wide range of fractures, niches, surviving original and altered forms of previous institutions occur, which create new syntheses and allow for innovative developments. In the following, I aim to sketch out the background of Samothraki's society and differentiate into groups of actors with regard to their function within or relation to the water supply SES.

4.3.2. Geographic and Cultural Differences

The diversity in landscapes on Samothraki has been used for a range of activities and needs - ranging from ritual sites aligned with topographic landmarks, the cultivation gardens in the water-rich north, finding shelter in the protected, bay-like rock formation around Chora, up to seeking protection from the Ottoman persecutors by hiding in the mountains for several days. Arguably, the different requirements and opportunities of life in the arid plains of the south as opposed to the water-rich foothills of Mt Saos in the north brought about distinctive cultures and life styles. The cultural north-south divide intensified however with the changing conditions accompanying the island's transition to a modern-industrial society: With the development of tourism, villages in the north gained importance due to their vicinity to archaeological sites, refreshing pools, stunning waterfalls and tourism-related

infrastructure (Interview GK) Especially Kamariotissa, formerly a small fishers' town, increased significantly since the construction of a port and the establishment of a regularly operating ferry line. It now hosts most services and relevant business (supermarkets, pharmacy, post and police office), while smaller villages nearby tourist attractions increasingly feature Tavernas, guest houses, convenience stores and street vendors. Meanwhile in the south, agriculture continues to persist, with olive groves and livestock dominating the scenery. The residents of the smaller southern village are mostly involved in farming or livestock keeping (Municipality of Samothraki 2016) and apart from visits to Kamariotissa for administrative or economic purposes do not cross paths with tourists much (Interview GK).

While the specific development pathways of the north and south of Samothraki produced different socio-economic realities, increasing mobility and fluid job boundaries reduce the significance of location. Today, many farmers live in towns of choice and commute to their fields, and the large majority has at least one side job (Personal communication with Giorgos M., November 2020) Conceptually, the idea of a north-south divide is very strong, however, and corresponds to an axis of two different mentalities: An open-minded, modern, more cosmopolitan mind-set on the one hand and a more conservative, sceptical and phlegmatic one on the other hand. The former is usually attributed to younger residents or neo-locals, often with higher educational background, working in the service sector and living in the larger villages or northern countryside, and the latter to middle-aged, long established men living in the south and mainly occupied with livestock keeping, herding or farming (Petridis et al. 2013; Petridis and Fischer-Kowalski 2016; Rümmele et al. 2020). While the former is associated with openness to to change, cooperation and innovation, the latter represents the continuity of an agrarian mindset. Studies on locals perceptions repeatedly confirm residents of the former cluster to share interest in natural conservation, sustainable life-styles, and moderate tourism development as well as "the believe that they could individually and collectively benefit from such a scenario"(Petridis and Fischer-Kowalski 2016)[15]. The afore mentioned concept of 'neo-local' is also relevant in this context: Neo-local is the slightly ironic self-reference of residents who moved to the island as outsiders *and* of Samothrakians who return after having spend a considerable amount of time 'abroad', be it to study on the mainland or because their family left the island to work abroad when they were young. In any case, the newcomers and returners are not granted 'full' local status by the 'dyed-in-the-wool' local population, a social act manifest in every day live (Rümmele et al. 2020). However, in the presence of true outsiders, ie. foreigners or Greek mainlanders, the differentiation between locals and neo-locals melts away. The protests against the construction of wind-farms seems to be an example of such unity (Vlami et al. 2020). The UNESCO MAB project on the other hand has been welcomed and supported by locals of the first cluster while it has been eyed with some scepticism by the second type of locals (Fischer-Kowalski et al. 2011). The same holds true for production cooperatives (Interview GK, also Rümmele et al. 2020).

[15] See also Fischer-Kowalski et al. 2011; Petridis et al. 2013; Rümmele et al. 2020; Vlami et al. 2020

4.3.3. Cooperation and Conflict

Samothraki's background is that of an agrarian society. Agrarian societies are marked by a strongly hierarchical social organization centred around the family. Regaring labor, there is little functional differentiation, necessity and social ties determine someone's tasks more than professional qualification (Fischer-Kowalski et al. 2020a). Samothraki was close to self-subsistence as an island and through the intensive use of μπαχτσές, small agricultural plots/gardens/orchards, most families could sustain themselves. Undernutrition was common, however (Petridis and Huber 2017), and the island could be considered 'poor' according to general standards (Baierl 2019). All this has implications in the patterns of thought, worldviews, and mental models present in the society until today, subsumed sloppily as agrarian mentality in the following. Relevant in this context is the concept of Zero-Sum Game, according to Giorgos M. the idea, that there is a finite amount of resources, and that every human being is a burden to that common pool of resources. Implicit to this is the notion of natural resources as finite stock, and human activity as purely consumptive. Consequently there is competition for the available resources, and any newcomer adds to the pressure. The potential of newcomers to create additional resources or to contribute to and enlarge the community in any other way is not seen. Therefore, anyone outside the own community (family bonds, village, island) generally and newcomers in specific are regarded with suspicion. A distinct feature of agrarian society, as Giorgos K. points out, is their resistance to change. "Once they solidify a form of production, they continue doing that even if this form of production is manifestly not functional any more" (Interview GK). From this strategy arises the mentality that whatever worked for the parents and grandparents will also work in the future, and consequently an inherent resistance to change. Remnants of such mental models have an impact on the variation of cooperation: "In consequence, mutual trust between families and co-citizens is low, each decision is suspected to be in somebody's particular interest, and not for a fair joint benefit" (Fischer-Kowalski et al. 2020a). The resulting cooperation pattern can be subsumed as 'one hand washes the other', characterized by case-specific support dependent on whether the person in need provided support in the past, or judged by the likelihood of doing so in the future. Giorgos K. speaks of υποχρέωση, obligation, in this context, a concept which plays a major role on Samothraki - to the extend that locals commonly say "I am obliged to you" to express gratefulness (Interview GK). Within families, cooperation occurs on a more general basis, as family members are obliged towards each other due to their common effort in providing subsistence anyway. While this cooperation pattern accredits high symbolic capital to those who support others, especially if they were not obliged to in the fist case (Interview GK), it makes cooperation on complex issues very difficult. Even in the presence of a common goal, the lack of clearly distinguishable returns, complex feed-backs in multilateral settings, and time frames wide into the future are not compatible with a consequent'tit-for-tat' strategy. In order to "[collaborate for complex common goals] one needs networks of like-minded individuals with various competencies who trust each other to be able to work together in functionally differentiated structures with flat hierarchies" (ibid.). The society of Samothraki is said to be antagonistic and highly prepared for conflict (Interview GK). As the joke cited in section 4.2.4 demonstrates, quarrelling is part of the island's culture. In combination with the importance of family ties and the significance of 'being obliged' as outlined above, people tend to

take sides in a conflict based on their relationship to those involved rather than based on their stance on the issue. As a consequence, there is less room for unity based on like-mindedness to emerge, and conflict resolution built on deliberative elements is limited.

4.3.4. Social Capital

"In a small island community of less than 2500 inhabitants, economic and social survival is dependent on the exploitation of all forms of capital available within a limited geographic and communal space." Kostakiotis and Trakas 2014

Norms, rules, relationship networks and any kind of institution which helps a society organize itself in manner leading to desirable outcomes are commonly also referred to as social capital. With reference to the concepts of human, physical, and cultural capital, social capital refers to a set of socially produced assets capable of generating future benefits for those sharing them (Ostrom and Ahn 2009), such as trust, reciprocity, common rules, norms, sanctions, and connectedness in institutions. In can be through of as "the glue for adaptive capacity and collaboration" (Folke et al. 2005). As social capital is socially produced, it is an attribute of a community more than of individuals. In a participatory refinement of the SESF, Mar Delgado-Serrano and Ramos 2015 and the community involved identified the following forms of social capital: traditional forms of collaboration, as trust and reciprocity, attitude toward corruption, traditions and community values related to natural resource use (ibid.). Many aspects have already been touched upon and are therefore just subsumed here: As characteristic for agrarian societies, Samothraki was marked by hierarchical family ties as organizing structure of the society, supplemented with societal hierarchies bound to land-ownership status mainly (section 4.2.1). With large scale labour emigration and the introduction of other indicators of status, such as administrative jobs and pecuniary income (Interview GK), community ties and respective rules and norms weakened and partially dissolved (as the institution of μπαχτσές, section 4.2.1). Other norms persisted, such as the significance of reciprocity, see section 4.3.3 above, while new networks and customs were brought back by returning migration workers and newcomers alike (Fischer-Kowalski et al. 2020a). Now, there are the two distinctive clusters of community values outlined in the section above, which are not mutually exclusive nor strictly bound to the socio-economic background associated with them. Nevertheless, thinking in terms of social capital, some means of producing assets of social capital are consequently bound to those clusters, as is the future benefit generated thereby (eg. the privileges of being granted full local status)

4.3.5. Relevant Groups of Actors

Considering the role water plays for the people of Samothraki, the relatively delimited boundaries of the SES, all near-3,000 inhabitants of Samothraki are relevant actors. This entity can be divided into different subgroups of according to their relevance, competence, attributes and connection to the resource system. Regarding the description of water users, notice, that the differentiation in domestic

water supply users, PVC pipe system users and irrigation supply users refer to as prioritisation of different infrastructures, not distinctive groups of users.. A farmer may consume most water through a mix of several irrigation infrastructures, registered and unregistered, while still using the municipal supply for domestic uses. Primarily domestic users may switch from to watering their gardens through PVC pipes to tap water according to the availability of water and costs connected with either choice.

4.3.5.1. Municipal administration. The municipal council, consisting of 17 members, deliberates on and sets the Water Regulation (see chapter 4.2.5.2). It discusses temporal rules and priorities, such as the shutting down of certain parts of the water supply in cases of drought. Constitutional rules of the Municipal Council are described in section 4.2.5.3.

4.3.5.2. Hyrdrological engineers. There are currently two hydraulic engineers employed by the Municipality to maintain the island water infrastructure. With insufficient staff and resources (Skoulikidis et al. 2019), the engineers are working around the clock an work on the whole island. Their task is to keep the domestic as well as irrigation water supply network operative, deploy minor extensions and brief external workers. The elder of the engineers is said to be the only person on the island who has knowledge of the whole water related infrastructure. The only map is said to exist in his mind (personal communication Nikos Skoulikidis, June 2020). The second hydraulic engineer is in the process of learning from the more experienced as much informal knowledge as can be transferred. Their knowledge is crucial for research, assessment and integrated planning of the water resource system and related infrastructure.

4.3.5.3. Domestic water supply users. The domestic water supply network covers all settlements to serve all household, but also provides water to secondary and tertiary sector water users. These currently include: nine hotels, thee hostels, two camping sites (one cooperative and one municipal) and about 700 guest rooms; 97 cafes and restaurants; 9 super- and minimarkets; a cooperative olive press; two wineries (one cooperative and one private) and a beer brewery ; a cooperative dairy; a municipal slaughterhouse; three bakeries and two confectioneries; about 30 other service providers such as electricians, hairdressers, carpenters; various manufactures and small producers, eg. a ceramics workshop, manufacture of traditional sweets, drinks and pasta, manufacture of traditional and local foods and herbs, a cheese factory, a distillery, etc.; ans wood and concrete production (Municipality of Samothraki 2016).

Information on the details of water use per unit could not be obtained. However, some residents use the domestic supply for watering their small gardens or plots (personal communication with Giorgos M., November 2020). Considering the various economic activities being provided for through domestic water supply network suggest that water consumption through domestic water supply lines exceeds domestic water needs. This was also the outcome of calculations on domestic water use by Skoulikidis et al. 2019.

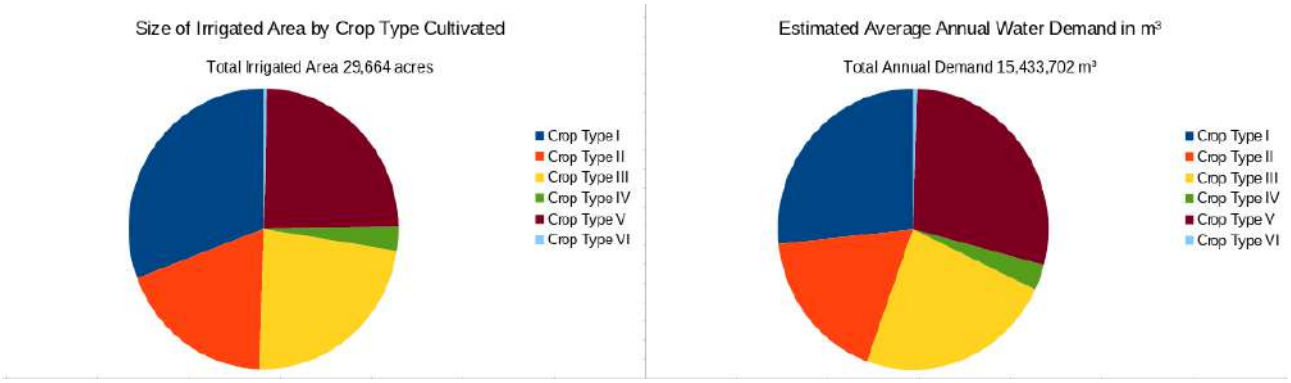


Figure 4.22. Irrigated Area and Irrigation Demand by Crop Type. Crop Types are: I - Olive Groves and Vinyards, II - Livestock Feed, III - Legumes and Trees, IV - Fruit and Vegetables, V - Cereal, VI - Oil Seeds and Pastures.

4.3.5.4. Agricultural water users. Farmers arguably constitute the most relevant actor group. According to Skoulikidis et al (Skoulikidis et al. 2019), irrigation water demand accounts for more than 98% of total water demand. Thus, changes in their practices, requirements, or number greatly influences the water balance of the island. Together with livestock breeders and foresters, farmers account for 21.34% of the total economically active population (Municipality of Samothraki 2016). It should be noted, however, that farming nowadays is often one of multiple occupations and that the primary sector is in decline (see figure 4.18). Farming is mainly done as family business, however, most farmers are old and assume that their children will not continue the profession (Apostolopulos et al. 2019). The main cultivations on Samothraki include olives, barley, durum, hay, and vineyards. Most of the agricultural production serves as livestock fodder (40.4%), although it only provides about 10% of the total fodder, followed by olive groves (35.1%) and cereals (19.7%), see also 4.22. According to the municipality, irrigation is undertaken from June - September, and irrigation systems used on the island are canals, drip, surface and sprinkler irrigation as well as artificial rain (Skoulikidis et al. 2019). The price of water plays a crucial role (personal communication with Giorgos M., November 2020). Formerly, a farmers cooperative controlled the management of drillings. Today, they are managed by the municipality. The introduction of a fee of about € 2.6 per hour of drilling operation has significantly reduced the use of the boreholes (ibid.), and it is said that only farmers who can afford to irrigate. Of the farmers who continuing to use the municipal drillings, some complain that the hydrometer is manipulated and records higher than actual use (personal communication with Giorgos M., November 2020). Unregistered surface water abstraction is estimated to be highest among farmers, adding up to 13.67 hm³/year (ibid.).

Livestock on Samothraki includes sheep, goats, horses, donkey, mules, cows, pigs, chicken, turkey and beehives. The most numerous and relevant in regards not only to water management but all ecological concerns are small ruminants, ie. sheep and goat. In the past, breeders moved their animals every six months from the lowlands to the mountains and vice versa, while today ruminants roam the island as free grazing, semi-wild livestock populations (Municipality of Samothraki 2016). After an explosion of numbers in ruminants in the 1990s, following EU Common Agricultural Policy subsidies favouring remote farms and high numbers of livestock (Fetzel et al. 2018), the goat and sheep population is now slightly declining, although still significantly higher than the estimated carrying capacity

(50,000 to 20,000). Feed provision from grazable land is not sufficient, and up to 90% additional feed was needed in recent years. Considering that Crop Type II and partly Crop Type V are cultivated for supplementary livestock feed and taking into account their respective irrigation demands (see figure 4.22), livestock contributes substantially to the high water demand of agriculture.

With the decline of the primary sector and the phenomenon of free-grazing, the role of shepherds has decreased over the past decades. Today, they constitute one significant group of retirees on the island. Active shepherds are occupied with finding good grazing spots, and complaints by owners of gardens and pastures about shepherds cutting open their fences speaks of the desperation. Erosion is a major pressure on the SES, threatening water quality, quantity and man-made infrastructure. Through the lack of vegetation, run-off increases, and without any resistance to slow them down, floods carry a much more destructive potential, resulting in mud- and landslides as those in September 2017.

4.3.5.5. Tourists. Tourists do not only compose a major sub-group of domestic water users, their characteristics and the type of tourism they bring to Samothraki indirectly affects how water resources are managed, as tourism is a main provider of livelihood for the islanders. Tourists' preferences shape local development on Samothraki and vice versa, the 'image' Samothraki sells as tourist destiny determines the type of tourists attracted. For example, in the early 1980s, tourism has driven the expansion of built environment and waste generation (Noll et al. 2019). In recent studies, tourists have been found to be overwhelmingly supportive a conservationist development scenario in terms of tourist infrastructure (Fischer-Kowalski et al. 2011), an attitude which could play a constitutive role in promoting sustainable pathways. At the same time, intensive tourism continues to adversely effect social and ecological aspects of Samothraki (Schwaiger 2017), and a sustainable development strategy needs to confront unsustainable patterns and strictly prioritize sustainability. Regarding water demand, the consumption of tourists is included in domestic water demand in section 4.3.6.1, calculated on the basis of local consumption. However, in low- and middle-income countries, tourists are generally found to use more water than residents (Becken 2014) Regarding social interactions, in some exceptions tourists' may participate in community activities or local ecological projects, such as 'work and travel' on organic farms (Maria P., personal communication, June 2019), or the social-ecological summer schools organised by the SEC and Sustainable Samothraki. While some tourists encountered during the visits to Samothraki were very aware of potential pressures to water resources and actively persuade other tourists to act accordingly, others seem less concerned with potential consequences of their interactions with natural resource system.

4.3.5.6. Associations. Associations pose a relevant opportunity of shaping the political agenda and the degree of citizen participation therein in. There are various non-governmental initiatives working on aspects of the political, economic and social organisation of Samothraki.

One major actor in this context is the association Sustainable Samothraki, which co-initiated the civic-science collaboration described in section 2.1.3.1, creating a science-community-policy interface. The anchoring of sustainability in developmental strategies of the island is to most part due to the associations effort, and it continues to place sustainability issues on the political agenda as also in community spaces (Fischer-Kowalski et al. 2020a). The association introduced methods of civil participation in political consultation processes, brought youth education on sustainable resource use to the local schools, organised meetings between stakeholder and engaged in many more activities, while continuously facilitating civic-science projects [16]. An example of successful intervention is the project ReThink!, which introduces wholesome and sustainable waste management practices to Samothraki, starting with composting projects for primary school children (see http://sustainable-samothraki.net/project/compost-initiative/).

Another initiative facilitating stakeholder-involvement and deliberation in local politics is the Open Forum, an annual semi-public gathering which brings together local politicians and stakeholders with "distinguished Greek and foreign scientists, entrepreneurs, governmental and non-governmental organizations"17 to discuss pathways of sustainable development. It is organised by a former resident and business man and has a more entrepreneurial perspective than Sustainable Samothraki, which is rooted in community organising. The Open Forum aims at “boosting local entrepreneurship, increasing local revenues and introducing sustainable business practices in Samothraki and Greece in general” [17]. Iinitiatives such as Sustainable Samthraki and the Open Forum open up spaces of discussion between stakeholders and decision makers. They work out suggestions for a common political agenda. However, as participatory modes of deliberation are only weakly institutionalised in the polity of Samothraki, they remain limited in their potential and tend to involve citizens already engaged for or interested in the respective issues.

Zathey is a youth empowerment organisation. Realizing that genuine cooperation is a basis of functional society but is not encouraged by today’s culture and socio-economic conditions, Zathey teaches cooperation, confidence and leadership competences through informal learning, organizing international exchange programs which support team building, character development and exploration. These concepts, one of the youth workers says, are not conveyed in schools or other institutions. After one cycle of informal formation including trips abroad and common projects, the young persons are changed significantly, being more innovative, proactive and cooperative than the adult members of the association (Interview MP).

Various other organisations and associations exist as well as some individual initiatives which work and collaborate on issues such as organic farming or ecological tourism.

[16] See http://sustainable-samothraki.net/el/local_action/sustainable-samothraki-association/activities// (greek, accessed 13.12.2020)

[17] Source: https://samothrakiopenforum.com/?lang=en, accessed 13.12.20

4.3.5.7. Cooperatives. Increasing the diversity of business models, reducing the impact of market based mechanisms, and creating spaces of deliberation, community building and collective action, cooperatives can play a vital and active role in the transition towards sustainability. On Samothraki, initial efforts to build cooperatives in the fishing and livestock sector to gain better prices failed due to the lack of trust and fear of being disadvantaged (Interview GK). Recently, however, a number of bottom-up forms of cooperative models (re-)emerged: The camping site Varades is successfully run by three young locals with flat hierarchies and as collective enterprise. A cooperatively operated olive press allows farmers to label their oil as organic, granting them market advantage. The cafe of the municipal camping site Platia was repeatedly taken over by social cooperatives, and recently a farmers' cooperative successfully got established under female leadership (Fischer-Kowalski et al. 2020a). The latter is of particular importance, as irrigation demand has been identified as the main driver of water abstraction. Considering the positive effect deliberation and collective action can have on sustainable transformations, the farmer's cooperative could play a major role in reducing pressure caused by agricultural activity.

4.3.6. Societal Water Demand

Subsuming relevant connections between the attributes of actors described above and their respective influence on resource use, it is remarkable that irrigation demand currently accounts for the largest proportion of water use, while the increase of tourism and third sector economic activities will in turn increase the rate of domestic water use. Irrigation and domestic water use still differ by two orders of magnitude, however, with irrigation demand estimated at 98.6% and domestic water demand at 1% of total water demand (Skoulikidis et al. 2019). Both are highly seasonal and stand in competition.

Due to the partial use of or coverage with hydrometers and the lack of other documentation, water demand has been estimated by Skoulikidis et al (see (ibid.) for details on the calculation). Documented domestic water use has shown to exceed estimated demand by a factor of 2.3 while documented irrigation water use falls behind the estimated demand by a factor of 8.8. This supports other evidence of widespread unregistered water abstractions for irrigation purposes.

4.3.6.1. Domestic water demand. While there is some uncertainty of the data on domestic water consumption due to missing or inactive hydrometers (510 out of 3.425,(Municipality of Samothraki 2016)) and frequent disruptions of the water supply in summer, it gives some indication on the amount of water used through the domestic supply network. For the year 2016, based on hydrometers and estimations by the municipality, total annual domestic water consumption is reported to be 371.160 m^3(see 4.2), which is considered lower than average on the basis of 2016 being a particularly dry year with frequent water outages (Skoulikidis et al. 2019). Based on an average domestic water consumption of 250 l/day/capita and the population (including temporary residents such as tourists, seasonal workers and second home owners), the total domestic water need of Samothraki has been calculated

Table 4.2: Water Consumption per Settlements in 2016, Source Skoulikidis et al. 2019

Settlement	Water Consumption (m³/year)
Chora	120.395*
Kamariotisa	101.308
Lakoma	36.803
Alonia	29.557
Therma	25.528
Profitis Elias	19.090
Palaeapoli	14.942
Kato Kariotes	12.914
Xiropotamos	9.413
Ano Meria	7.072
Makrylies	6.742
Ano Kariotes	4.577
Total	371.160

at 178,523 m³/year cite Schoder et al 323,390 m³/year (according to IGME) and 303,994 m³/year (Skoulikidis et al. 2019). Using as a base the daily average domestic water consumption at the nearest mainland city Alexandroupolis of 129 l/capita, which is considered more realistic by Skoulikidis et al, the calculated water demand drops to 156,860 m³/year.[18] The reported water consumption is thus significantly higher than estimations of domestic water needs indicate. Plausible reasons for this could be water loss through the numerous leakages on the supply lines or domestic water use for irrigation of gardens and small scale cultivations (personal communication with Giorgos M., November 2020).

4.3.6.2. Irrigation water demand. Data on irrigation water consumption is even less exhaustive. Drillings operated by the municipality register the duration of abstraction and average discharge. For the 14 out of 16 municipal drillings under operation in 2018, total water consumption is calculated at 1,631,324 m³/year. For registered private resource use, water abstraction is provided only in theoretical values of minimum and maximum abstractions. The average of those values results in 127,008 m³/year for private irrigation water use. The combined registered irrigation water use thus adds up to 1,758,332 m³ in the year 2018 (ibid.). As outlined in 4.1.3.1, this amount however accounts for the irrigation of but a fracture of total irrigated lands. Considering the high proportion of unregistered water use for irrigation purposes, Skoulikides et al made efforts to estimate irrigation water demand based on crop types and needs. Using estimations of the irrigation needs of different crops provided by the Thrace Hydrological District and on the area of cultivation per crop provided by the municipality, the irrigation period and efficiency, the average annual irrigation demand was calculated at 15.43 hm³ (ibid.). The estimation is in stark contrast to the registered irrigation demand of 1.76 hm³. Observations and discussion with local experts lead to the conclusion, that the gap of close to 90% of total irrigation needs is provided by through unregistered abstraction, of which stream water

[18] Two further estimations of 860,000 m³/year and 500,000 m³/year by the RBMP and Karavitis and Kerkidis, respectively, are not considered here as the base of their calculations is could not be reconstructed.

abstractions comprise the largest share (Skoulikidis et al. 2019). Demand for livestock was calculated by (ibid.) in a similar manner, based on estimations of livestock water needs and the number of different livestock on Samothraki, with a result of 60,444 m³/year (ibid.). Of the total calculated water demand, irrigation needs thus make up for 98.6%, while domestic and livestock needs only make up 1 and 0.4% respectively.

4.3.6.3. Other water demand. It is important to note, that water demand of other sectors has not been studied. Small scale productions, such as the dairy, olive press, distillery, brewery, and slaughterhouse, are supplied with water through the domestic water supply network. Likewise, water needs for tourism-related and other services, which by now make up most of the island's economy in terms of employees and revenue, are included in the domestic water supply network (Municipality of Samothraki 2016) The source of water demand of small mining and construction activities could not be identified.

4.3.6.4. Temporal and spatial variability of water demand. Variability in demand is driven mostly by irrigation needs, which comprise of 98.6% of total water demand. According to the municipality, the irrigation period is from June to September, during which 99.9% of cultivated area is irrigated. Estimations made by Skoulikidis et al. 2019 regarding the total annual irrigation water demand result 15.43 hm³, the majority of which is assumed to be abstracted from surface waters. This very narrow temporal distribution of high water demand is slightly increased through tourism and growing related services and infrastructure (Schwaiger 2017). According to estimations by Skoulikidis et al. 2019, tourists account for 43,110 m³ of a total domestic water demand of 303,994 m³/year. This means that around 14% of the overall domestic water consumption is bound in its temporal distribution to the tourist season, which reaches from mid June to mid September according to (Schwaiger 2017).

According to the municipality, farmers irrigate in the period from June to September (Skoulikidis et al. 2019), resulting in a high seasonal irrigation water demand. At the same time, domestic and third-sector related water demand increases as tourism-related economic activity increases together with seasonal residents and second home owners' stays. The patterns of electricity consumption give a rough idea of the scope of the differences (figures 4.24a and 4.24b).

Due to tourist seasons and related rise in visitors and economic activities, this 'domestic' water demand is highly seasonal. It is also highly competitive, because domestic and economic water uses compete for water use through the same network in periods of drought. Another relevant aspect is the increasing centralisation of residents and tertiary sector economic activity in the harbour city, rendering current water supply and sewage networks insufficient. Extension, replacement and upgrading of the current network is in progress. Still, the ongoing 'urbanisation' trend remains a challenge for water management in terms of planning resources and capacity.

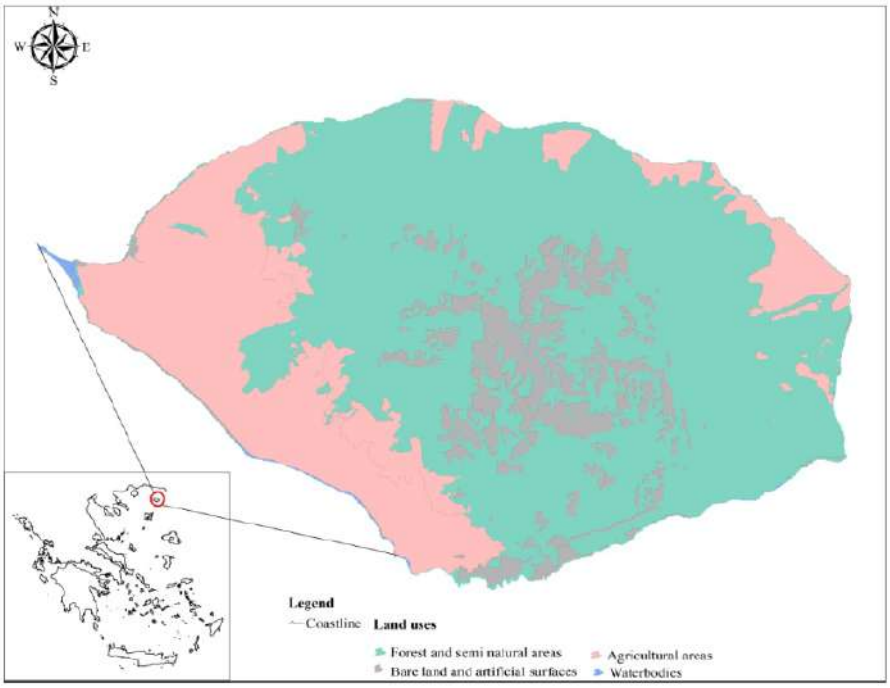
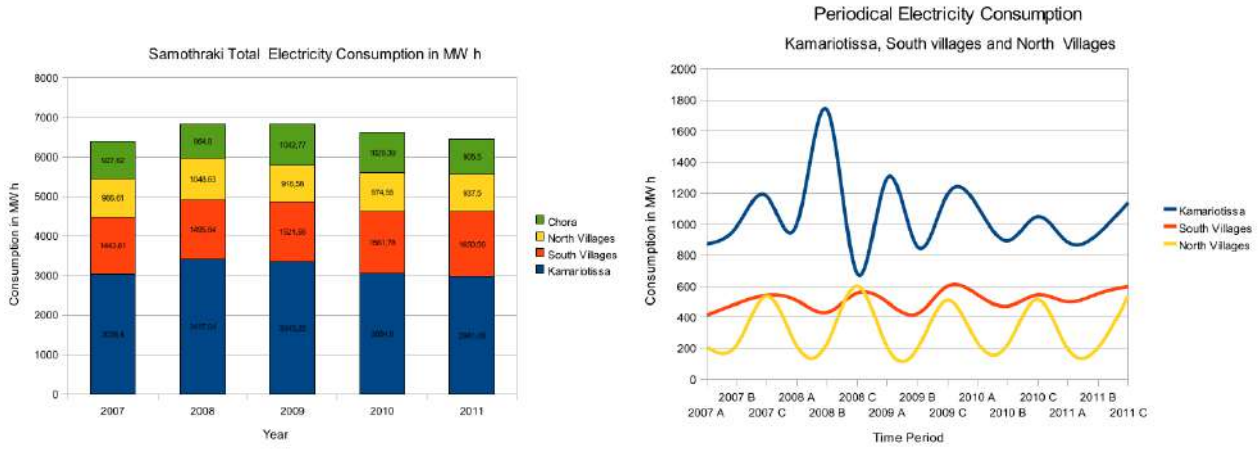


Figure 4.23. Land use map of Samothraki according to CORINE2006. Source: Skoulikidis et al. 2019



(a) Total Electricity Consumption in Samothraki per village 2007 - 2011 in MW h, adapted from Public Power Corporation S.A 2011 by (Xenidis 2012).

(b) Periodical Electricity Consumption in Kamariotissa, Northern and Southern Villages in MW h, adapted from Public Power Cooperation by Xenidis 2012

Figure 4.24. Variations in Electricity Consumption

4.4. Focal Action Situations

The Action Situation as the core diagnostic tool of the SESF (see section 2.2.1) describes interactions which are informed by the system variables outlined in this chapter so far and generate outputs which, in turn, affect the system. I chose three focal interactions for which I have good data accessibility and which each exemplify a wider array of similar interactions. These are AS 4.4.1, unregistered water abstractions, AS 4.4.2 a municipal council's discussion on water pricing and AS 4.4.3, self-organised drinking water supply.

4.4.1. Unregistered Water Abstractions

Although unregistered connections and water abstractions are punishable with a fine twice the installation payment (Municipal Council of Samothraki 2014), extracting water for irrigation of gardens and small cultivation plots is common practice (Interviews MP and NK). Water users acquire PVC pipes and place them in a surface water source at a reasonable vicinity and altitude to redirect the abstracted water to the desired destination (Interview MP). Initial deployment and occasional larger scale repair works require collective action of at least a few persons, and users often call their relatives to support in these tasks (Interview NK). Once installed however, the maintenance of the individual PVC pipe system can usually be handled by the respective water user alone. It includes regular monitoring of the pipes, de-clogging or removing any obstruction, putting pipes back into place after minor storms and repairing them, preparing the pipes for off-season time as well as refurbishing the system before spring. Some water user additionally install and maintain filters (see figures 4.17). While unregistered abstraction are not governed by collective institutions, patters of behaviour generally accepted do exist. Competition between water users using the same source is often handled by simply removing the competitors pipe from the stream or demolishing it in such way that it becomes dysfunctional, which can set off a spiral of vigilantism. These acts are sometimes also carried out as a consequence of non-water-related conflicts between individuals or groups (Interview MP).

The abstraction of surface water for irrigation purpose is encountered all over the island, as the photos show. However, according the the different conditions in the north and south of the island (see sections 4.1.1, 4.3.3 and 4.3.6), abstractions in the north serve the irrigation of gardens and small cultivated plots while in the south is assumed to support irrigation of large agricultural fields. No information could be obtained regarding the numbers of farmers relying on unregistered surface registration. The assumption is based on observations and Skoulikidis et al. 2019's estimation on irrigation water demand (see section 4.3.6).

The act of unregistered abstraction is associated with the perceived advantage of not having to rely on others (Interviews NK, GK, MP) and the reduced effort in maintenance, both in contrast to the former channel-based system. Main driver however is assumed to be the evasion of costs related

to irrigation water provision through the municipality (Municipal Council of Samothraki 2014). Both Interviewees abstracting surface waters via PVC pipes themselves live in the north. Nia K., a retired worker of the diaspora in Germany, lives on Samothraki during summer. She uses the abstracted water to irrigate her garden and vegetables, and uses a pipe system which she installed with her departed husband in a manner so that excess water is redirected back to the stream. When first installing the pipes, her husband was interested in cooperating with other water users but refrained out of concern of being perceived as intrusive outsider imposing German standards (Interview NK). Every time upon arrival, Nia asks her brother and other relatives to join her controlling and reconnecting the pipe system, which remove from the stream before leaving in autumn. The procedure is quite cumbersome, especially with increasing age, as it requires walking through steep terrain, relocating unhandy pipes and clearing out clogged foliage from hard-to-reach spots. As she and her relatives become less fit for the job year by year, she will either have to find younger locals willing to help, engage someone or switch to abstraction from a stream crossing her property via electric pump (Interview NK).

The plot Maria P. uses to cultivate permaculture gardens in contrast is not connected to her domicile but part of a cluster of gardens (Interview MP). Such grouped, small-scale cultivation plots are found frequently outside of residential areas on Samothraki. As all of the neighbouring plots are watered through surface water abstractions as well, a bundle of PVC pipes winds up the nearby stream to the individually chosen abstraction points in higher altitudes. Maria acquired the irrigation system together with the piece of land, thus did not have to install it herself. The maintenance required however involves quite some effort, as she regularly walks up and down the stream banks in search for broken connections, clogged parts and pipes removed purposely or through natural events. She proposed other water users to cooperate or coordinate to increase the effort and inefficiency connected to it, but did not attract any interest. After other users met her suggestions with blatant disinterest, she refrained from taking further incentive. There is a small degree of cooperation between the immediate neighbours of the plot regarding the local dispersion/watering systems in form of information sharing, small acts of mutual support and communication, which however does not extend to the supply system (Interview MP).

From above outline it follows that unregistered abstractions are connected to all three types of rules-in-use: operational rules because the daily practice of unregistered water use can be understood as operational choices made by water users within a certain range, which is not determined by formal but informal collective rules. The latter are difficult to discern from distance, but are influenced by the generally present societal norms and values. For example, the practice of cutting open a foe's pipe resonates with the antagonist mode of conflict management mentioned in section 4.3.3. Operational-Choice rules by the municipal administration, namely **not** to exercise their power to sanction water users, also play a crucial role, greatly reducing the cost associated with unregistered abstractions. The non-implementation of sanctions is an 'open secret' known to users and the Municipality alike, not intended but also not fundamentally changed by the administration (see following section), which renders this rule ineffective. Last but not least, the municipal administration's initial inability to pro-

vide an alternative after the collapse of the channel-based Nerokopou system and its encouragement of users to adopt individual PVC irrigation systems facilitated the establishment of this regime in the first place. Collective-choice rules influence the situation as they (1) illegalize and formally sanction unregistered abstractions (2) set the prices to be paid for water consumption, thus influencing the costs connected to choice of consumption patterns. A users location on the stream and the technology/infrastructure available to them further is of importance. Although conflicts between upstream and downstream users were not reported, the point of abstraction makes a difference. Generally, pipes are deployed far upstream, thus irrigation of downstream fields requires much more material than abstraction from the same point but for a garden nearby. While on Samothraki, cases where the opening of the pipe submerged in the stream was set in cement were observed, as also full cemented enclosures of spring. Material, economic background and available technology thus matter. The self-organized PVC irrigation system is highly dependent on the resource system variables: storms and floods regularly tear apart the pipe systems and scatter them all over the environment, an unaesthetic as well as ecologically adverse consequence. For the users this implies a lot of reconstruction work. In general, dynamics in the resource system directly influence the performance of the PVC system in terms of discharge, water turbidity, and maintenance. From Nia's story it also becomes clear, that social capital is pivotal to the functioning of the system. Expecting to be left without a minimum related persons up to cooperate on the installation and maintenance, Nia prepares to switch to an alternative system. Without respective connections and support, people who cannot maintain the pipe system in their own are ruled out - disadvantaging vulnerable groups such as elderly or disabled persons[19].

4.4.2. Municipal Council's Discussion on Water Pricing

Municipal council meetings are the official arenas of decision making regarding local policy on Samothraki. As mentioned in section 2.3, the municipal council does not act fully autonomous, but is nested in national and European law. Based on the minutes of a Council Meeting in 2014 (Municipal Council of Samothraki 2014), a discussion on water prices can be reconstructed. The debate evolves around the question of whether it is legitimate to consistently sanction non-compliance of water users with the municipal regulations while the municipality fails to provide satisfactory service. From the minutes, there seem to be at two prominent lines of argument. Suggestions of then-mayor Athanasios Vitsas to report pending debts of water users to the higher finance authority as a means to increase pressure on water users to transfer their payments to the municipality is countered by a member of the Νίκη της Σαμοθράκης party fraction. The latter speaker implies that the municipality fails to guarantee quality of water supply throughout the year and overcharges users due to incorrect consumption values or dysfunctional water meters. The mayor in turn refers to the missing resources in terms of staff. In the following discussion, other members of council bring up the issue of missing water meters and the municipality's hitherto unmet obligation to provide their installation, as also the imbalance of power between the municipality, which can impose fines and report debts, and local profession-

[19] on the other hand, the system is open to anyone regardless of formal rules, eliminating restrictions caused by citizenship and access to administration. Refugees eg. are reported to live on Samothraki, but no information was given as to their rights and access to water supply.

als who are lacking means to effectively invoke their right to year-through provision of good-quality water. After a closing remark by the mayor confirming the need to consistently install water meters, for otherwise “room for misinterpretation and lawlessness” is created, the water fees presented in section 4.2.5.2 are unanimously decided for by the 12 attending members of the Municipal Council (Municipal Council of Samothraki 2014).

On the surface, this AS is about collective choice rules discussed by the municipal council in the setting ascribed to it through constitutional rules, as discussed in section 4.2.5.3. It is the course and content of the discussion however which discloses information about the interaction of actors, their surroundings (other SES variables) and their actions. Regarding the cultural context,‘blame-games’ between different administrations, or different parties within one administration, seem to serve as political routines (Interview MP) and reflect a generally antagonistic tendency in conflict resolution on Samothraki (Interview GK).

The stalemate situation between adequate provision of service and implementation of rules suggests an unsolved interdependence delimiting the room of manoeuvre of each side. In the discussion, the mayor, representing current municipal policy, mentions insufficient means as a limiting factor to install meters and control water use and fees. The opposition politician, speaking up for small businesses, names lacking control and sanction mechanisms against the municipality as a problem of agency. In this context, further questions come up regarding the apparent inability to act: Is the urgently required renovation and extension of the supply network coupled to revenue from water users? How much is the supply systems’ performance dependent on rule compliance? And which means do the water users of Samothraki have to control and sanction the municipal administration’s water policy practices? The situation seems to be on in which neither the receptors nor the provider of the service fulfil their obligations due to the other side’s non-compliance with the arranged terms - a classic collective action problem. While in community managed CAPs, reciprocity between equal partners plays a major role, the municipality is obliged to provide adequate water supply to the community according to collective rules on a higher level, ie. state law - regardless of individual members’ compliance to the rule, see section 4.2.2.2. This perspective shifts the obligation to fulfil to the municipality and respective bodies on higher levels which ought to provide the local municipalities with the means necessary to do so. The issues addressed in the discussion thus connect to accountability, capability to act, legitimacy, and power.

4.4.3. Self-Organised Drinking Water Supply

Starting with autumn 2020, outages of the domestic water supply of Chora occurred, with more frequent incidents leading to an intervention by the Municipality after which tap water was running turbid (Municipal Union Cooperation of Samothraki 2020). Around the same time, Maria P. decided to start using spring water for domestic purposes due to a slightly unpleasant taste in tap water. She chose a spring close to Paleapolis, known to lead water of very high quality and made a routine out of

driving to Paleapolis every other day to climb the small hill on which the spring is located and refill a couple of water bottles. A month after drinking but from the spring she realized that her distaste for municipal tap water had increased, and convinced her partner, who could not make out any difference between the two types of water, to try the 'spring water therapy' as well. Through friends and colleagues at the Zathey association, word of the superior quality of the spring water spread, and when Maria visited the spring recently, three women were already there, communicating while waiting in line to refill their vessels. While Maria relates this to the unfortunate recent decline of tap water quality on Samothraki, she attributes great value to the situation. The presence of joyful conversation and communality during an activity actually considered labour spread a sense of "aliveness". She likens this experience to the way that people of her home-town (outside of Samothraki) cooperated on common tasks - collectively, communicatively and with great fun involved, such as a common dinner and dances afterwards.

In this action situation is a harvesting interaction at first, but develops into a situation strongly manifesting networking and information sharing. The difference in quality between the pristine spring water and water distributed through the municipal domestic supply is obviously big enough to chose in favour of the former - although the latter was no less safe to drink at that time. Meanwhile, a waterborne gastroenteritis pandemic has unsettled Samothraki, through which Maria and the other women could pass unharmed thanks to their newly established institution. The information sharing involved in this case built on previous connections - working colleagues, partners or friends. Self-organizing did not evolve into a collective or communal process yet, nevertheless, a small community self-organises resource use apart from the municipal infrastructure (Interview MP). And even though the water collected from the spring does not replace all domestic water needs, this shows that different, self organized systems of water use could offer an alternative to municipal networks, increasing - especially when municipal networks fail to perform well - the overall system's resilience.

4.5. Outcomes

Under the tier Outcomes, the SESF aims to evaluate the system's performance taking into account the information gathered on the other tiers (RS, GS, A) and their interactions analysed through the Action Situations. In their SESF model, McGinnis and Ostrom 2014 suggest to differentiate between social performance criteria (eg.efficiency, socio-economic sustainability, equity, accountability), ecological performance criteria (eg. overharvesting, resilience, biodiversity, sustainability) and externalities to other SES (see also figure 2.3). Building upon this, Mar Delgado-Serrano and Ramos 2015 refined Outcomes sub-tiers (see figure 4.25) which I refer to as a guideline. The sub-tiers developed by ibid. correspond well to the intention of this thesis, as they include further criteria which evaluate prerequisites or conditions of adaptive governance, such as empowerment, social adaption strategies, and management effects.

A frame of reference is inevitable in evaluating a system's performance. While the working definition of sustainability as formulated in section 2.1.1 provides an analytic framework, it needs to be enriched with knowledge on the biophysical, cultural and societal determinants of desirable long-term life support systems. On Samothraki, a comprehensive vision of a desirable future of the island is outlined, amongst others, within the municipality's Municipality of Samothraki 2016, and discussed in forums organised by citizen-science networks, such as Sustainable Samothraki or Samothraki Open Forum. In synthesis with previous historical, socio-economical, environmental and societal studies, my own findings as well as locals' and expert perspectives in the SESF, these form the ground to suggest what determines a sustainable water supply SES and evaluate the current system accordingly. At the same time, evaluating outcomes against a predefined goal risks setting a static prescription of sustainability when it actually is understood as procedural and participatory. This attempted evaluation within the SESF should not function as a by-pass of target and transformative knowledge production (see Partelow 2016), but facilitate a grounded analysis of the interaction of SES variables in regards to sustainability.

As social and ecological system compartments are interwoven, so is their performance. A socio-economic adaption strategy (O1g) such as a dam, for example, may handicap the resource system's resilience (O2f) or adversely affect the natural habitat condition (O2c). For an integrated evaluation, the assessment of single variables thus should consider the system as a whole, including various spacial and temporal scales. In the following, I will therefore touch upon relevant SES variables connected to the Outcome variable under evaluation, while the causal connections underlying these will be discussed in detail in chapter 6, the analysis. Approached in such way, the evaluation of Outcome sub-tiers allows for a deeper understanding of the system dynamics, which facilitate the following analysis.

4.5.1. Socio-Economic Performance

4.5.1.1. Efficiency. From a socio-economic perspective, the water supply SES is not efficient. It is not so regarding resource use, economic management, and societal values. The desolate state of the domestic water supply infrastructure does not only cause avoidable losses, which result in more water being abstracted from the resource system than actually needed (see section 4.3.6), thus straining fragile riverine ecosystems. It also allows the entry of pollutants into the distribution system, resulting in adverse consequences for the health of the community, as the 2021 gastroenteritis epidemic starkly illustrates. Frequent outages caused by repair works furthermore affect households and destabilize second and third sector economic activities.

In regards to economic management, the implementation of an efficient and comprehensive approach towards water supply and use remains unaccomplished. On one hand, the municipality is loosing out on planned revenues as it fails to consistently charge domestic water usage fees and fines according to the water regulation. As AS 4.4.2 demonstrates, weak legitimacy, lacking long-term

Second level variables	Description	Third level variables
Socio-economic performance measures (O1)	Evolution and impacts of the socio-economic concepts included	O1a. Efficiency O1b. Socio-economical sustainability O1c. Equity O1d. Accountability O1e. Effects of deliberation processes in the SES O1f. Empowerment O1g. Adaptation strategies
Ecological performance measures (O2)	Evolution and impacts of the ecological concepts included	O2a. Environmental sustainability O2b. Pressure on resources O2c. Natural habitat condition O2d. Effect of SES management on natural hazards potential impacts O2e. Environmental quality O2f. Resilience O2g. Vulnerability
Externalities to other SES (O3)	Non desired effects (positive and negative) that occur as results of processes	O3a. Positive externalities O3b. Negative externalities

Figure 4.25. SESF Outcomes with Sub-Tier Variables as suggested by Mar Delgado-Serrano and Ramos 2015.

accountability mechanisms, and missing resources on the side of the municipality contribute to its current inconsistent practice. The dense and highly interdependent social networks of Samothraki further prevent harsh sanctions, as they reverberate through reciprocal relationship structures - as interviewee Giorgos K. expressed with the term of υποχρέωση (see section 4.3.3).

On the other hand, registered and, even more so, unregistered individual surface water abstractions currently form a crucial and institutionalised part of Samothraki's irrigation water supply. While there are no studies so far on the PVC systems' efficiency in terms of resource use, observations indicate wide-spread leaks, overflow, and redundant use of material. Nia K. referred to the practice of directing excess water back to the stream, which most other water users seem to omit. The easily damaged or dislocated pipes need frequent replacement, and as they are installed individually, parallel pipes add up to a redundant amount of material used per stream (see 4.26). Meanwhile, the municipality struggles to include the PVC systems in its economic and resource management policy, although the system could not only emerge due to the easily accessible nature of the RS, but was actively called for by the municipality during the transition from the former to the current irrigation water supply system. Largely outside of municipal control, the principle of cost recovery as stated in the EU WFD and the municipality's water regulation cannot effectively be applied to individual water abstractions.

Finally, administrative and bureaucratic processes impact the municipality's efficiency in the implementation of infrastructure projects. For example, in the Municipality of Samothraki 2016, officials complain about the municipality's unwillingness to proactively invest, even at times when the

Figure 4.26. Redundant Pipes at Sotiras. Courtesy of Maria P.

financial situation would have allowed for it. In the prominent case of the Xiropotamos dam (see section 4.1.3.1) on the other hand, citizens' objection to building the dam contributed to its immense delay. In both cases, inefficient practices arise due to organisational weaknesses, which will be discussed below.

4.5.1.2. Socio-economic sustainability. As discussed before (see section 2.1.1 as well as the introduction of this chapter), sustainability can evolve into various forms according to the specific environment, determining variables, and intended communal goals. For this reason, the context of socio-economic practices needs to be considered when evaluating their sustainability.

As mentioned in above section, current water supply economy is nested in the principle of cost recovery through water users. The assumptions underlying this principle, however, might prove inapplicable in the long run. The majority of Samothraki's population is not affluent and municipal prices for irrigation water were claimed to be unaffordable (see section 4.3.6 and 4.2.5.2), while domestic water users regularly fail to pay their fees (see 4.4.2). In addition to that, there seems to be a culturally and historically manifested sense of 'owning' the common water resources (as interviewee Nia K. expresses when suggesting that the municipality should repair the old channel system and provide free access to the freshwater resources, see interview NK)

According to the municipal council protocols, the costs for operating the irrigation pumps should to be covered by water use fees, while no information could be obtained on how the domestic water supply system is financed. However, with Samothraki's population being economically marginalised and water resources being perceived, at least partly, as historical and cultural commons, an economic

system based on cost recovery seems inconvenient. For larger infrastructure projects, the municipality relies on national or foreign funding, which in turn is bound to the finance policy of higher levels within the nested water governance structure and involves lengthy bureaucratic processes.

Apart of the funding, current tendencies in water use itself potentially undermine socio-ecological sustainability. An increasing part of Samothraki's population depends on revenues through tourism, whose annual peak coincides with the highest intensity of irrigation in agriculture. This coincidence results in a sharp competition between water use for different economic activities and echoes through social tensions.

Agricultural water demand is heightened through inefficient irrigation techniques and the cultivation of water-intense crops, constituting an agricultural economy poorly fit to the water-scarce south of the island. As section 4.3.6 shows, a large part of irrigation water demand is further linked to fodder production for livestock farming. High numbers of livestock have been found to cause economic disadvantage to the keepers, and have been connected to the ecologically adverse practice of free roaming. Reducing the exceeding numbers of free-grazing ruminants has already been identified as the most urgent field of action against further erosion of the island's soils. A relevant part of freshwater is thus used to uphold an unsustainable economy around livestock farming.

Tourism, on the other hand, becomes an increasingly relevant source of livelihood, as do related sectors. Water outages and insufficient coverage of the water supply network were already mentioned as substantial problems for the second and third sector economy. On the other hand, the recent trend of urbanisation, ie. growing numbers of residents settling in Kamariotissa or other touristic and economic centres, exceeds the capacity of current domestic supply networks. The different scale and character of urban water services requires adaptions in the supply infrastructure, such as the tanks already being installed in vicinity to dense settlements. Sewage infrastructure is an urgent need. While the former water supply system depended on communities of water users grouped around a channel system and disintegrated with the rural exodus of the 1960s, the current water supply system is less dependent on community support. However, demographic changes still pose a challenge on its own. Continuous emigration, rising numbers of second home owners, and the high seasonal variability of Samothraki's population potentially hinder community building efforts and a consistent long term resource management, which are crucial for an adaptive governance process. As Petridis and Fischer-Kowalski 2016 point out, a population of 4,000 - 5,000 is the threshold for a community to be able to provide key services. Also the socio-economic divide between 'neo-locals' and 'locals', agricultural and service workers, 'urban' and rural population may diminish adaptive capacity of the island community by further enhancing societal fault lines. These challenges notwithstanding, efforts toward socio-economic sustainability are made by various sides. The residents of Samothraki and more so its visitors prefer moderate and eco-tourism over mass tourism development. Participatory programs are under way to restore over-grazed pastures and re-educate farmers in sustainable livestock-keeping methods, these are organised by local environmental initiatives in cooperation with

international scientists and the municipality. Local non-profit organisations put effort into environmental and emancipatory education of the youth, and a growing number of farmers and restaurateurs invest in local and seasonal produce. It seems within reach that similar efforts be extended to the field of water management, ie. education, public discussion on the preferred future, citizen-science pilot projects etc., which could significantly improve the current socio-economic impact of water management.

4.5.1.3. Equity. In times of high resource availability, access to water seems to be distributed fairly equal. Spatial differences in the quantity of water resources, as between the arid planes in the south-west and the water-rich north-east or between settlements in high altitude and lower ones in vicinity to streams and aquifers are balanced through the municipal water supply networks. When water availability is low, hoever, and competition between uses intensifies, access is depends on the location as well as economic and social resources, as no mechanism in terms of resource allocation is effectively in charge that would regulate access to water otherwise. In regards to domestic supply, the municipality connects all households to the supply network, and no claims of unequal treatment were documented during research. The ability to pay initial charges and continuous fees is a prerequisite of course. However, the fee collection is not implemented consistently (see AS 4.4.1), thus allowing economically weak unhindered access to water. Similarly to domestic supply, municipal irrigation water is accessible to everyone, but preconditioned with economic charges, as the pumps can not be used without the electronic card. The municipal irrigation system is contested by farmers claiming that the pumps charge more water than actually use and complain that fees are unaffordable. Initial charges and fees have recently been reduced (see section 4.2.5.2), however, and the situation needs to be re-evaluated according to the changes. As for unregistered abstractions, AS 4.4.1 and interview NK show that access to this infrastructure depends on the users physical condition, social capital and socio-economic background. In times of water scarcity, water access is highly unequal according to the infrastructure used and location of water users. Shortages in domestic water supply occur most often in southern villages in high altitudes, while towns with high economic activity, such as Kamariotissa, face a higher impact following shortages. Users of the PVC irrigation system face higher competition, thus those using better technology and having the means of extending their pipes to higher altitudes are in advantage. Domestic and PVC water use impact each other during low water levels, as the municipality supplements the spring-water used for domestic supply with water from streams, which are already contested by numerous individual PVC pipe abstractions. Regarding groundwater aquifers, no information could be obtained on unequal access. Abstractions through the municipal system are bound to fees, as mentioned above, while private drillings are bound to the economic means and location of the user. With the municipality in control over the domestic supply, it can reduce water consumption through purposeful outages, which are announced via its online communication channels [20]. Water supplied through PVC systems however is not controlled, and although the municipality reaffirms its determination to consistently persecute illegal surface water abstractions during periods of scarcity, little action follows, granting PVC pipe users de-facto privileges in terms

[20] eg. https://samothraki.gr, accessed 01.01.2021

of policing. Other aspects of equity in regards to water supply such as gender inequalities, differences between social or demographic groups, as well as privileges could not be addressed thoroughly due to the scope this study.

4.5.1.4. Accountability. Due to the central organising role attributed to the municipal council through national legislation, it has the constitutional power to decide over most aspects of water management. Mechanisms to hold the municipal council accountable for mismanagement are, however, quite limited. Form the side of the population, members of the municipality are held accountable through the act of voting. As one administrative period lasts four years, the frame of reference to evaluate the administration's performance is very narrow, considering the time frame required for sustainable solutions. It also causes to a shift of priority from crafting genuine water management policies to presenting short term successes in order to convince the electorate of one's own or a party's re-election. Blame-gaming between parties or politicians is commonly used to pursue this goal, as unresolved water-related problems are claimed to lie within previous administrations' responsibility (Interview GM). Consequently, it is difficult for water users to hold municipal council members accountable, especially for long-term water management strategies spanning consecutive administrations. From the side of higher governance institutions, no mechanism of accountability could be discerned. As discussed above, the municipal water regulation foresees sanctioning of unregistered and unpaid water use, but sanctions are not implemented. The municipality itself commits to regular quality controls conducted by a state laboratory, but failed to provide transparent controls during cases of water pollution in autumn 2020 and inform the residents timely during the 2021 gastroenteritis epidemic. As water users are cooperating rarely, there is no institutionalised means of holding each other accountable, whereas it seems to be a seldom practice to sanction other PVC pipe users by cutting or damaging their pipes. For those users who are cooperating, eg. by sharing and maintaining a former channel system for irrigation of μπαχτσές, direct contact and communication seems to suffice, thus relying on social ties for accountability.

4.5.1.5. Effect of deliberation processes in the SES. Deliberation processes were observed in the municipal council, in public or semi-public forums, and in small groups of coordinating water users. Cafés and tavernas seem to be an important forum for discussions on various topics, including water management. Due to their spontaneous and arbitrary nature, however, they are not included in this evaluation. Little institutionalised participatory deliberation practice exists so far from side of the municipality. As stated in the Municipality of Samothraki 2016, relevant actors and the general public are invited by the council to deliberate on issues of "significant local interest". As far as I could discern, there was no such invitation in recent years regarding water management. However, the active participation of citizens in policy making and cooperation with local bodies are part of a comprehensive strategic plan developed by the municipality to guide its policy in the near future, envisioning a sustainable, liveable, vivid governance of Samothraki (ibid.). Non-governmental associations play a crucial role in deliberation and empowerment, as the Open Forum or incentives by

Sustainable Samothraki show (see 4.3.5.6). So far, public deliberation on water resource management has only taken occurred in a few cases. When the Greek state planned to install wind turbines on Samothraki, the initiative Sustainable Samothraki organised talks in which the scientist Nikos Skoulikidis discussed potential threads to the microclimate (see Skoulikidis 2018). The movement against the installation of wind turbines picked up the argument and the general public's awareness for the fragile ecosystem of the island grew. Similarly, but in a much smaller scale, discussion on drinking water quality encouraged water users to change their habits, collecting drinking water from the Paleapolis spring instead of using domestic water supply (see AS 4.4.3). These examples suggest that public discourse and deliberation have an effect on water governance, however, the actors involved were engaged citizens in both cases. Whether deliberation can take similar effects in the municipal administration or less engaged citizens remains to be seen.

4.5.1.6. Empowerment. In terms of empowerment, working with children and youth has showed great results in environmental and social accountability and community stewardship in general (see 4.3.5.6). The civic science collaboration encourages farmers to experiment with new ways of pasture management and co-evaluates the result, creating a supportive and collective learning environment. Such incentives are mostly based on voluntary engagement, and in spite of their valuable contribution to social as well as ecological sustainability struggle to organize all the material, financial and human resources necessary for their work. With regards to water management, the action of reclaiming decent water resources, as did the women in AS 4.4.3, seem to empower citizens faced with dissatisfying water services. In general however, a sense of frustration seems to prevail regarding water management - interviewees mention insufficient service, conflicts related to competing water needs and lack of long-term cooperation on sustainable water use as issues where they feel a lack of tools and capacity to act. Some interviewees also mentioned a strong sense of belonging (see interviews NK, MP) with regards to the water on Samothraki. This 'owning' of the resource could pave a way to empowering actions on a collective level, which so far seem to remain in the individual sphere - such as Maria P. voluntarily clearing streams from entangled PVC pipes.

4.5.1.7. Adaption strategies. The development of adaption strategies is remarkably absent in the practice of official water management policy. This might be most obvious in regards to hazard management: Although heavy rainfall events are projected to increase in the future, no pre-warning system was installed yet, even after the devastating experience of the 2017 floods. Other examples are the discussions on preventing uncontrolled water abstractions, which occur during each period of drought but do not seem to manifest in the water management policy. Repeatedly occurring problems are being addressed with strategies which failed in earlier attempts, as there seems to be very little learning capacity within the municipal policy making. To a some degree, this is connected to the lack of resources such as staff, financial means, and knowledge. Even more so, however, ineffective deliberation processes (see AS 4.4.2), short-sightedness (see 4.5.1.4 above), and unresolved responsibilities seem to prevent a steeper learning curve. If at all, adaption strategies are present in small collective

and individual scales, such as AS4.4.3 illustrates. Citizen-science projects such as the restoration of pastures demonstrates a good example of participatory and observable experimentation. Such spaces of trying out different water management strategies on a small scale can contribute to the overall system's resilience and offers ground for larger scale adaptation processes. Long-term and large-scale changes, such as rising variability in precipitation, more frequent droughts, potential salt intrusion into aquifers, health risks through polluted drinking water, water use conflicts and changing demographic patterns nevertheless require collective and long-term learning processes.

4.5.2. Ecological performance

4.5.2.1. Environmental sustainability. The water resource system of Samothraki seems to still be perfectly able to reproduce, ie. sustain itself. However, the system's equilibria and related threats are not well enough understood yet. The microclimatic phenomenon of condensation in high altitude is one of the system's drivers, and if disturbed, risks altering the water balance of the whole island. Anthropogenic activity has impacted quality and quantity already to an extend which produces significant consequences for surrounding social and ecological systems. While a water supply system covering all societal needs through abstractions from the resource system is seen as compatible with ecological sustainability (the estimated available water resources surpass current annual demand by a factor of five, also see Skoulikidis et al. 2019), the mode of abstraction is considered inherently unsustainable. Leaking pipe networks and inefficient water use increase the amount of water abstracted beyond actual needs, and the high seasonality of water demand stresses ecosystems already suffering from aridity during summer. The consequent desiccation of streams causes habitat and biodiversity loss and reduces aquifers' potential to recharge, therefore critically altering crucial flows and autopoietic potential of the water cycle. Furthermore, climate change projections predict increasing variability of water availability and higher frequency of heavy weather events such as droughts and storms (see section 4.1.1). Anthropogenic pressures as well as the system's responses are discussed in detail in the sections below (see pressures, 4.5.2.2, resilience 4.5.2.6 and vulnerability 4.5.2.7).

4.5.2.2. Pressure on resources. Pressures subsume anthropogenic activities which adversely impact the resource system. On Samothraki, impacts or alterations to water resources are visible with regards to quality as well as quantity. To this add anthropogenic impacts indirectly affecting the water resource system, such as over-grazing and soil erosion. As mentioned in section 4.1.2, biochemical examinations of water show a deterioration in quality of certain streams. The alteration is connected to the inflow of waste water, as most settlements do not have adequate waste water treatment and many individual households use inappropriate sewage tanks. Animal faeces or carcasses pose a relevant point source of pollution, as free ruminant grazing is common on the whole island and water resources are not protected appropriately. Soil-erosion caused by excessive grazing and formerly high rates of logging further increase the percentage of surface water run-off as opposed to infiltration and amplifies the destructive force of mud-slides during floods. Agricultural activity, ie. fertilizer use and livestock waste water, too, contributes to raised nutrient levels. Tourist related pressures have not been

confirmed by biochemical indicators, however, a greasy surface was visible repeatedly during visits to sites with high numbers of daily visitors. The high discharge in those streams (eg. Fonias) is likely to sufficiently dilute traces of chemical products usually used by tourists, such as sunscreen (N.S koulikidis, personal communication, June 2019). Regarding the volume, surface water abstractions from Gria Vathra, Agkistros and Xiropotamos are assumed to be the cause for periodic desiccation in the stream's lower reaches. The phenomenon is difficult to quantify, as many of Samothraki's streams are intermittent and dessicate before reaching the sea for several months each year, anyway, requiring extensive long-term monitoring in order to make out the difference. Additionally, the amount of water abstracted cannot be easily calculated due to the high fluctuation of the amount of PVC pipes used and the difficulty to create controlling conditions. The results presented in section 4.3.6 however indicate that the water abstracted from streams constitutes a relevant part of irrigation water supply. Regarding ground water resources, deterioration of their quality or quantity has not been reported on. Skoulikidis et al. 2019 however warns from salt-water intrusion as a result of excessive ground water abstraction, which could render the aquifer unqualified for agricultural use.

4.5.2.3. Natural habitat condition. In terms of natural habitat condition, drying-out of local ecosystems is by far the biggest pressure. Heavy over-grazing decreases natural protection through vegetative land-cover, speeding up evapo-transpiration processes and increasing rainwater run-off. Surface-water abstractions reduce the stream discharges up to the point of desiccation. Precious habitats which are home to a variety of endemic and rare species (see section 4.2.4.1).

4.5.2.4. Effect of SES management on natural hazards potential impacts. In spite of the collective, traumatic experience of the 2017 flood, hazard management on Samothraki has not been developed so far, despite initiative from side of the SNO to install an appropriate pre-warning system. The meteorological station installed in Koufouklio is a step to this direction. Current management practices do little to increase hazard impact. If anything, the lack of adaption strategies aggravates potential hazards. In early 2021, when the gastroenteritis endemic unravelled, something prevented the municipal administration from conducting quality controls and inform the citizens in time, despite warnings of the hospital staff. Considering the stale-mate situation in AS 4.4.2, the municipality's unwillingness to act appropriately could be connected to fears of being held responsible and unresolved issues of responsibility (ie. under which administration water networks got susceptible towards waste water intrusion.) With respect to droughts, Xiropotamos dam is under construction to alleviate irrigation water demand during summer. Nikos Skoulikidis pointed out that the dam would not have been necessary if other freshwater resources - aquifers, streams and springs - were used more efficiently (personal communication, June 2020). There seems to be no consistent connection between SES management and hazard impact so far, but public-science cooperation between the SNO and the municipality envisions installation of an early hazard warning system, while the SNO continuously collects data which will provide grounds for discharge projections.

4.5.2.5. Environmental quality. Water resources of Samothraki seem never-ending and of pristine quality. As one interviewee said, it is quite irritating to encounter problems with water on an island with such pristine resources (Interview MP). As discussed in more detail in section 4.1.2.2, most of Samothraki's freshwater resources are of above-average quality according to biochemical parameters. The initial high quality and availability allow some range of manoeuvre for the community, pressures can be buffered up to a certain threshold. In summary, environmental quality remains high, though markedly disturbed through wastewater inflows, large scale water abstractions and potentially also a neglectful management of groundwater aquifers.

4.5.2.6. Resilience. Resilience is a system's capacity to deal with disturbances by adapting to alterations of system variables without losing crucial social-ecological functions and relationships. On one hand, the current condition of the ecological system already is an adaption to previous pressures (such as logging). On the other hand, possible future alternate states in which the system could settle (see 2.1b) have not yet been explored yet. Signs of resilience show in the system's capacity to deal with reduced discharge in its streams and its ability to dilute pollutant concentrations to a certain degree. Also the system's recovery from high-impact external events, eg. the 2017 floods which uprooted riverine forests and altered whole riverbeds, is remarkable. The evaluation of resilience however remains vague, as even though observations indicate a more of less healthy resource system, damage buffered so far as well as tipping points underlying the complex system are not well understood yet. For this reason, the precautionary principle should be applied as basic assumption when considering the system's ability to adapt to outside pressures.

4.5.2.7. Vulnerability. Vulnerability is a descriptor of a system's 'weak spots' - potential tipping points triggered by snow-ball effects, low buffer capacities, or unidirectional change. Salt water intrusion into the XGWS aquifer was mentioned as such a tipping point, as once a certain concentration of salt has been reached, the aquifer cannot be restored for freshwater use in the near future. Vulnerability towards heavy rainfall, manifesting in destructive flash floods, is due to the other aquifer, SGWS, having a very low storage capacity, which forces high precipitation to run off on the surface. The vehemence of water, mud and soil masses can destroy much of human built infrastructure, as the flood in 2017 demonstrated, and permanently alter riverbeds. The'nightmare', as the event is locally known[21], has also left a trauma in the collective memory of the Samothrakian population (Eleni Kotsira, personal communication, 2019). Of enormous importance for Samothraki, the microclimatic freshwater controls in the mountain range constitute a system equilibrium of unknown stability. Macro-climatic factors such as wind and aridity seem to play a relevant role, however, near to no research has been conducted to identify the system's controls. If altered, Samothraki's water balance will undergo drastic changes, as a crucial part of the island's water balance is dependent on inflows from condensation. Desiccation of streams poses another risk which the water resource system might

[21] Source: https://aesengagement.wordpress.com/2020/05/12/the-vanishing-land-in-search-of-a-myth-for-samothraki/, accessed 31.12.2020

not be able to buffer. Especially riverine ecosystems are highly sensitive to recurring water scarcity, including endemic and rare species. Thus biodiversity loss is a probably consequence of continuously increased stream flows.

4.5.3. Externalities to other SESs

The reduced water flow and impaired water quality affects social and ecological systems which are connected to or dependent on the water supply SES. The inconvenience caused to households, secondary and tertiary economic activities as discussed in action situation 2 (AS 4.4.2) was already mentioned. The most affected sector however remains agriculture, wthe largest consumer of freshwater on Samothraki thus most severely affected by water scarcity or reduced flows. Salinization of the aquifers would have devastating consequences for soil quality and agricultural productivity, and recurring heavy weather events put infrastructure and harvest at risk. For users watering their gardens with tab water, the increasing unreliability might push them towards complementing watering supply with a PVC pipe system- similar to how the reduced quality and taste of domestic water pushed users to collect drinking water from springs directly (see AS 4.4.3). On the other hand, the self-organizing activity performed in this action situation might have benefits for other SESs through increased communication, the creation of social capital and learning outcomes.

The reduction of discharge has a great impact to downstream ecosystems, which, on Samothraki, constitute of very precious oriental plane forests, lagoons, and coastal wetlands (see section 4.1.2.5). The large scale abstractions turn some previously perennial rivers to intermittent streams, thus intercepting off the flow of freshwater and nutrients to marine ecosystems. While the potential impact of this is likely to be of little concern at the moment (personal communication wit Nikos Skoulikidis, November 2020), a long-term interruption of mineral and nutrient input has shown to harm coastal marine ecosystems (Kawaguchi 2003).

4.5.4. Summary

In summary, the water supply system on Samothraki cannot be considered sustainable, neither with respect to governance practices nor in an ecological sense. Despite the pressures and alterations it is exposed to, the freshwater resource system still maintains its fundamental flows and crucial functions, amongst it the capacity to supply the island community with sufficient water of decent quality. While the natural resource's state is slightly deteriorating in terms of quality and quantity, it is not on the brink of collapse. The systems capacity to fulfil crucial functions, ie. sufficient water supply, deteriorates drastically only upon entering into the human-built infrastructure and management. Extreme weather events aggravate the impact of mismanagement, but water losses, pollutant intrusion, inefficient water use, ineffective deliberation processes and inadequate management strategies occur within the control of the various actors involved. These findings suggest that, although current practices are unsustainable by principle, there is a range of time and leeway for the community of

Samothraki to learn about and adapt towards sustainable water management. There are only very few risks which currently have the potential to push the SES towards a tipping point with drastic, non-reversible consequences. Most consequences of unsustainable practices, such as low stream flow during summer, pollution, adverse effects for water users, etc. are buffered by the natural resource system's resilience and the community's adaption strategies. Nevertheless, urgent action is required to avert tipping points and to craft pathways of a sustainable water governance. Therefore, after an excursion to former water governance practices in chapter 5, in chapter 6 I try to formulate an analysis of the weaknesses in current water governance, followed by a discussion on how to address them and develop sustainable governance practices.

5. HISTORICAL WATER GOVERNANCE

Before the installation of a pipe network providing the households with running water, water supply relied on different technologies and was governed through different institutions. According to Nia K., a former resident who lived in Chora and Ano Meria as a child in the 1950s and 1960s, households in the capital town of Chora were provided for through fountains, from which the residents would collect water according to their needs. There were no conflicts or competition regarding water allocation. The only problem encountered was during harsh winters, when the water froze. The mother then collected snow and set it aside to melt for later use. Nia's family spend the summers in the Northern country side to cultivate small plots of land (so called μπαχτσές[1], gardens or orchards which were well kept and provided most of the family's sustenance over the year, see interview NK 10.5) - a common practice on Samothraki. There, the irrigation of the μπαχτσές relied on a diffferent system of water governace. The water was provided from streams and springs in higher altitude through the aqueduct and channel systems mentioned in section 4.1.3.2. Each neighbourhood of Ano Meria employed a νεροκόπου or νεροκόπος, Nerokopou or Nerokopos, which roughly translates to water labour, "a man with a huge watch" (Interview NK) who was responsible of allocating water to each plot. The Nerokopos calculated the time allocated to each household for irrigation based on the needs of the family, size of the land, and availability of water. According to his calculation, a Nerokopou redirected the flow of water by opening/closing using sluice-gates at channel bifurcations (see figure 4.14). Walking along the channel, he[2] ensured that the water flowed to the intended direction and that to water was abstracted by others along the way. The continuous rotation of irrigation water had as a consequence, that it could be one's turn at any time. Nia K. remembers getting up in the middle of the night to overlook the irrigation of their plots. The family was only informed a few days in advance, and depending on the general water availability, weeks could pass in between two turns of irrigation. According to Nia, this never posed a problem, however. "One should not spoil the plants, anyway!" was a saying Nia remembers well, saying that the vegetables and crops which they cultivated were surprisingly tolerant of drought and the gardens thriving.

As far as Nia remembers, the decisions taken by the Nerokopou were generally regarded as appropriate and based on a just division of available water resources (Interview NK). However, other elders recount water related conflicts, and bribery and nepotism are likely to have occurred at least with some Nerokopos (see interview GK 10.2). Platforms of conflict resolution are not reported of. The Nerokopou's actions were likely bound to a collective understanding of the criteria he based his decisions on , as the role of Nerokopou did not impose a strong authority in itself. Elders also describe

[1] similar to Turkish *bahçe*

[2] Nia K. only mentioned male Nerokopou

the society of that time as more cooperative and kind, an argument supported by the higher awareness of societal values observed in elder people on Samothraki (Interview GK). While the Nerokopou was a full-time job, no information could be gained regarding his remuneration. The profession however lost its relevance and base of support with the mass emigration to Western Europe, leaving behind too few μπαχτσέ cultivators to maintain the role. Other relevant developments was the emergence of administrative bodies, which offered well-paid jobs and and centralized resource management, the adoption of monetary economy, and eventually the introduction of affordable PVC pipes, which started replacing the channels as main water infrastucture technology in the 1970s or 1980s (Interview GK). When the municipality of Samothraki took the responsibility for water provision of the whole island, it could initially not provide sufficient means to adopt the water supply infrastructure to the changed conditions. Water users were therefore advised to individually install PVC pipes (Interview GM), which eventually resulted in the water supply regime the administration of today aims to battle.

The Nerokopou is not mentioned in recollections of various occupations formerly present on Samothraki, including blacksmiths, tailors, shoemakers, saddlers, tinkers, and manufacturers of agricultural machines next to herders, farmers, fishers charcoal producers and other more well known professions (Municipality of Samothraki 2016). Also referred to as Νερουλάς or Τδρονομέας in other, usually more arid, mountainous or urban areas where water had to be transported from a remote source, the role of Nerokopou was a well known profession up until the 1930s in large parts of Greece (*18 Professions Lost in Time* 2015; Primary School of Faneromeni, Trikala 2011). Also in other parts of the world, similar professions exist, e.g. "Waaler" in South Tyrol[3] "Suonenwächter" in Switzerland[4] and "Mirab" in Iran (Yazdi and Khaneiki 2016).

[3]Source: https://www.sentres.com/de/magazin/der-waaler-der-fast-vergessene-beruf, accessed 31.12.2020
[4]Source: https://logbuch-schweiz.net/suonen-im-wallis/, accessed 31.12.2020

6. ANALYSIS OF THE SES IN REGARDS TO SUSTAINABLE GOVERNANCE

In the following, I will review the results discussed in section 4.5 in regards to sustainable resource governance. As stated in section 2.3, sustainable governance is not a prescriptive set of measures to be enacted but rather a collection of principles which characterize a governance that is able to steer complex systems within a sustainable range. As sustainability is "notional and situational" (Leach et al. 2018), it is ultimately up to the involved community to define what is considered the sustainable range of a "desirable and meaningful life support zone" (ibid.). Developing future pathways thus requires participatory processes involving the residents of Samothraki into deliberations on sustainability. Such processes are part of the long term civic-science research on Samothraki, to which this thesis aims to contribute to by informing the discussion on sustainable water governance. The following analysis therefore is not a complete management plan. Instead, I point out the direction which sustainable governance approaches could take considering the complex system at hand. I will do so through an evaluation of current practices based on the theories of sustainable governance discussed in section 2.3 and discuss which principles could apply according to the circumstances. According with the call for the implementation of Integrated Water Resource Management (Skoulikidis et al. 2019) and promotion of participatory management and policy designs (Fischer-Kowalski et al. 2020a), I suggest that a transition towards sustainability can only be achieved through the comprehensive implementation of adaptive and participatory governance principles. Drawing on Ostrom's design principles of collective action (see figure 2.5) and (Dietz 2003) requirements of adaptive governance (see figure 2.7), in the following I analyse which issues would need to be addressed, which current governance arrangements would need to change and which learning processes would be encouraged if adaptive governance was applied. As Dietz (ibid.) state: "The challenge is to devise institutional arrangements that help to establish [conditions of effective governance] or [...] meet the main challenges of governance in the absence of ideal conditions ".

6.1. Learning from the Past

Former water governance on Samothraki seems appropriate according to the social and natural settings on the eve of the transition form an agrarian to a modern society. The institution of Nerokopos was widely accepted and effectively could manage the provision of water supply, maintenance of relevant infrastructure and an allocation of water perceived as just, allowing the communities to

cultivate enough produce to bring them through the winter months. As Nia K. mentioned, “There was plenty of food, I cannot remember me or others suffering hunger”. Regarding Ostrom’s institutional design principles for sustainable resource governance, many seem to have been present (regarding some, not enough data could not be retrieved to draw any conclusions): The system’s boundaries were well defined, as the households of each village district employed their own Nerokopou. Appropriation and provision rules were congruent with the local conditions, as the Nerokopou adjusted the hours allocated to each household according to the overall water availability and the family’s needs. Monitoring was undertaken on a daily, sometimes hourly basis by the responsible Nerokopou, and maintenance of channels was done collectively upon arrival in the northern villages in which the families spent the summer months (Interview NK). Furthermore, Dietz 2003 refer to conditions which facilitate the emergence of such institutions, which also seem to apply here: Changes in resource, resource user populations, technological developments and social conditions were moderate. The community had frequent face-to-face contact and relied on dense social networks (families, in this case), which “increase the potential for trust, allow people to express and see emotional reactions to distrust, and lower the cost of monitoring behavior and inducing rule compliance” (ibid.).

As the societal conditions changed with the onset of the agrarian-to-modern metabolism transition, so did the arrangements in which institutions of water governance had developed and to which it had adapted to. Documentation of the institutional decline of the Nerokopos-based governance system is missing, but considering the general developments on Samothraki, I assume that the structural changes in demography, changing norms and societal rules in addition to the emergence of a new economy rendered the Nerokopou system dysfunctional. The Nerokopou relied on relatively dense settlement and garden clusters for a distribution of water to be feasible. The system also relied on collective employment and coordinated working actions in order to work. The sudden emigration of large parts of Samothraki’s population and a growing tendency to move to larger settlements such as Chora and Kamariotissa left behind a semi-deserted country side. “I guess there were simply not enough people left for this type of water management to be feasible”, comments the interviewee Nia K. (see Interview NK). In addition, the emergence of monetary economy and new sources of income, namely tourism, migration labor and EU subsidies made small-scale cultivation redundant if not impossible all together, as the requirements for ‘new’ and ‘old’ jobs were mutually exclusive, considering the need of cultivation for constant attendance and its high seasonality). Last but not least, the modern requirements to water supply infrastructure and technological developments rendered the channel-based system insufficient. Meanwhile, the formal governance body of the municipality was equipped with the sole responsibility and competency to organise water supply on the whole island, and accomplished, step-by-step, the installation of domestic water supply lines. As for irrigation, the newly responsible municipal administration lacked sufficient resources to provide a comprehensive network for agricultural irrigation. New, affordable technology in form of PVC pipes was readily available, and although the former channels were still functional, the Nerokopos system was either dysfunctional or weakened and given up in favour of individually plotted PVC pipes. At this point, also the municipality announced their incapability to provide an irrigation supply infrastructure and advised

the remaining cultivators, livestock keepers and farmers to abstract surface water using PVC pipes (Interview GM). It is difficult to reconstruct the range of possible choices the new water governance body, the municipality, had when it called for water users to establish the institution of individual surface water extraction. However, it is clear from this recollection that the pace of change in socio-economic and structural settings was too rapid as for the development of new, sustainable institutions to follow up, and alternative responses by the community were not (sufficiently) discussed or experimented with. As covered in section 2.3.1, adapted institutions evolve through interactive processes over time. The municipality's call for using PVC pipes however sounds more like the rate of change was overwhelming involved actors, the deliberation and collective action processes of that time.

6.2. Current Institutional Misfits

"The notion that effective environmental governance depends in part on achieving a reasonable fit between institutional arrangements on the one hand, and ecosystem and social processes on the other, has been central to much thinking about social-ecological systems." Lebel et al. 2013

Institutional fit matters. As the collapse of former institutions and the establishment of an irrigation water supply regime now widely recognized as unsustainable show. Reasons for the former were shortly discussed above. In the following, I discuss institutional misfits which contribute to the unsustainably of the current water supply system.

6.2.1. Economic Sanctions as Condition of Compliance

As (Fischer-Kowalski et al. 2020a) point out, traditional patterns of cooperation are no longer appropriate to deal with the complexity of problems faced as complex, social-ecological system. The υποχρέωση-based system of cooperation, according to which one person is obliged to another in return for a specific service, is not functional when it comes to the water governance of a whole island. Instead, the main regulation which the municipality relies on are financial mechanism: The more water is consumed, the higher the price per unit. Non-compliance to the rules is sanctioned with fines, and even if they are not collected, the threat of sanctions aims to serve as a regulator of water use during scarcity. As discussed in section 4.4.1, however, these rules have not been effective so far. First of all, the for-pay infrastructure can easily be circumvented without reducing the access to water, as the relative abundance of streams and availability of technology allows users to build their own water access. Secondly, the rule does not seem to match the economic power of water users (see section 4.5.1.2). Thirdly, it puts economic benefit-and-cost calculations at the basis of water users choices, assuming a rational economic individual where actually more complex and social rules govern: As Ostrom's research has shown, a perception of humans as bounded within a community,

set of values, mental models and world views is more realistic and facilitates sustainable governance, than the assumption of a rational individual. Dietz 2003 furthermore emphasizes the importance of participatory, analytic deliberation with users and the development of accountability mechanisms and monitoring in order to induce rule compliance. Currently, none of the latter are effectively the case on Samothraki. I therefore suggest that the assumption of financial sanctions and incentives as the ultimate driver of compliance and cooperation be relaxed. The crafting of institutional rules of collective action require the socio-economic background of users and factors promoting cooperation and compliance other than financial sanctions be included in deliberation on compliance mechanisms and monitoring.

6.2.2. Collectively Owned - Centrally Governed

As outlined in section 2.3, water management is allocated to the municipality only. The local community's involvement in water-related planning, deliberation and decision making is mostly reduced to the act of voting representatives. Representative policy making is determined by the larger governance structure which Samothraki is part of, as well as locally anchored through societal institutions, even though the last election turn up was below 50%[1] Even if the representatives and their decisions are seen as eligible and legitimate by the water users of Samothraki, the concentration of political agency within the municipal council creates a dis-congruence between problem-owning and problem-solving. Giorgosos M. suggests that this leads to water users feeling less responsible for contributing to sustainable solutions as they are ascribed agency only in electing a representative administration (interview GM). Simultaneously, not having access to deliberation processes and problem-solving disowns water users from participation in water resource governance. The administration, on the other hand, is likely to set up rules which lack general support, if they do not follow collective deliberative process which include various relevant perspectives. This dynamic is observable in AS4.4.2, the stale-mate council discussion on water fee collection. An adaptive approach in contrast relies on participation as a means of institutional crafting. As adaptative governance draws its strength from social learning (see section 2.3), the engagement of a wide variety of actors, experts, interest groups, etc. is determines the quality of governance outputs. To this point, decentralization of knowledge is an important aspect: The fact that on all of Samothraki, there is only one map of the complete water resource system and that is in the mind of one of the hydrological engineers is an amazing demonstration of brainpower, but also a weak spot in the governance of such a complex system. However, means of participatory policy-making have only sparsely been used by the municipal administration, and participatory processes still a marginal practice, as a recently founded initiative, 'Islands of Hope' points out: "The lack of the tools and culture of genuine dialogue has led to major conflicts within the community (e.g. about wind farms, tourist development and animal grazing), while the institutional barriers for citizens to influence regional policies has led to feelings of resignation" (source: https://civic-europe.eu/ideas/islands-of-hope/).

[1] Source: https://ekloges.ypes.gr/current/d/home/municipalities/9009/, accessed 31.12.2020

As discussed in section 4.3.5.6, initiatives promoting learning, conflict resolution, participatory processes, information sharing, informal education, the development of trust and community building all originated from civil society organisations, such as social, ecological, and youth associations as well as cooperative enterprises. While highly invested in a sustainable future of the island, resources and outreach of these initiatives is limited.

6.2.3. Competence vs Capability

In the Municipal Council's discussion on the recollection of fees (AS 4.4.2), a council member's statement on the administrations inability to provide a sufficient quality of service can be understood as the continuation of the Municipality's dilemma since the very start of taking responsibility over water governance: The devolution of central state power without parallel resource allocation to lower levels of policy was criticized in context of the Greek Kallikrates reform as well as later in regards to the EU WFD's requirements (Dercas 2020), see section 4.2.2. The municipality is essentially understaffed and lacks resources to implement changes at the scale necessary. Under these circumstances, the municipality refrains to treating symptoms rather than working on the underlying causes. This condition has severe consequences on water management, where reforms in governance towards the adaption of integrated and long-term management perspectives are as necessary as are large-scale technical renovations. The misfit between allocated competence and capability contributes to the municipality's difficulty in treating the roots of water related problems.

While the municipality struggles to address water related problems at the scale neccessary, self-organised responses emerge, as AS 4.4.1 and AS4.4.3 illustrate. Actors engaging in self-organised water supply solutions, over time, gain knowledge and experience regarding the resource system, the construction or use of relevant infrastructure, and participate in the crafting of new institutions. Thus, actors which are not officially recognized as policy-makers, ie. are not granted competency within the official political system, acquire respective skills and engage in a bottom-up, adaptive process of resource management and policy making, where official bodies struggle to fulfil their assigned tasks. This phenomenon was a common experience in post-crisis Greece, when thousands of small cooperatives self-organized and kept up crucial societal services which the Greek state was no longer able to provide, such as schools, kindergartens, vegetable gardens or social centres (Varvarousis, Kallis, et al. 2017).

Relaxing the assumption that water governance should rely on only one player, ie. the government or local municipality respectively, such as polycentric and co-governance suggest, could allow for advantageous syntheses between official and self-organized actors. As discussed in section 2.3.3, polycentric approaches are based on the simple recognition that informal networks of power contribute to a resource governance system. In the case of Samothraki, so far, self-organisation does not occur coordinated enough to be labelled as 'centre of power'. However, the continuous omission of the municipality to enact sanctions indicate that networks of power exist other than the Munici-

pality, as do networks of knowledge (see AS 4.4.3) as well as physical social-ecological networks, such as the users and supply infrastructure along one stream. If self-organisation grows stronger, co-management could offer a promising direction for a more appropriate governance system, with water user cooperatives as one power and the central municipality as another. This would require a strengthening of self-organisation processes, encouraging trust- and community building as an important first step. Further, a clear analysis of competencies, accountability mechanisms and consensus on terms of mutual cooperation would need to be developed. As discussed in section 2.3.3, decentralizing power also includes poignant analysis of power, otherwise devolution risks to only take place on formal levels. Noll et al. 2019 leans on Valentinov (2012) in describing continuous government regulation over cooperatives as one of the main failures of Greek cooperative systems.

6.2.4. Temporal Scale Misfit

The lack of a long-term perspective in municipal water management and its interdependency with accountability time frames were shortly discussed already. As different temporal scales are a relevant aspect of complex systems as well as in the crafting of sustainable governance, I want to deepen the discussion further: As shown in section 4.5, the elections, which are the main tool for water users to evaluate the municipal administration's performance in water management, take place every four years. As re-election is desirable, not only politically but also in terms of status and income, the administration is encouraged to prioritise work which will please voters within the short time period of four years rather than to tackle fundamental issues, which is less likely to guarantee immediate return (see interviews MP and GM). Sustainable water governance, on the other hand, requires long-term strategic planning, with planning periods necessarily spanning multiple consequent administrations at a time. Inter-administrative cooperation seems weak, considering the blame-games between former and current administrations occurring whenever a problem arises which is connected to past management practices (Interview MP). The current coupling of water governance to single administrations and centralisation of knowledge within the municipality is an obstacle to sustainable governance. A system to ensure long term planning, cooperation over long time frames regardless of the current political power, and accumulate knowledge on the SES as well as of past governance experiences would be crucial for adaptive governance: "A collective memory of experiences with resource and ecosystem management provides context for social responses and helps the social-ecological system prepare for change." (Folke et al. 2005).

7. DISCUSSION AND OUTLOOK

In the institutional design literature, attention is drawn to the difference between institutional analysis and the crafting of new institutions: “Analysing community institutions already in place is different than designing institutions, certainly different from imposing new institutions on communities from external sources” (Prateek and Carr Kelman 2016). With this thesis, I primarily analyse institutions. In the following however I want to discuss the results considering the questions posed in the beginning: As an island-community committed to steering Samothraki towards sustainability, which aspects of the discussion on sustainable water governance undertaken in this thesis are interest to the actors on the ground? Or, vice versa, which actions does the governance-oriented analysis of the water supply SES call for? In the following closing remarks I discuss implications of the previous chapters and suggest a direction of possible future activities.

The two main factors shaping Samothraki’s society have already been laid out in previous sections: Insularity - the awareness of relative isolation, the precarious uniqueness of being an island community and the resulting development of distinctive coping strategies, societal traits and culture (see section 2.1.3) - which is omnipresent and affects aspects of the SES on different levels. Another major role plays the socio-metabolic transition from an agrarian to a modern-industrial society which Samothraki is going through (see section 4.2.1), the further path of which is not yet settled. As both of them combine, sometimes at odds with each other, a wide range of fractures, niches, and innovative developments occur, to which the potential of emancipatory change is immanent, as discussed on the chances of island sustainability in section 2.1.3.

Chaffin et al. (2014) touched upon how some of resilience literature conceptualise the “window of opportunity” (see section 2.3). Apart from preparatory activities, such as building trust and connections between key stakeholders/actors, he says, society needs an initial shift in order to set off greater changes. Such changes “ may appear as a significant boost in capital or legitimacy, e.g., a shift in policy, a disruptive political election, a significant increase in funding or autonomy, a biophysical perturbation such as a natural disaster, or the recognition of a previously informal network as a formal governance organization.” (ibid.). He also mentioned resource mismanagement potential trigger for a complex SES. As many of such smaller disturbances occur over the year on Samothraki, the thought of each of them as a potential trigger for change is encouraging. Especially as, with its numerous cooperatives, associations and committed individuals, Samothraki seems well prepared for a change. In terms of water governance, the situation might not be as developed as in other sectors of the SES, there is still much work to do in terms of connecting, trust building, cooperation and knowledge sharing. However, preparing with a core of committed actors for the right time to introduce something

proactively, eg. new governance institutions , might be a more feasible pathway than any other official or informal strategy currently at hand.

Further elaborating on the concept of preparedness, I want to point out that among all the notions of failure, insufficiency and the dramatic character of the recent epidemic, there are many potential hubs of an emerging, more sustainable governance. Examples are the women connecting through their water fetching at Paleapolis spring, which is a result of experimentation and knowledge sharing through social networks. Also, the establishment of a farmers' cooperative, which succeeded after multiple failed trials, not only for farmers' but also fishermen and livestock owners, under a female lead. Interestingly, the one of the oldest and most successful cooperations on the island is Axiokerska, a cooperative only run by women and records high export numbers of sustainable and local products. Or the youngsters easily cooperating while helping out Maria in her garden - a consequence of their 'metamorphosis' during the youth exchanges though which the learned about cooperation and mutual aid (Interview MP). All these feed-backs should be carefully analysed with regards to the how they facilitate a more sustainable governance.

Interestingly, the main characters of such promising developments are women and youth. While men are strongly represented in visible spaces of deliberation, such as Municipal Discussions or Facebook, a lot of women are involved in initiatives promoting ecological and societal change on an every-day basis, as the examples mentioned in above paragraph show. Also youth and children's work is mainly done by women. Here, young people are encouraged to develop inner values, are given the opportunity to go abroad and learn about sustainability as early as in primary school, among other learning processes, resulting in a more educated future generation more likely to engage in environmental stewardship. These results suggest that women and young people should not only be taken into account, but prioritised in efforts towards a sustainable future. Additionally, more "voiceless" groups need to be included as a newly founded deliberation platform, Islands of Hope, does:

> Decisions on insular development are of direct relevance to the entire community of around 3.000 residents. We will engage citizens from all strands of the community, including representatives from local associations, regional bodies, as well as the around 30.000 regular visitors. Since some voices are more dominant, we will especially ensure the active participation of the 'voiceless': women, migrants, foreigners, illiterate, and the elderly. Based on our preliminary work, we will especially target representatives from already identified 'polarized' groups, e.g. middle-aged male farmers leading a traditional life with little contact to outsiders vs. younger more educated citizens working mostly in tourism services who sometimes perceive the "specialness" of the island as backwardness. Islands of Hope 2021

As the SESF analysis showed, the social strata of Samothraki is divers and the features very different mindsets, value-systems and expertises. Taking recollections of elders regarding former transformations, modes of governance and related societal institutions into account further diversifies the pool of knowledge which individuals and groups involved in social-ecological change can draw from, increasing the community's ability to cope with future challenges by nurturing diversity. An aspect of continuously high potential is the co-production of knowledge with outsiders. Interestingly, when Samothraki experiences one of its first social-ecological crises in form of extensive logging for charcoal production, Nikolaos Fardis from Samothraki tried "to persuade his fellow islanders to stop this activity and [was] left alone to discuss the problem with foreign travelers'" (Xenidis 2012). While it is the people of Samothraki alone who define, struggle and achieve sustainability eventualy, exchange with people from other contexts and with different perspectives remains a pillar of deliberation and knowledge production. Through the, by now, deeply rooted cooperation between locals and international researchers, such knowledge co-production got institutionalized, and Samothraki turned into a highly valued destination for a (modest) community of sustainability researchers. But the exchange with other regions is developing as well, as Samothraki is part of the Dafni Network of Sustainable Islands in the Aegean Sea[1]. Others which could be of interest to Samothraki include, for example, SOCLimpact[2] for climate change impact studies specifically regarding islands and Hydrousa[3], a network to improve water management on islands. Networks like these are designed to connect places with similar conditions and facilitate knowledge transfer in between them. Different coping and adaption strategies regarding similar problems can be evaluated and shared, further adding to the pool of transformative knowledge.

Interesting from an Austrian perspective in this regard are the similarities of former water governance on Samothraki and in various regions of the Alps. The valleys form similarly insular communities, and the bio-geophysical conditions create similarities in the hydrological networks which the communities deal with. In a long-term study on the channel irrigation structures used in the Swiss Alps, Baur and Binder 2013 found that farmers had recently developed new institutions, including adaptions to the decreasing numbers in irrigation infrastructure users due to larger socio-economic developments. Samothraki as one island of sustainability (see section 2.1.3) has many placed to learn from and to share its knowledge with.

I conclude with the argument, that the prerequisites for a sustainable governance of social-ecological systems, including water supply, are present on Samothraki. In the pre-transitional phase, it is crucial to promote social organising and the strengthen the relatively functional and rich informal networks supporting a transition towards sustainability which are already present. For, as Folke et al. 2005 remarks: "Successful social transformations toward adaptive governance for ecosystem management seem to be preceded by the emergence of informal networks, orchestrated by key individuals, that help facilitate information flows, identify knowledge gaps, and create nodes of expertise of signif-

[1] https://dafninetwork.gr/
[2] https://www.soclimpact.org/
[3] https://www.hydrousa.org/

icance for ecosystem management that can be drawn upon at critical times. These networks place emphasis on political independence, out of the fray of regulation and implementation, places where formal networks and many planning processes fail."

Such informal networks work as incubators of new approaches for governing social-ecological systems. Regarding water governance on Samothraki, the cooperatives, associations, young and women constitute the basis of such networks, which could craft more adaptive and decentralized forms of governance to provide a sustainable water supply, which the municipality alone does not have the capacity to. I suggest it is time to encourage these networks to take the stage.

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8. APPENDIX A: SESF Tiers and Variables

This is an overview of the SES tiers and variables used in this thesis. The adopted structure is based on McGinnis and Ostrom 2014 and Mar Delgado-Serrano and Ramos 2015. The first tier is indicated with Arabic numbers, first sub-tier with letters and Roman numbers.

1. Resource System
   (a) Geology, topography and climate
      i. Geology
      ii. Topography
      iii. Climate and microclimatic conditions
      iv. Climatic trends
   (b) Freshwater resources
      i. Springs
      ii. Streams
      iii. Groundwater Aquifers
      iv. Water resources available for freshwater exploitation
      v. Other water bodies
   (c) Human constructed water supply infrastructure
      i. Municipal water supply
      ii. Historical water infrastructure
      iii. Individual water supply infrastructure
   (d) Temporal and spatial variability
2. Governance System
   (a) Historical social, economic and political context
   (b) Nested resource policies
      i. The EU WFD
      ii. Fragmented competencies of Greek polity
   (c) Local government organisation
   (d) Property rights regime

        i. Areas of nature conservation

    (e) Rules-in-Use

        i. Operational choice rules
        ii. Collective choice rules
        iii. Constitutional choice rules

3. Actors

    (a) Demographic background
    (b) Geographic and cultural differences
    (c) Cooperation and conflict
    (d) Social capital
    (e) Relevant groups of actors

        i. Municipal administration
        ii. Hydrological Engineers
        iii. Domestic water supply users
        iv. Agricultural water users
        v. Tourists
        vi. Associations
        vii. Cooperatives

    (f) Societal water demand

        i. Domestic water demand
        ii. Irrigation water demand
        iii. Other water demand
        iv. Temporal and spatial variability of water demand

4. Focal Action Situations

    (a) Unregistered water abstractions
    (b) Municipal Council's discussion on water pricing
    (c) Self-organised drinking water supply

5. Outcomes

    (a) Socio-economic performance

        i. Efficiency
        ii. Socio-economic sustainability
        iii. Equity

iv. Accountability
v. Effect of deliberation processes in the SES
vi. Empowerment
vii. Adaption strategies

(b) Ecological performance

i. Environmental sustainability
ii. Pressure on resources
iii. Natural habitat condition
iv. Effects of SES management on natural hazards potential impacts
v. Environmental quality
vi. Resilience
vii. Vulnerability

(c) Externalities to other SES

9. APPENDIX B: Interview Guideline

1. Introduction
   (a) Could you introduce yourself in a few words?
   (b) What do you associate with the waters of Samothraki?
   (c) How do you generally interact with the freshwaters of Samothraki?
2. Background & Involvement over time
   (a) What do you work on currently as a scientist/municipal worker/activist?
   (b) What is the history of your involvement?
3. Evaluation of water resources and management over time
   (a) How does the freshwater system seem to you at the moment?
   (b) Have you observed any changes in the quality or quantity of the surface waters over the years of your involvement?
   (c) Which changes have you observed regarding in water management over the years?
   (d) What do you related the changes to?
4. Municipal water supply system
   (a) Which water sources are being used?
   (b) How is the water quality monitored at the source and in the distribution system?
   (c) Through which infrastructure is the water distributed for domestic purposes?
   (d) Is the same network being used for economic activities? If yes, which? (eg. cooperatives, shops, hotels..)
   (e) Which infrastructure is being used for irrigation purposes?
   (f) In which state is the municipal water supply network? Which major technical problems occur?
   (g) Does the water supply cover the whole island? Is it different in different parts of the island (both regarding domestic and irrigation supply)?
   (h) What happens with the water after being used?
5. Water Management

(a) What does management mean to you?

(b) Who is responsible for decisions on water management?

(c) Who is involved in discussions on water management? Which platforms are used for discussions?

(d) Are decisions by the officially responsible bodies/persons accepted and implemented? Are sanctions in place for not following the official rules, eg. not paying the price of water use?

(e) How are you involved in water management? (eg. decision making, discussion, consultation, ...)

(f) Do you witness conflicts between water users during or outside of your work? How to you react? Are the conflicts resolved? How? If you want, use an example.

(g) Are water users involved in discussions on management, creating general rules on water management and/or taking concrete decisions on water management?

(h) Other than municipal workers, are there any other people involved in maintenance of the municipal water supply system? Who are they, what are their roles? Who are they working for or paid by?

6. Historical Water supply

(a) Do you know how domestic and irrigation water supply was organized before the municipality created the current network?

(b) How were decisions made regarding the distribution of water?

(c) Through which infrastructure was water distributed?

(d) How was the infrastructure maintained?

(e) Who was involved in discussion and decision making?

(f) Were there any sanctions if someone did not stick to the arrangements?

(g) Who was involved in maintenance of the infrastructure?

7. (Optional) Issue of unregistered abstractions

(a) How was this situation created?

(b) How many water users to you think abstract without registration?

(c) What do they use the water for?

(d) Is the situation different in different parts of Samothraki?

(e) How does it affect the municipal distribution system?

(f) Are there any informal rules or regulations which you know of regarding unregistered abstractions?

(g) Is there sanctioning of unregistered abstraction from side of the municipality? Is there sanctioning from other water users or from any other side?

(h) Why do you think this issue is problematic? What do you think could be a solution to this issue?

8. Other factors

   (a) How do demographic changes affect water supply in recent years?

   (b) Which current changes in the island's economy do you think could significantly affect water supply? Eg. increasing tourism, changes in agriculture or production. How?

   (c) Are there any natural or man-made threats to the future water supply?

9. Closing remarks

   (a) Are there any stories about water which you would like to share?

   (b) Is there anything you would like to remark which I did not include in my questions?

Thank you a lot!

10. Interview Transcripts

10.1. GM

Giorgos Maskalidis is a resident of Samothraki, co-founder of the association *Sustainable Samothraki*, a bee-keeper, has an academic background and is involved in a wide range of social and environmental activities. A first informal talk was held on the 14th of November 2020 via phone and minutes taken by AB. A second talk was conducted via Video Call on the 5th of December 2020, the recording of which unfortunately was lost due to a technical error. The following are memory minutes from both talks.

Q: What are current problems in water management, and how did they emerge?

A: Currently, the main responsibility for water supply lies with the town hall. The municipality installed a system for domestic water use, which is monitored and paid for by the users. Agricultural use has been managed in the past through employees paid by the farmers, who maintained the concrete channels. They had a system which channelled water to the farmers according to the availability of water and an agreed-upon rotation plan. With the younger population leaving the island for the mainland and country-side residents moving to cities, the maintenance of channels for the remaining farmers broke down. Consequently, the question arouse of how to guarantee water supply for the remaining farmers. The municipality could not provide an alternative system, so the farmers were told to simply plug a pipe into the streams to get irrigation water. So the municipality, in the beginning, supported the illegal and individualistic practice which we see today. I think that instead, the process could have been managed in a controlled, collective way by the municipality - for example by installing one pipe which carries the water to a distribution system further downstream. Nowadays, when farmers have some problem with the water supply, they tend to go to the river and, if there are any other pipes abstracting water from the same stream, cut them off. There is no collective spirit whatsoever.

In the lowlands around Kamariotissa, drillings were made without previous advise or research on the topic. The drillings which are owned by the municipality now work with cards which you can purchase. You then have access to a certain number of hours of water abstraction. The water meters connected to the drillings belong to a company, and many farmers have complained so far, at least in private conversations, that the meters are manipulated so that the farmers pay more hours than actually used.

Sustainable Samothraki approached the previous mayor with the suggestion for a project, to 'cultivate' the springs instead of relying on drillings and the reservoir. The idea was to work on the springs and the surrounding water infrastructure so that efficiency would increase and the amount of water extracted be higher. It was a good idea, but the mayor refused out of concern that the system would have been prone to natural disasters such as land slides.

The domestic water supply system is very old and partly broken, but because some pipes cross private property, it is not easy to replace them as people can refuse access. Again, collective spirit is missing.

I heard the municipality is looking for funding to replace the whole system and build a new one from scratch. But the only person who really knows the water system is Yiannis (an engineer employed by the municipality - AB) , who will retire soon. Nikos K. (a hydro-engineer employed by the municipality - AB) is working with him to understand and learn about the water system.

Q: What about the societal background of those issues?

A: Some problems which we have with water provision are connected to being a small agrarian society. There is a null-sum-game logic. Every new player is seen as a potential threat to your wins - as in contrast to seeing other people as potential contributions to the whole.

At the same time people are not very connected to previous generations and to the land. In 1821, the Ottomans swiped out 90% of the island population in a massacre after some refused to continue paying taxes to the occupant. Many residents fled ino the mountains, but their hide-outs were given away by a few islanders who cooperated with the Ottomans. Afterwards, Samothraki was repopulated by people from the mainland, Istanbul, and Asia Minor, who made use of the already existing farm houses and lands. So also the historical connection to the land and to other residents is relatively young. The trauma is still present, and perhaps even a sense of collective guilt.

Q: What is the role of political organisation?

A: The lack of collective engagement is also a problem of the kind of democratic system which we have here - as soon as the mayor is elected, the people who elected him or her do not feel responsible any more for governance, decision making, or implementation. These things are considered responsibility of the municipality, and the people do not consider that they could do something themselves. This is why a civic forum as the one which Panos and the others (a group of researchers/scientists) want to hold is a very good idea. To start discussions amongst the residents of Samothraki. Another interesting and positive example of cooperation is the farmers' cooperative: It's head is a woman, and after long struggles, farmers got together to cooperate on issues which concern them. To me, this really is an indicator of change.

As for *Sustainable Samothraki*, the board changed. Locals on board currently are more concerned with preserving their islander identity.

Q: How could this thesis support the development of sustainable water governance?

A: It is important to understand the current system, its handicaps and possible solutions. An outsider can bring in an important perspective. You could act as a collector of thoughts for possible solutions.

10.2. GK

Giorgos Kostakiotis is a anthropological researcher who was involved in research and projects on elder care and social bonds on Samothraki. The following interview was conducted via online video call on 20th of November 2020.

Q: Marina (Fischer-Kowalksi, AB) mentioned that during your work, you also came across the topic of water supply. What were you working on in this regard?

A: Traditionally on Samothraki, there was some kind of superficial network of water distribution for small vegetable gardens, which they call Vaxedes. They would cooperate in some way through these. Supposedly, in the old times, they would say that eg. I take the water for an hour and then we close the channel and the another person takes the water for an hour and so on. This I think, as far as I heard from my informants, happened quite spontaneously.

Q: The rotation?

A: Yes. And also the channel system, in the beginning, was nothing more than small water channels dug into the soil. At some point it appears that they made some irrigation system made of concrete - you can see the remains in several places on Samothraki. One goo example is up Gria Vathra, this is a river with a waterfall, a very touristic place now, and they used it to irrigate the Vaxedes. In the old times. Back then, the municipality even had special people employed, they were called Nerokopi, literally water cutters in translation, which was a person which was supposed to channel the water through the channels and all over the small properties. And I think it was about the mid 70s or 80s that people started using the plastic tubes. So what happens now is a chaos because everybody finds a comfortable place in a river or in a small lake or whatever and as they say, they pull the water from there directly to the field. This is not so sufficient and also, in my opinion and in the opinion of many others it is an aesthetic pollution to see such tubes everywhere.

Q: I had the possibility to go to Samothraki and had the possibility to see the system as it is nowadays. I am curious on how it worked before the PVC pipes. You said the Nerokopi were employed by the municipality, did they have wages paid by them?

A: Wages were gathered collectively by the owners of the field, this is what I know.

Q: Do you know why the system was abandoned?

A: I think because the system was not without conflicts.

Q: Which type of conflicts?

A: About the time that you were allowed to irrigate your own property. And I heard that in many occasions people fought for the water.. and that they were beating each other, I mean that happened. It was not a seamless procedure.

Q: Good to keep in mind - not to idealise the past.

A: No, we shouldn't. Actually, from the farmers' point of view, this kind of irrigation system is obsolete. Nowadays, with the tubes, they can go whenever they want and they can get as much water as they like. So according to them, it's a kind of progress.

Q: I had the impression, too, that people from the Sustainable Samothraki Association and scientists are those who say it is inefficient, it is problematic. I was curious what the farmers of the south say, whether they find it easier. But still they are fighting, still they are cutting each others lines so..

A: Yes, old habits never change. They are antagonistic in Samothraki in general.

Q: Do you know if there were, during the time that those Nerokopi went around to distribute water, if they had any platforms to resolve problems? Would they meet or was it the municipality or the court, any way in which in which they discussed issues?

A: I am not sure because my own project did not go so far as to do in-depth interviews with people about Nerokopi. The idea was that we would find those people who were Nerokopi by asking older people and interview them, but we never realised that.

Q: Why, actually?

A: I was into many projects back then and then we were also looking for some funding which never came. I had a PhD running and was working at the same time. So there were a lot of projects with Samothraki, with the municipality, social policy projects.

Q: Oh, that is a lot. On what where your projects?

A: Elder care. We had to do a lot of managerial work also, we had this municipality organisation and also a centre for creative activities for minors, younger children under 12.

Q: How nice, does it still exist?

A: I don't know, I left Samothraki for personal reasons 7 years ago.

Q: So then I am going to go back to some questions about the past, perhaps you know something about it. You mentioned that they used channels dug into the earth, and that they then made concrete ones - do you know around which time that would have been?

A: I think that must have been during the 70s. This I think also expanded personally I think into the 80s.

Q: When at the same time they were using already the plastic pipes.

A: Yeah they started using the plastic pipes. Of course you have to confirm the information I give you, because as I said I have not been to Samothraki for 7 years.

Q: Of course, but it is also very interesting that you had something similar in mind as I am trying to do now, just at the moment it is not possible to go there... I still think that you have a lot of useful information.

A: Ok. I can give you a good contact, a guy who works in the municipality and who actually is interested and has written quite a few things about local folklore. His name is Petros Apostoloudies (perhaps misspelled). I don't know how good his English is though, you might need an interpreter.

Q: Thank you very much, I have a friend who helps with the interpretation, I don't know how that can work remotely but we can try. So you said he is interested in folklore, is he also interested in history in regards to water?

A: Water history, no, but he knows everything. And he has a past memory. He can remember anything, everyone... he is fantastic. I also used him as an informant as some point.

Q: Informant sounds cool, like a person with secret knowledge.

A: Well it's actually the term used in anthropology...

Q: Oh, I am sorry, I am not very familiar with the vocabulary of social sciences. It is often undervalued, how valuable these people are who are up to share information which is not written in books or academic work.

A: This is how I have always worked as an anthropologist, with personal interviews, key informants, observation, collecting data on the field.

Q: Your PhD on family ties, it's in Greek I suppose.

A: Family ties and elder care. Yes. I have a couple of publications in English which you can find on the internet, which you can have a look at, but they are very specific.

Q: Yes I have seen some of them and got curious why Marina suggested to get in touch with someone who is working on elder care, but it is understandable now.

A: Yes, we have cooperated quite fruitfully with Marina in the past. How is she?

Q: That is good to hear. She is fine, full of energy as I guess she was also in the past.

A: Yes that is how I remember her. Good luck, then. It is a very nice project, I think.

Q: Yes, I got interested in it because of the connection to the locals. Since 10 years they are working there, it is a long term project so it is possible to built up something and I hope it will be useful for the people of Samothraki.

A: In my opinion the residents of Samothraki are very negative on change and innovation. But it could be. Things might have changed a bit since I left.

Q: I think some things even changed during the past year that I have been involved.

A: Good to hear.

Q: So I might try to talk with Petros. About the former period, when they started to have Nerokopi, do you know anything about how they arranged who will get water at which time, how they arranged the rules or who was involved?

A: It is not like Nerokopi had a strong authority. It's more like some would bribe the Nerokopos with some vegetables or that the Nerokopos was relative with some and would take a part. All this kind of stuff...

Q: But where there some rules that we was accountable to formally, like, according to the size of the fields everyone receives that much hours of water per day?

A: Yes I think so.

Q: And who would control the Nerokopi?

A: I think their mission was just to regulate, so it was open to negotiations between the owners of the small fields.

Q: And these negotiations would take place directly between the owners or did they have some platform, eg. at the municipality.?

A: I don't think it was so evolved so that they would have some standard procedure on how to distribute the water. I think the general direction would be to have a just distribution so that everybody received the water which they needed, according to the availability of water, but this of course this leaves a large field for negotiation [laughs].

Q: But already there is a value of just distribution, that is already something. This is something I have been wondering about, which values there are in the current and former society that are important in the way that they regulate water supply.

A: I think this is for you to discover. I cannot tell you much about it cause I didn't do interviews. I have a general idea but cannot be more specific than this.

Q: How did you understand in the first place that there was a former system of irrigation for the small gardens and so on?

A: I discussed with older people and they told me. This information was quite in the margins of my field work.

Q: You said you worked on family ties on Samothraki. How would they be relevant for something like resource use?

A: Actually my PhD is about elder care. Family and elder care is a family issue, and it is about love and obligation so this was the main theme of my PhD.

Q: Would you say that love is an important value for most of the people that you came across?

A: Yes, in the way that they understand it. It is not unconditional. It is a give and take love based on gratitude and obligation. In Greek, Ypochréosi, a very important word on Samothraki.

Q: Obligation?

A: Yes, obligation. For example they would not say I am grateful in Samothrakian dialect, they would say I am obliged.

Q: In which situation?

A: For example, I was head of a team with which we were providing care at home. So they would ask us for example that we should pay attention to so-and-so, okay? This was part of our official job, to identify needs and to address them. If supposedly we would do our jobs well, they would think that, for example, it is because we are good, not because we do are jobs as it has to be done. So our goodness in providing the proper care, it was understood as some sort of obligation for return. What kind of return you would not know. But if I need something for example, supposedly, if I ask from a person or a son or a daughter who was part of the project, they would feel obliged to assist me. This happens everywhere in Samothraki: I help you to cut the wool from the sheep, all right? This traditional sort of cooperation. I would expect from you that if I would ask your help with cutting the hair of my sheep, you would be there. Or, if I for example would need help with some other agricultural activity, you should provide me because you are obliged. If you are not obliged it is kindness, but kindness creates obligation. This also happens in families. For example the good parents provide a house to the daughters - this is out of love, okay, because they love their children - but the children, when their parents grow older and are in need, the former kindness creates specific obligations towards them.

Q: And that's the reason why they would take care of them when they are old?

A: I would not say that is the only reason, but that is how things work there. Another example: There is a poor family. And this poor family cannot provide a house for each of their girls. So they chose to provide for some of them, perhaps the most needy. Or for the one that is closer. And for some reason this person fails to provide the care that is expected from them, okay? So this makes them bad persons, dis-valued. If another person of the same family that is not obliged provides the care, they gain symbolic capital. Everybody says how good they are. What they also say is, she was so good to provide to these elders, although she was not obliged. You get the point?

Q: Yes. I guess because... it sounds so similar to the small country side town in which I grew up in Bavaria.

A: Interesting to know.

Q: And I also recently spend some time in a small town in Serbia and this was more or less what happens - one day we decided to give our neighbour a hand with his agricultural work so the next day he passed by to give us cheese, and then again us we went there because we were obligated somehow to be grateful for the cheese, so the next day we would pass by again and help him... And through this a very tight network of help or solidarity one could say came up, except that it was not based on some common, universal belief, you know, that solidarity is good or kindness is good. It was this one-hand-washes-the-other phenomenon.

A: Yes that's the point, I think you got it right.

Q: I will be in a big debt, then, if I ask many people to help me by doing interviews with some stranger on the phone [laughs]. I will have a lot of sheep to cut.

A: [laughs] I think that you will find some people that are genuinely interested to be part of some research, I don't think that you create significant obligation with these activities.

Q: First obligation is anyhow to do something useful for the people so I hope this will work. And you are right, so far also the people who I worked with on Samothraki were genuienly kind and open. It was just a joke... But it is bad news for the water management cause as long as everyone is fine individually and is not dependent on support from others, it sounds like he motivation will not be very high to change the water disribution system to something more collective.

A: If there would be - because I know that water has become quite scarce now

Q: Sometimes

A: - so if they would be somehow that there could be a better management of the resource they might find it positive. That there is enough for everyone.

Q: Actually they are building a reservoir at Xiropotamos river.

A: They have been discussing that for quite some years. I heard about that for 15 years.

Q: I know!

A: And there are also some ecologists on the island that do not give much credit to this dam, they don't think that it will really serve the people and it might also be an ecological disaster.

Q: I agree. I am not an expert but so far what I know about dams is that if there is some way around, you should look for these options. And there are ways around the dam also on Samothraki, if they would change management in other aspects. Also experts prove that if agricultural practices and irrigation techniques were changed then we would not need

a dam. But I don't know how good of an alternative the drillings are. Do you know how long they have been around on Samothraki?

A: I never thought of asking but from what I know, cause my father is also from an agricultural area, drillings I think started during the 80s mostly.

Q: When they had the machines to go down.

A: Yeah. Drilling is an issue also, irreversible.

Q: And from your work on Samothraki, what do you think how much people were connected between the families and also between the villages in the past.

A: In what aspect?

Q: Exchange of information for example. Would they arrange how much of the water farmers would get, was it easy for people supplied by the same river to talk to each other?

A: Well.. What I think is that you can see any possible variation in the social relations. Everybody talks to everyone, but whether they talk in a friendly manner or not is at least contestable. Some people would not talk to one another, some people would be cooperating in an official way, some people would be friends, there would be parties between them, split..

Q: Parties as in political parties?

A: No, unofficial parties. Party is not the proper word.. just like two sides. And of course if I am obliged to you, in some other way I would take your part regarding the water distribution.

Q: What do you mean?

A: For example, If we were relatives, I would take your part. Or if you have helped me substantially in many in many phases of life, I would also take your part.

Q: You mean in conflict?

A: Yes, your side.

Q: Were there some points which created a certain conflict or can it be anything?

A: I think the locals are quarrelling about everything, they have conflicts about everything. There is a local joke there, they say if you want to know who is the owner of a field, you may go there and start building a fence.

Q: [irritated] Okay..

A: So that the people go there and start quarrelling, and the person who stays until the end is the owner.

Q: [laughs] Because everyone would turn up!

A: Because everybody has a claim to everything.

Q: It is good to talk about these things, because I understand more of the society. In generally I wonder, because I heard that the society in Samothraki changed a lot -

A: - not for the best in my opinion. I really believe that during the 50s and the 60s, and also the 70s, they were more cooperative and more affectionate to one another, more caring to one another. But after that period I think they were more antagonistic towards another.

Q: How do you think so?

A: This is what they told me. Of course, you know, if people talk about the past they often refer to some golden era, to some age that everyone was happy and that they loved one another and so on.. But I can tell you that older people, the elders, in their majority, they had better manners, they were more polite and they expressed more solidarity towards another. In my opinion because the life was so hard that you would need to cooperate with other people in order to survive.

But later on, as money started flowing, some sort of status mentality emerged - I am better than you, you know? - and people became antagonistic.

Q: Which changes from the outside do you think were connected to the fact that money starting playing a central role? Higher incomes? Tourism?

A: It is connected to tourism, to migration.. to the monetarisation of economy in general.. It is also connected to the fact that many positions in the municipality, public offices, appeared and people started to compete for thsee public offices - cause they implicate salaries and also status.

In the old times, I mean during the 50s and before, there was this distinct an upper class in Samothraki - rich people that were land owners. The majority were poor people that only had very small fields that were not substantial for their survival and they had to work for the richer people. So this also created some sort of solidarity. But also some sort of, how to say, competition and also ... In the Roman empire we had the rich people and we had the Plebs. And the Plebs were connected in an uneven way with some rich people.

Q: I do not know the reference but... Do you mean that some people managed to be in a higher position, not yet in the class of land owners but still managed to step up in the social scale?

A: Yeah, something like that.

Q: How did it change, that owning land is one of the characteristics of the upper class?

A: One reason is that after the vast migration - because in the 70s the island literally emptied - so what happened then was that a lot of people came back with money. And also that land lost its value. Migrants bought land - a couple of rich families sold a lot of land and invested it elsewhere - so land was more equally distributed than before.

Q: And what sort of mentalities would you use to describe the older generation that you talked to? You already mentioned that they had different manners, that they seem kinder and more helpful, that they understand solidarity as a principle...

A: Not the way we understand it, though. They never though of solidarity as something very diffused - as an universal value. But they would understand the need to share and they would also have bigger urge to assist the people that were in need. In my opinion because they would know that they would be in need later on. Also because they had been in such situations and they had more empathy than the younger generations.

Q: What I found interesting, someone mentioned that since there is, in these kind of democracies we are living in, that there is the position of a mayor for example who officially has the role to resolve conflicts or to manage, to take care for example of the water provision, but then also people feel less involved themselves or obliged to find a solution themselves because there is position, this mayor who has been voted into his office to do this for us. Another interviewee described it as part of the mentality which hinders people from getting involved and finding solutions to problems. Do you think that's valid?

A: As far as I know, you know that Samothraki was occupied by the Turks until I think 1910 or so. Until then there was a Greek representative council that would mediate between the Turkish authorities and the Greek. It was like this everywhere in Greece. The Turkish named it Millet I think, there was this role in the Ottoman empire that religious communities had some sort of internal self-governance. So there were, I think everywhere, in any part of modern history, you would find a mayor-like figure.

That the locals would turn to in order to resolve conflicts, solve problems, and so and so and so...

Q: So you think that there was some structure like the town hall before it was issued by the Greek government.

A: Yeah. And don't forgot that the town hall was issued since 1910 also. It has always been there in one way or another.

Q: It is complex...

A: This is all my opinion of course.

Q: It is helpful that you share all this. I did not plan to do research from such a distance. I am already distant because I am not familiar with the region, its history, the language, culture.. But now it is even more distant because of the pandemic. So it is really valuable that you share all those insights.

A: I would dare to you to visit Samothraki as soon as possible.

Q: Unfortunately it might not be possible before I have to hand in the thesis. But this is a cooperation with the research group, I would be happy to continue working with them and visit Samothraki in the future.

About the island, the geography, climate and water availability is very different on different parts of the island. You studied the society there - could one also say that the society is different? The way that they are organising, according to the different geography?

A: There are different lifestyles - in the north, now, you have a lot of tourists and mostly families which live there, and they mainly live on tourism. And rooms to let, taverns, etc. Some of them are shepherds, also. The southern side, it has more to do with olives, sheeps and goats, and agriculture, field agriculture. They grow, I don't know, corn or whatever they plant there. And you would say that the southern side is a bit more 'backwards'. They are more hard-core peasants than the people in the north. With exceptions, of course, on both sides.

The other thing is that, what I noticed at some point, that it is a very small island. And through intermarriage the separation between the northerners and the southerners is not as clear as we like to think of it.

Q: I also heard that there was quite a lot of movement around the island, that there are some towns which are now deserted because people moved to other towns.. Or that nowadays, as people have cars, they might live on one side of the island but have fields on the other side of the island.

A: Right. And also don't forget that nowadays, everybody has a car, and distances are not so big anymore. So it would make sense 30 years ago - but nowadays, I don't know how relevant the north-south divide is. But you find some very old school hard-core peasants in the south.

Q: What does it mean, what are they characterised by?

A: Er.. a person who only likes to speak dialect, they only care about their sheep and goats, er... they don't like tourism in the island, they don't like people from the mainland in the island, they just want to continue the way in which they live, as their fathers, parents and grantparents did.

Q: Fair enough [laughs]. Well but maybe there will be some way to form an alliance to move together with them to a more sustainable future. They want to cut down tourism, that could be a start [laughs].

About sustainability, the way that you are familiar with the term: If you look at the society and the way that it used resources back in - let's say before the 70s - do you see any points that would be interesting to connect to in terms of sustainable societal values, sustainable organisation of resources - any points where you think 'whoa that is interesting, actually this worked better in the past' or 'that is something to learn from'?

A: Okay... Samothraki, in the past, it was very intensively cultivated. Meaning, every family had their own small gardens, the Baxedes (μπαχτσές), and these would provide most of the food

for the rest of the year. Nowadays.. also the small Baxedes they would be very well cared for and provide a lot. Nowadays the significance of the Baxedes is minimal. What is really significant is sheep herding, animals, livestock. You know, a lot of money enters Samothraki through subsidies of livestock - a vast amount of money.

Q: These EU subsidies?

A: Yeah. So this also changed balances, destroyed the landscape, it destroyed their mentality to love and care for the earth and the fields, because now, for the majority of Samothraki, the natural environment is just pasture - nothing more.

Q: While in the past - what was the connection to nature?

A: People, I tell you, they would... what I believe is that they would work hard on the land in order to sustain it and to live out of it - and also that everybody would have the work they needed. And the island could sustain a lot more people than it does now. It hat two or three times the same population - and it was self-sustained. Poor, of course!

They were poor and they would make a living with difficulty. It was not easy. Nowadays, life is easy, but their natural environment, which I think is forest and also the fields that many of them have abandoned, they are just expendable. They don't care. What they care about is that the goats have food for the next day. They would go with chainsaws in the Macchiera - you know the term, right? - and there they would cut branches so that the goats would eat the leaves.

And then they would wait until these branches dry and then used them as wood. Of course, this is illegal, but everybody does it. So, what was the mentality? At least back then, what I observed was this: to maximise your short-term profit, even at the expense of the profit or the survival of other people. From the 90s to the 00s, this is what I observed. If you would ask me to give you a general picture of the local mentality within a couple of words, this is what I would tell you.

Q: Phew. But it correlates to what others observed.

A: I remember for example, I had a discussion with a woman who was a school teacher, and she was supposed to be educated. We discussed overgrazing and I told her that, okay, within a couple of decades - at most - Samothraki would stop being green and it would become as arid as any other Greek Aegean island. She just shrugged her shoulders and said okay maybe it is part of a natural procedure. It's meant to be. But it is of course because of what people chose to do with the administration of the natural resources.

Q: Ja... what you said about the mentality before - I wanted to say before capitalism hit the country but I don't know if it's true so let's say before the 70s - it seems holistic. Their own life is connected to the lives of others, is connected to nature, is connected to the future and the past - somehow it sounds more holistic as today. Do I care if my children or the future generation will have a green island or an arid island? No, because it is already so much

separated, to pass on to future generations, the separation between nature and our lives, then as you say nowadays people go shopping in the supermarket instead of growing their own vegetables in the garden so they barely touch the earth - it is something we struggle with, also here, in the environment I am living in, there is this segregation between all this different parts of life. And if the mind cannot understand it as a whole, why should I care about these other parts? It is sad.

A: I remember a friend of mine, environmentalist, he had a discussion about the - he was against the burning of garbage because it produces dioxide and dioxide produced cancer etc. In Samothraki, in the past they had a hue problem because they could not agree to find a proper place to create a proper disposal area. What they did finally, and the locals do that, they exported the problem. At some point, I don't know what they do now, but for several years they were sending their garbage with trucks to a garbage area on the mainland - with the ship to Komotini

Q: Yeah, they are still transporting it to the mainland.

A: So yes this is the way in which they think: We - whatever it is this we, my family, my extended family, my village, my group of friends - should pass on the problem to a group of other people. This is part of their mentality, I can guarantee that.

Q: It is going to be much more challenging than I thought initially, I guess.

A: Yeah. So I remember a discussion in which some local said 'why should we not burn the garbage? We used to burn the garbage and everything was fine, why should we not continue burning the garbage?' My friends told them, 'because your children are going to have cancer and die'. He angrily said, 'why do they say this about my little children?!'

Q: All the organic waste which they had during the last centuries, it has never been a problem. How can now someone comprehend that burning plastic is different from burning organic waste.

A: Yes it makes sense in a way. But they explained him all of this. They are stubborn in a way. At some point I had a course social geography I think, I remember that one of the most outstanding things that I ever heard was that agricultural societies were the most stable societies in terms of mentality and the most negative in change. If they know a way of working the earth for example and producing some specific produce - if they solidify a form of production, they continue doing that even though this form of production is manifestly not functional any more. So this is the case on Samothraki also. If you learn to plant potatoes in a specific way you continue to plant potatoes even though there is now this disease that kills all potato plants, for example. Because this is what you know, what you do. They never consider changing..

This is also what has happened with the way they treat livestock.

Q: You mean the animals themselves of the issue in general?

A: The animals themselves and the way how they exploit them. Because what happens now - I have met elderly shepherds and they were telling me with disregard, these guys nowadays, they are not shepherds. Because what we did is that we had 50 or 100 or even 200 goats and we would milk them and we would use their hair and we would make cheese or whatever and we would work, because it is hard work, but we would make a profit out of it. Nowadays they have 1,000 animals, they do not care for them, all they do is that they throw some corn to them so that they don't starve. And look at what has been done - the island is naked, they live on subsidies, and they complain all day. And they also, they told me so, the new generation of shepherds, they are all fat with big bellies, while we were thin and muscular.

Q: I can easily imagine these different lifestyles. This is also interesting with regards to the issue of water, this respect for natural resources - also respect for animals. Of course you exploit them in order to have milk or cheese, but at the same time you see that they live according to some standard...Ii mean it is probably again this interdependence, I don't want to idealise it and say that there was a general understanding of the societal-nature relationships as holistic or some spiritual understanding, but it can also just be that they were dependent on the resources. In regards to water you see how it is wasted. It is wasted a lot in the irrigation, in the supply system it is wasted.. So I also wonder, which is the mentality behind it and did it change over time.

A: Yes but I think that there is a mentality in Samothraki regarding how you would treat an animal. They would think of animals as - they do not really love animals -

Q: ... as a tool?

A: Yes, they have these instrumental relations with them. And they can be very hard with animals if they think that they are not profitable or if they think they are dangerous. If the dog is not doing what it is supposed to do the Samothracian would hang it from a tree.

Q: It is very similar to small town communities in Bavaria.

A: So it is not like what you have in mind regarding I don't know regarding American Indians that they would slay a dear and before they would slay a dear they would ask for forgiveness from their soul... it's not that.

Q: I was also surprised to heard that many people from Samothraki... Because in another talk I said yes, I understand that some habits are so hard to break because they've been working since a long time or families have been living there since a long time and then another interviewee pointed out that in fact, most of the families living on Samothraki live there only since the massacre of the Ottomans. After it took place many people from the region repopulated the island. Actually, quite few people from the original population survived. Do you have anything to say on how that affected the island and the social structures on the island?

A: I am not really sure. I think this is.. well, there has been this slayer, it has happened. I am not really sure that the vast majority of the older habitants of Samothraki did not live. What I know from other examples, is that many people were enslaved and later on freed, and they returned to the islands. What I also know from narratives of older people, some of them were like 100 years old, is that there were a lot of people that they went up the mountain and they stayed there. That is how they survived. They have a saying in Samothraki, when someone is dumb, stupid, and easily persuaded, they say that ah, this guy is one of the 700! Because when the Turkish came to Samothraki, the narrative says, the Turkish told them - everybody had left and fled to the mountain - so the Turkish said that everybody that would appear would be spared. And 700 people believed them and they came down and then their heads were cut. But even these stories survive, so at least a significant part of society never left the mountain, so they survived. Of course there was a repopulation, I don't know how it affected the island, I cannot tell. What I know is that around the middle ages, the island was mostly deserted, due to piracy. There were invasions for slave trade etc. In my opinion, during the middle ages or the earlier Ottoman era, there were times when Samothraki was not so densely populated, and that's the reason why you find many very, very old forests, these old trees. They are the remains of forests that emerged during that period - it's a theory. Of course, it is not my field of expertise, but I could not find any way to check this theory.

Q: Something that came up and now comes to my mind, that I would like to ask about - how much did you learn from the older people who you talked to... If there is a conflict, for example let's say I did not follow a certain agreement or I did not give back to you what I am obliged to do, so for sure there were some mechanisms that people could use in order to sanction me. For example if we have a fight they could take your side, just to show me that, well, you mistreated be earlier so I will not support you in a conflict, or they could also not turn back their obligations of favours.. Do you know if there were other sanctions that people would use?

A: To resolve conflict?

Q: Yes or rather to punish someone if they don't follow the rules.

A: You mean traditionally.. formerly. I would put it in terms of social capital . If you would do these kind of things, and these things were known to the rest of the people, then you would acquire a bad name. People would not trust you. They would not help you because they would not expect that you would be helping them, they would not talk to you maybe. They would scorn you. This is I think how it worked. And this applies quite a bit today, also. But people are not so interconnected in terms of, for example, if I am a civil servant, if I don't care if you speak to me or not, I can keep up with my life as it is with no great losses.

Q: Yes. Because individual survival is quite independent of each other, people can survive basically independently.

A: And if I am someone significant, everybody might say bad things about me but everybody would ask for my help and create obligation.

Q: So they would do deals with you while talking bad behind you?

A: Yeah sort of.

Q: If I think in terms of water management, again, it seems like okay in old days there were the Nerokopi who would distribute the water, it was discussed and it was a bit flexible but somehow people managed to make arrangements that suited everyone who needed water - at least to some extend, though it would be interesting to know if there were people who did not have access to this discussion, also if it was taken care of that everybody received water.

A: In my opinion, I think this applies generally in resource distribution on Samothraki. Everybody has a say, but the opinions of people are not equally weighted.

Q: So you think everyone participated in finding agreement but some people, because of their social capital -

A: - social capital, or status, or earning, their property or power in general, there would be like inequalities.

Q: And nowadays there is this... well, of course officially people are not supposed to put the plastic pipes into the river, officially people are supposed to use these municipal drillings where you have to pay per hour - some card system - but people are not. People are using the plastic pipes instead.

Marina (Fischer-Kowalski, Anm. AB) said that the reason why the mayor, who has the executive power to punish them or to do something about it, the reason -

A: It depends on the votes.

Q: ... and the votes might come from the person who he punished, or that person's cousin, or his wife's relatives etc.

A: Right. This is the case. This is how things work in Samothraki.

Q: So you agree [laughs].

And the mayor, it's not only the status and the... constitutional power through their position, right, it is also a natural authority isn't it?

A: Yes. But not much respected. Everybody has complaints about the mayor.

Q: Yeah, I would not like to be in their shoes.

A: Me neither. I was a good friend of the former mayor and also I have good relations andI respect the current mayor. I think they try their best... they are two very different people. The former mayor was a educated, very rational technocrat. This mayor is a person that comes from the lower classes, but step by step he became favourable and they elected him. The former mayor I think he thought that if he would try the best for the island, and in general, they would appreciate that. But they didn't. Because of micro-politics.

Q: How?

A: Because, for example, if I would try to stop illegal logging... it is understandable that it is for the greatest benefit of all to stop illegal logging. But people would think for example that he did not allow me to cut trees when I needed it etc., so I will not vote for him. When he also raised this issue of limiting the herding to specific areas, to protect some areas, the locals they wanted to kill him.

Also a former mayors before him, they created a lot of unuseful temporary posts so that people would get some salaries. He tried to contain the expenses and he managed it. But they thought that what he did is that he cut all the salaries of people, bla bla, and I know because my daughter she was always working there... And he took the bread out of her mouth and so on.

Q: So, what do you think would be necessary for some transition like what Marina and others of the island are after, a transition to more sustainable, ecologically but also in social and political terms, systems?

A: Well from what I have observed, I don't think it's feasible. But I think about that there can be some baby steps in specific areas. And specific initiatives or cooperatives, that could create some hubs of I don't know, solidarity or sustainability or whatever you may call it. Of course, this is my opinion from seven, or eight years before.

From what I have observed. I don't know what steps have been taken meanwhile.

Q: I heard that there is a new cooperative. The farmers' cooperative - or has it been there before?

A: I don't know, I don't know if you refer to the olive producers.

Q: No, a new one for farmers

A: I don't really think I know something about that. If it has happened, it is a very positive step. Because let me tell you a story from the 80s.

Q: you have been around for a long time huh?

A: Actually I have been there since 2002 but I have been around for 11 years or so.. And I got a lot of stories because I was very curious how this society works. I'm from Athens. I mean these people, they seem to me as strange as they might seem to you on this. And different.

So okay, I'll give you two examples. The one example is from the eighties, the other example is from 2010 when we had been doing some my group interviews with focus groups of interest, one of them was a small fishermen. Small scale fishers.

First example: During the eighties.. Okay, so what do they do with their animals in Samothraki except from subsidies? In order to wire money? They slay young goats during Easter and they sell them to merchants. The merchants, they give a very low price for the meat. So, everybody complains - eeevery year. Every year.

One guy or I don't know if it was one or two or three guys, they had the money and they said that, okay, they went to each and everyone of the shepherds and they told them that, for example, this year, I want to buy the animals, the meat, from you. And instead of, let's say, 10 € per kilo, fictional price, I will give you 12, or 13 €. Okay - deal? Deal! They shook hands etc. When the time came, nobody brought the animals. Nobody sold the meat to this people, to the locals. Why? Because they said, oh yeah, if I give him, he will make a lot of money, and he will become someone, with my own animals..

Q: I see. Like rather sell for the lower price than give profit for your neighbour.

A: Yes, like that. And not to make your neighbour more significant than you. The other example.. These small scale fishermen. They were desperate, they had these complaints about the big fishing boats, that they were breaking rules, they were over-fishing... And they were right. And also they complained that there were two - the shop where you can by fish from - I don't know the name, but there where two of them and all of them, they were selling the fish which they caught to these two shops. For low prices.

So we told them, okay, there is a building in the port, a municipal building which was supposed to become a collective fish market. So that all the fishermen could gather the fish and bring it there and sell it for a better price - directly. And this sounded like a very nice idea actually. Okay, why don't you do that. They said - oh yes, but we need to buy a machine that produces ice etc., and it is so expensive blah blah - we told them, how expensive is it? They told us an amount and it seemed feasible. We told them, if you gather the money, you can buy the machine and then you can run a collective fishery. And they told us - very concerned - okay, we have a problem. We asked, what's your problem? They said, we are going fishing every day in the sea. Someone has to stay there and sell the fish. Who is going to stay there and sell the fish? My wife? His wife? The wife of the other person? Because the women would also need to have a salary. So they would have, in their own mind-set, they would have to make preferences to one against the other, and that would create conflict, so they knew it would not work. Although they were desperate. They could not believe that they would find a set of rules that everybody would take, I don't know, a shift or I don't know, propose.. a solution to this.

Sorry I am a bit pessimistic but this is what I observed. I have been there for a long time, I really wish that things have changed. I think that not all people are like that anymore, things change on Samothraki as they change everywhere. People nowadays and while I was there, I mean they were a lot more open minded in 2010 than they were in 2002 when I first came.

Q: Really?

A: Yes, I think so. But there is this old mentality which is, you know, very deeply rooted in the local society. And it always comes up.. in any occasion. On the other hand, Marina is a natural born optimist. She likes to see things more possible. And the people who formed the Sustainable Samothraki association in the very beginning were people that were not from the island. So they formed a group that was quite alienated from big parts of the local society. And from the hard-core, old-school peasants and shepherds, which are the majority there.

Q: But yeah, I think, if I'm not too personal here, I think it's good trait to be sceptical in your head, but from what you tell about your engagement it still seems like you are an optimist by action, pessimist in the mind, optimist in the heart as they say.

I don't know how much I will be involved in the islands future but it is a good lesson for me to learn how to change occurs. Because there is idealistic way of thinking like if we all believe strong enough and if we understand how the system works and if we stand what hinders us and if we understand how it's all constructed, we can also deconstruct it and build something else. But in reality, and I always was a bit sceptical of that, but in reality, I think it works through very simple learning mechanisms. That people learn if they experience something repeatedly something that works.

So I think on Samothraki it is obvious that if there's if there is a cooperative of farmers and repeatedly they will be able to make more money than the other, then the others will start to think. And if there would be a water cooperative that manages to provide water, even if there is water scarcity, even if there's a landslide, manages to distribute waterfall of the members, then maybe others would start thinking about it. Just approaching the people and telling them, yeah, water scarcity will be a problem in the future, you will have a lot of conflict because of the way that you deal with water, nothing's going to happen. I think it doesn't work that way.

A: I think your approach is a very well grounded, I think you are right in the way that you think about.

Q: It is just things that I hear. Thank you a lot for sharing these very valuable information and thoughts on the issue.

A: Thank you - actually it was a good opportunity for me to remember things that I had forgotten. I would like to wish you good luck and great success.

Q: Thank you! I do hope that one day I will be able to pass by and have a tea in Alexandroupolis.

A: Sure. And if you manage to do your own field work on Samothraki I would be very curious if you could share your results with me.

Q: I don't know if field work will be possible under these circumstances but I will make sure to send you a copy of this work. Thank you again!

10.3. NS

Nikolaos Th. Skoulikidis is a geologist and biogeochemistry researcher affiliated with the Hellenic Centre of Marine Research and a long-term visitor of Samothraki. He previously did research on the hydrogeochemical quality of streams on Samothraki and then got involved in the Sustainable Samothraki research, within the frame of which he calculated the water balance, outlined steps for an integrated water management plan, and continues research on the origin of the island's water resources.

Q: I would like to ask you some questions about your involvement in Samothraki and also about your impression of the water resources, and then also your perspective on management. So first of all, what is your connection to water on Samothraki?

A: Connection to water in general? Okay, so I am an aquatic scientist, and as Samothraki is full of water in comparison to other Aegean island, and as its environment is spectacular in my opinion, I thought to work on the island. Because I was visiting already since many years. So I was examining some Rivers on biological and chemical quality. Then I included them in an European project, the purpose of which was to help implementing the EU WFD. And then I also included these rivers in the national WFD monitoring programs. And then we did a research on our own initiative on many streams and springs of the island regarding the chemical, biological quality, hydro-morpholgical quality etc., and after this I was wondering why Samothraki has so much water. I was involved in hydrological issues, and I thought that - because there were many people saying water from Samothraki is coming from other places from Thrace or I don't know, Romania, from other groundwater resources, but since the island is constructed by massive magmatic rocks, I thought it is local water. And in fact it is local water: We have this big mountain in the sea, and as water evaporates from the sea and is blown up the mountain, the water condensates and turns into vapour through a drop of temperature which collects on the ground, on rocks, on plants, etc. I had this experience last summer when I was on the island, we went to the mountain during the night and we got totally wet without any rain falling. And I also observed that the springs and streams have more water during the night because this phenomenon is taking place dominantly during the night, when temperature is low, and during the first morning hours. We have also installed a meteorological station at 800 m asl.

Q: Since when is it operating actually?

A: Since three years. We also put automatic discharge recorder at the outflow of Fonias. And what we observed, we could proof: there was more discharge during the night. And we also saw that we have high humidity at the 800m asl station. One third of the measurements showed 100% or near 100% humidity - mainly during the night. So this shows that in summer, when

the rainfalls are scarce, the water of Samothraki comes from evaporation and condensation of vapour. The vapour condensation feeds many small springs around the mountain tops, which feed the streams.

Q: So it is because of its high mountain that Samothraki is different to other islands?

A: Yes. Next, what we have to do to prove this is we have to do some isotope measurements of the rain and fog in order to see where the stream water comes from, from the rain, from the snow melting, condensing from vapor, etc.

Then I can a contract from the BOKU, from Marina Fischer-Kowalski, and I was involved in the water management research on the island, registering all water resources, water uses, etc., and calculating how much water is being used per year. Through various uses. What I saw was that the main water use was illegal water abstraction, taking water illegally from the streams and using it for irrigation. Also, that the island has more than enough water to cover the various uses . The problem is water management. It is not modern and very ad-hoc. The island needs an integrated water management scheme in order to use water efficiently and to have water throughout the year for every user. That's all, if you have any other questions.

Q: Yes, a lot! From your perspective - that you are involved since a long time - how did the water resources change over time?

A: I don't think that there is a visible change. Because of the management, however, the resources are not as abundant as they are in their, let's say, natural state. For example, because of the illegal abstractions, some rivers dessicate earlier - they are temporary streams, meaning that they do not reach the sea throughout the year, but dry up on their way to the sea anyway. But I have noticed the point of dessication moving upstream.

Q: I also saw on Facebook that the municipality announced often cuts and shortages in different places because, I don't know, either it is not sufficient or there are some constructions.

A: Yes, they do that, but I don't know if they do any studies for this or if they just go and construct. Some study that has a connection to the Water Management strategy for the whole island. I am not sure if that is a study there.

Q: And how is the European Water Framework Directive relevant for water management on Samothraki?

A: The region of Eastern Macedonia and Thrace create water management plans which they have to send to the European Union. You can read them, they are also in English. But what is interesting, there is one combined plan for Samothraki and Thassos, a nearby island. And there is very little information on Samothraki, in general. The only measures which they suggest are about groundwater salinisation and nothing else. So the official master plans are totally insufficient.

Q: What do you suggest for an integrated management?

A: Most important is that they have to cut the illegal abstractions and replace it with a system managed by the municipality. Also a flood pre-warning system is very important. I wrote about that in our latest report. For the water, it is most important to repair or replace the water supply system - it is very old and inefficient - and then to implement quality controls and frequent monitoring. But for the future of the water system, and also the whole island, it is important to fight erosion and to make sure that the climate of Samothraki, this process of condensation, will not be disturbed. You can check our latest report for more detailed suggestions.

Q: Okay, thank you very much Nikos.

A: And feel free to contact me if you have more questions.

Q: I will, thank you!

10.4. MP

Maria Pitiakoudi is a resident of Samothraki and part of the local association Zathay Social Cooperative, in which she is working with youth in non-formal education and youth exchange. She was also cooperating with the Sustainable Samothraki association and involved in their Summer Schools.

Q: I wrote to your cooperative because of the things that I saw on the internet, that you are doing a lot of education, also covering social and ecological issues, I wonder what is your perspective on the way water is dealt with?

A: Well, I see it concerns our cooperative but right now, the youth exchange branch is active right now. The whole cooperative is not active for the last 2 years. So we are not really doing things as a group. But the part that I am working in now is the only active part of Zathey, it is youth exchange and non-formal education. Of course, now even that is very difficult and challenging because of Corona. But anyway, we do have a lot of things to do and to prepare and things like that. So about the water, I'm quite interested in the water situation as I am interested in general in every situation on this island.

It's very funny because the same day you asked me about your water research, Evgenia - do you know her? - another collaborator of the Sustainable Samothraki project, she's doing a podcast about water on Samothraki at the moment[1] And in many different ways during the last three days, I am thinking a lot about water - while it's raining!

Q: Oh that is interesting! And is it still raining?

A: No, now it's clear. About the management of the water... if we start from the past, I can say through observation and not through scientific research and prove and data, that there was a very simple and very effective way to distribute water in the - and also efficient and aesthetically upgraded way, meaning that it was just some beautiful nice channels that were taking the water from the sources, from the rivers, and then it was splitting into many different directions and then it was happening as you told before, that there was always a person, or a couple of persons, that were charged to have this responsibility in distributing the water equally and keeping timelines and, and then open and close different gates from different channels and distribute the water and there were agreements between the neighbours and the people who were using the channel, about which time they will have the water, which time this would turn to somebody else. This person in Greek was called, is called, Nerokopos, and there were many of them, maybe even changing through time.

This was working the system was working until not very long ago and maybe in some places it still works. But from what I can see from observation is that most of the channels are abandoned because of destruction, natural destruction mostly -

[1] see https://water-scarcity.gr/en/, accessed 14.02.2021

Q: Do you mean leaves and rocks and so on?

A: No, leaves and rocks are not an issue but all of the environmental issues that we are facing, a lot of landslides are happening, so many of the channels are broken from the weather conditions and then because people are not very interested anymore to continue this way they just let them, yeah, deteriorate even faster.

I have a land near Chora and the garden and next to me is the little stream of Sotiras. And there used to be a nice channel system as well here. It was working until just before 2017, before this flood. It wasn't working anymore with one specific person doing the work but through agreements between neighbours, they would change the water and give it to the neighbour and so on, but in 2017 after the flood, the whole tunnel system is severely broken. It is really difficult to rebuilt with the current economic, mental, ...state of people. And because not so many people are interested to preserve the old ways. And now the old ways are replaced with this, to me, really bad, although I also do the same because what else to do, plastic tubes - black plastic tubes, 32 -

Q: [laughs] Ah I was wondering how big they are, thank you for that!

A: Yes, most of them are 32 or 25. This is not to 32 diameters, it's the number which it is called by the tube brand. So yeah, most of the people are using that - I use that! Taking water from the river and then bringing it in. And then in the land, I have my own water system to be able to reach all the other parts of the garden. But this, what I am doing now, it's happening with all of the lands and from this specific river, now, first of all, the biggest part of the source is going to Chora and Alonia, to give water to the whole village -

Q: Is it the same source that you are using?

A: The source I am using, my land is directly next to this source, and it is being used by the municipality of Samothraki to water Chora and Alonia. And these are very big tubes taking the water from the source.

Q: Directly from the spring?

A: Yes, but there are no problems lately with this whole operation. We have a lot of cuts and dirty water, there is a bit of a scandal in the last days about how they manage it. I don't have accurate information, but I know that what they did is they opened a very big hole where the water is collected and on top of that, there's a lot of leaves and whatever else you can find - ya, it's really crazy but we will go and make some videos later because I'm also curious as I've been seeing some things on Facebook that look quite disturbing. And what also is disturbing is that you open the tab and you have brown water because it comes from this water with the leaves.. you know.

Q: Especially on Samothraki where you know that there's some clean water around every corner.

A: Yes it is something amazing to notice in general, how an island that has maybe the most water, from all the Aegean islands, has such a big problem with water distribution. Because we do have a big problem with water distribution. And of course, there is... the water is less and less every year. Droughts are more often and climate is changing, and the fact that at forest and plants are getting less and less, this also makes the water go less and less... Plus, you know you know, less is filtered into the earth because of erosion so we lose a lot of water in general. So I think it's quite bad water management going on the island.

So I think most of the drought problems that we have are because of bad management and not due to a lack of water. And when I say about management, I mean not on a small scale, I mean on a big scale. In between people and also municipal management.

Well, I'll go back to this source where I am taking water from. Two villages are provided from this source, and I will tell you exactly how many pipes are in this source, only in a part of the river okay, so it is for sure seven pipes except the two big ones that go to the village - seven landowners have water pipes into the river.

Q: In Sotiras?

A: Yes Sotiras.

Q: So just to understand, there is this spring where the municipality takes water -

A: No what you say is above - it is Ai Giorgosis and the municipality is taking the water and distributing it to Alonia But the one at Sotiras is the one, you know, where there was a taverna which is broken due to the flood. So this is the location.

Q: I see, there are also still old channels and that place, isn't it?

A: Yes! But also I think at every source there are old channels. I think about 10% of the old infrastructure is preserved. And I am not actually sure but it would be a good research to do.

Q: Mind you, it was the plan to go and do such research, to talk to a lot of people and see all the channels and so on and now I'm sitting here being like, so could you please explain to me where this river is?

A: I was talking about management of this specific place but I don't think that is going to be much different in other places. The pipe system is spread all over the island because if you have your own pipe, then you don't need to communicate with others and you don't need to do to share or to have this trouble of communicating. Now everybody turned into this direction to not actually have to cooperate with anybody else. Which is also a sign of the of the era in which we're living, everybody is isolated in his or her own space and prefers to do most of the things individually, even if this is not actually the best idea. Because it will be much better if we all had one big pipe and then we could share, but it doesn't work like that anymore. And I would prefer the old ways because there were more sustainable. And no to much plastic and aesthetically these pipes are really bad. And I totally believe that it leaves an environmental imprint to the river

and into the water, this continuous streaming of water in the pipes inside. The last month I was so sick of the ugliness of the situation - because now, for half the week I live at the garden and for the other half of the week, I'm living at my home in Chora. Before I didn't have so much time because of work and running around, so I wasn't coming so often. And so the river, the space that we all share together was so bad. I mean, now, the pipes were in anarchy...

Q: The smaller distribution?

A: The landowners distribution, yes. There were pipes crossing each other, it was a big mess and I was so sick of this situation. Plus, lots of branches and leaves, too many for a river to carry... 'Cause also the season, it was autumnal season when this was happening. So I did, all by myself, a big operation [laughs]. I cleaned the river, I took all the pipes out, everything, I opened the pipes, so I put them on the side, I tried to make them separate so and then I took them out of the river totally, so now they next to the river - there are three pipes on the left and two pipes on the right. And they just run along the river and go into the water just a little bit, where you take out the water. Which I thought is much better for the water than before. And I do this quite often because yeah, these changes... Before I did that, for example, I met an old guy, a shepherd who has land further down - a local person - and he was there fixing his pipes, I was there fixing mine because this is also something that's always a problem, if there is a big rain then it goes out, or the animals step onto it and it goes out, or you have to check all the time if leaves or rocks close your pipe or if somebody stole your pipe or if somebody opened holes in your pipe - these things actually happen! And it shows also what are your relations with the neighbours.

I mean, that there are some bad relationships and because of this they go and put holes or steal the other's pipes. This is happening in different places. It doesn't mean that you did or you didn't do anything good or bad but sometimes it happens. You never know what the other has in mind. So yeah I told him let's clean the pipes, let's separate them so that they are not that chaotic and what he did was, he shrugged his shoulders and said something like, who cares? So then I did it by myself and didn't ask anybody.

Q: The area that you talked about, where you're having the gardens - a months ago, I talked to Giorgos (Maskalidis) and he also mentioned that he used those channels until a few years ago. Is that the same area or is it a different one, do you know?

A: Giorgos is taking water from Ai Giorgosis. Yeah there channels are also broken because of the flood. And I think most of the channels that were left working, especially in the area area for Chora, are all broken- in a very bad state. I mean really bad - you cannot even see the channels anymore. The part of the river which got most damaged here at Sotiras, which is outside actually my eastern walls, this is the most damage that happened to the river. There was a little dam that was made by people many years ago, I don't know exactly but for sure it was there for 20 years at least. So this dam, during the flood, was totally ruined. The way the river goes not was not the original way. They made this dam and changed the course of the river and

then it was going more towards our land. It used to go a little bit further to the East, now it goes to the West. So it returned closer to its original flow. The dam was a really small dam, more like what beavers do, not a big dam, but they did it with cement and stuff like that, but it was broken and that was what, formerly, created a small reservoir from which the water then was going to the channels. So the dam is broken and a lot of mud and stones filled it and it changed totally. I mean, the channels totally disappeared. And then the water is turning from the other direction now. And also I know that up in Giorgosis, they also had a big dam as part of the water system. Not only in the beginning of it, which for sure was totally broken, but also further down. So, yeah, these things happen. But also in the old days I think similar things were happening but just people would maintain and re-fix everything every time it was severely broken, And now people don't do it anymore, I think that's a big difference. Okay, the big flood of 2017 was more extreme than everything we were used but have but still I believe that these things were happening also in the past. Just people didn't have any other alternative than to fix them. They had to fix them. There were no pipes in that time to to buy and use.

Q: And they had to do together 'cause you couldn't do this alone.

A: Exactly. And this is something, if you want to rebuild channels you need a lot of hands, it is a lot of hard labour. Moving stones and yeah, it's hard and you need a lot of cooperation to it. And cooperation is, well, not something that is really working on islands like Samothraki - any more or I don't know. Yes, any more.

Q: I also had a talk with Giorgos Kostakios, who was on the island some years ago, and it was interesting because in the small towns or villages in the Alps, it is very similar I think. There are small communities which had to cooperate, but the cooperation was like, one hand washes the other - so they cooperate but actually it is a really utilitarian cooperation, so you remember who did what, this neighbour helped me with the hay last year so I will help him with the animals.. and so on. And then if you're not anymore dependent on each other, because of the changed ways of surviving and living, there is no general base of a cooperative spirit or solidarity.

A: Yeah, for sure in the past, people were cooperating in these ways, but there was also some genuine cooperation in the past. I grew up in a village and there were times when it worked. Of course in these times there was cooperation which was utilitarian, it is always like that, but it has to do with human relations. But you could find genuine cooperation - and actually having fun cooperating as well! But now, with the modern ways of living, genuine corporation is so rare to find, so difficult to achieve, because everybody is in some ego-state, so isolated. And we with television and Facebook and social media... People are like charmed into a weird sleep but yeah.. this is another conversation.

Q: What do you think was this cooperation based on, in the past?

A: Well, I grew up in a community before television came into our lives. And okay, I'm 40 now but in my Village, the extreme use of television started after the 90s. Before there was television,

but it was a social event that everybody would do together. So around '92, '93, slowly slowly people started to go into their homes and live more as a family unit. I'm talking about my experience in my area.

And I remember that there was genuine cooperation because I remember all the happiness and the beauty of people, of the neighborhood, some relatives, some not relatives, just neighbours - we would cooperate and communicate and create celebrations after big community events, like, for example, wood season. Like yes, it would be one day, alll of us would go to the neighbour to help and the next day, everyone would go to another neighbour and then they would come to us. And then by the end of the wood season, we would all meet and have a big, big celebration in someone's a yard. And there was a connection between the people, music and customs and things people had to connect them and they were living the tradition that now is something that we only see as a performance of traditional life. But in the past that was the actual life, they would sing the prayers that they would collect all the surplus tomatoes and have a big celebration while making tomato paste for the winter to come. Everything was happening in a space and atmosphere of genuine cooperation. And of course there were fights and difficult issues, but that was a small part of the life and of course there were mortal enemies in the communities - but still, that was always the exception and not the rule. Now it's the rule and the exception is to actually have somebody to celebrate with. And I also with Corona it became even worse [laughs] everybody's actually online talking like how we do now about things.

Q: Though if it can happen in real life, it can also work online! And where is this area that you grew up in? Is it the mainland or an island?

A: It is on the mainland and it is the same region, Evros, which Samothraki also is a part of. It is like 6-7 km north-east of Alexandroupoli. It is called Souffly, my home-town. And I lived in this life until I was like, yeah, teenager, like 90-something. And I really do remember that television and the bigger markets changed our lives a lot. I mean a lot. In that town we didn't have phones, it was just starting to have a little bit connection with very simple MS-DOS programming. You know, it was really the beginning of a new era, actually. The digital era.

Q: I missed the point in the beginning to give some background on the research. So of course, there is the question on water management on Samothraki, which I am covering with the master's thesis. But in Vienna, where I am at the moment, we do have similar problems of course. In general, this very individualistic culture is a increasingly global phenomenon. And questions of cooperation, why would people not cooperate, if it would make so much sense and provide a good solution? Somehow we are so much stock in our individualism and stories of, you have to do everything yourself, you will be successful alone. But what does it mean to be successful? So I think that it's just one example, Samothraki, and I could also study myself and my friends on the same question. Basically, what you say about the feelings and relationships we have to each other and the difficult of building bonds to each other, it suffocates me in Vienna at times because it's.. it's a different problem in the city but a similar background. Perhaps as an outsider it is easier to not be

involved emotionally so much. And the way in which it changed so much on Samothraki makes it perhaps easier to point out reasons for these changes, like, the introduction of pipes for example. I don't think that's the reason, people still could decide to cooperate, but it's a relevant aspect. So Samothraki is just one example of research is not like..

A: You know, I'm here for many years now. I'm living constantly since 7 years now, but before that, I was on the island since I am 17, you know, I came here for seasonal workers, vacation... Mostly actually, for seasonal work, because be goal was to live here and be here. Because Samothraki was always calling for healing. And to work here meant that I could be here from the end of spring until the beginning of autumn. And that would be for me is my recharging time, to recharge my inner batteries, my spiritual batteries, so I can continue to live afterwards I in the city. It was out of necessity that I was coming here because I felt that if I'm not going to come to Samothraki, I'm not going to be able to survive the city life. Cause city life was quite fun and full of adventure when I left my village to go to the big city and, you know, broaden my horizons and have experiences and connect with people... It was quite good for my 20s I would say, but approaching my 30s I could feel the suffocationin extreme. And when I turned 29, I felt I could not survive the city anymore. Without nature around me, without being able to see the trees, to have good quality water, to breathe good quality air. And it was not really so important anymore for me to be socializing and to have the opportunity to go to the theatre. I already understood that I will not be going to the theatre anyway, 'cause I worked two jobs and study and I had no time to do any of the cultural stuff, which I'm now doing when I go for 10 days into the City, and I have some money and I have a lot of energy and I go and then I enjoy culture. Before I couldn't enjoy what I had around me because I was constantly working and I was constantly exhausted by overworking and over studying so I said, what the heck, I go, there is no reason for me to stay here. And so it came to Samothraki. It was challenging in the first two years, I left and then I came again in 2010 and from then I'm here. So I have seen how difficult it is to cooperate on this island, but I have seen also how difficult it is to cooperate anywhere in Greece, specifically. I have experienced it differently, for example, when living in Holland for a while. There I learned, actually, the principles of cooperating. Because before that, and I'm saying that with big certainty, while I was in school - and this happens still now,I mean that was in school 22 years ago when I graduated high school, but this is still happening right now - that there is not, in the Greek educational system, not one task that is happening in cooperation with others. So there is nothing in the eduction system about the concept of cooperation. The only thing that you will learn in school is how to do things alone, isolated and competitive. And how to be the best, how to have the best grades and how to succeed on top of everybody else. There is nothing at all. Not even the single task that they give to the children or to the teens to do together in. This is why I decided to enter into the youth working environment and non-formal education. I was trained for 6 years to do this and what I do in the camps that we are creating with my partners from France and Germany is actually learning together with the kids and teach also the ways of cooperation. Through a very successful cooperative that we have with three partnerships, France, Germany, and Samothraki, it works very well as a joined

cooperative with a lot of inner processing. Because you cannot expect to cooperate if you don't process in your inner self, what's going on, and why the others behave like that and why you behave like that towards the others. Without this inner processing and reflection you cannot cooperate. And this is why I chose to work with teens and try to practically give examples of cooperation and this actually works because I can see the difference in my first group, seven teenagers from Samothraki that are so easy to cooperate with now. It really is, they come here, they came just a week ago, here to the garden to volunteer, to support me here and they could actually do something together in harmony, really nice and they just do it with easy! This is something I cannot even do with the rest of the members of my cooperative, you know?

Q: Were is the youth coming from? Do they come because they are interested or how do you find each other?

A: Well, when I started this program, when the cooperative actually started the program - at that time I was not in the cooperative yet, I mean Zathay cooperative. Because of my background with volunteerism and I went to Holland to live as a volunteer and my background in general has a lot of, let's say, experiences in the international field, so they came and they proposed me to take this job and be the youth leader and project manager. Of this Zathay youth project. So when we decided to do the first camp it was 2015, we made an open call to the high school with the target group of 14-18 years. And, ya, we just explained what we wanted to do and then we had some applications and to make it democratically we made an open lottery in which 7 people were picked randomly out of 12, in the first phase, cause these programmes are for 3 years with the same participants. So they experience in Germany, in France and in Greece the whole experience. So they know how people are doing things in three different countries. And so the second time we did it, now we are at the end of the second phase of with other seven kids from Samothraki and France and Germany. This again, I followed the same protocol and I had the seven people out how of 22 applications - it doubled - and yeah, now the third one, the whole adventure of Corona will end. It will find me with a bigger group, I have three new members, trained the last year, and two out of three are from my first group.

Q: Oh how beautiful! And it sounds very good this combination of abroad experience and personal development and cooperation spirit, that you mentioned.

A: Yes, especially the first group that I had - because the program was also two weeks duration, which makes me things even deeper thant the one week that it is now. The metamorphosis of this young people was so deep, that it was obvious even at the time it was happening! So, now, okay, the second group with only one week of camp is not as deep aa metamorphosis as it was in the first group. Of course it has to do with a dynamic as well - personally as well as collectively. But yeah for me this is one way through which you can change this very dysfunctional part of mis-cooperation and isolation. But yeah, we went out of the water issue.

Q: Yes.. I also wanted to ask you how available you are in terms of time, if I could get back to some questions regarding the water distribution?

A: Yeah, we can communicate and still now, I'm always quite busy because I choose to be [laughs] but yes and I can find some time...

Q: Ah thank you, but I meant now -

A: Now I can stay for another 15 minutes, let's say.

Q: Okay, let me have a look at the questions which I wrote down, while you talked - was a lot of interesting things I am curious about. So one thing that you mentioned was that in the old days, that the distribution between the different channels and the system in the gardens, they were based on some agreements between the neighbours, but also the Nerokopos. And he also mentioned that nowadays in your garden, you also have some agreements with the neighbours on which time, who will get how much water.

A: No, I don't have but a few years ago, the person who had this Garden before me, he had because it was before 2017 and the system was working. So they had agreements with the neighbours that, okay, until 6pm I have it and between 6 and 9pm you have it, and then 9pm to 12am the other has it and it was working somehow like that. But no, I don't have any agreement with anybody now because I have my own separate pipe and this is the same for everybody else. When you have your own pipes you have no reason to cooperate with anybody else.

Q: And there's not even something like water scarcity in general and then you would have to talk to each other because you all would have the same problem?

A: Until now there is no such problem, but there is a big possibility that this will happen.

Q: And in terms of these agreements before, when the channels are still in use, do you know, perhaps, if the agreements were made just between neighbours, or if it was including everyone who uses the same water source?

A: cannot give you this information because it's not coming out of my own experience. And what I only remember for my friend, Nikos was living before me here is that they had specific times that they needed to respect,that they had the water. And this is the only information I have not from immediate experience but close experience. But I think for this we need to think who actually has this experience from the past in the area, or different areas. And there are people, because this is not really far away in the past - it is like yesterday, you know?

Q: Yeah, I got some names of people who would know, but then, it would be complicated already to speak on the phone or online and then to translate at the same time. I think it's just too much. But there are some older women who speak German, so Marina, our professor, gave me the contact of one specific woman that we also met in the summer school. Tina. She speaks German which makes it easier. Because to speak with elderly people on the phone while having it translated - I don't see how. It surely is interesting but perhaps it's just not something for the moment.

A: Yes, it would be good perhaps if the researcher was Greek.

Q: Very true [laughs].

A: I am very interested in water in general. It is something that I have a very deep connection with in many different ways. So I care about water a lot - first of all, it's one of the most important elements of life and it is our second basic needs. So it's really important to care about what is going on with the water. It is really strange that just within a few days I have water researchers finding me from everywhere [laughs] ...is that a sign?

Q: Yes maybe things are going to change soon, who knows?

A: Things have always changed. Do you have another question?

Q: Two more short ones, actually. You mentioned about the pipes that are using that you have to replace them and work on them. Like how expensive are they? How often do you buy new ones during a year? How many days do you have to work on them? Just to understand how much work it is...

A: I don't have to work on them often and and I didn't buy at all in the beginnin because I inherited the pipes with the land. So I never bought pipes actually. But what I bought in high quantities are connections for the pipes. Because the pipes are not one big pipe but there are different parts that need to connect to each other. And so you need to have different kinds of connections and there are the very simple connections, but very difficult to actually use because the cheap ones that cost like 50 cents or something they are smaller than the pipe and then you put it in the pipe and then connect the pipes. But it's really difficult because a lot of things get stuck in there and it's very difficult to take it out and back in and to check, because you have to check your your pipes quite often 'cause many things are going in and everybody has different system how to prevent that. Everybody has different systems to collect water so that the pressure is high. So you if you make a round to the rivers and take pictures, you will see how many different systems there are to connect pipes without buying anything. I bought a lot of connections and they stole half of them during times that I did not come so much. So yeah, then I had to to find other ways to connect it again. It's a whole business and, yeah, you need to spend some time every day with the pipes to see if water is coming, find out if something is stuck, and if something is in, you need to find where it is. You are going up and down up and open the pipes and check if water comes.. you are swearing, you go up and down again... This, in the beginning, when I started to do this, I found it so hard and so difficult with the old way of the connections it wouldn't open because it was really stuck together by force. Slowly slowly, with the years, I became a kind of master of the pipes. So now I'm designing my own water systems and I am easily finding their the ways to unblock them and all that stuff. You just need to do something quite many times, fail a lot of times and then start to succeed after a while. So there is some work about the pipes. If nothing major happeneds, like a very bad flood, for example, in the flood of 2017, I lost a lot of meters of pipes and they were underneath big rocks so that

they couldn't be retrieved. So, I cut parts that are still underneath the big rocks because they cannot be moved. And then they were many of them with holes and some of them crashed and so, but I had some more to replace them, otherwise I would have to buy new. So if something like that doesn't happen, then you don't need to replace the pipes, they are quite strong and they can last for quite a while.

Q: Yeah, plastic.

A: I think it is a good plastic, the hard one. It doesn't deteriorate that easily. But yeah there are two things, weather conditions, floods, difficult stuff like that, which can make you lose pipes, or someone can steal your pipes.

Q: And about the issue that you mentioned, this recent issue about the water of Chora which is nor very turbid and muddy and so on - is it an issue that you connect to the current municipality or is it about long term management.

A: Sorry, I didn't get it.

Q: You mentioned before the problems with domestic water supply and I tried also to follow this on Facebook and from the discussions I couldn't understand, it seemed to be blamed on one hand on the current municipality and on the other hand it was said that no, its long-term problem from some time ago, some some consequences of earlier mismanagement. Where do you see the origin of the problem?

A: Okay, the origin of the problem for this specific issue - but not only for this, for all the issues in my optinion - is the lack of a bigger plan. I mean, nobody from the administration has an actual plan. We have to think holistically about the whole situation and take first steps in order to do that. And listen to people who actually know, like Nikos (Skoulikides, AB) who is here since so many years doing research on the on water and I'm sure that he would easily advise them and create something more efficient, but they don't listen. And they don't have a big plan. What is a big plan? It means that you design - you cannot do water distribution or create a system that is efficient when you're thinking only in patterns. How to make a patter.. easy fix, I mean, in order to solve a problem. Because everybody who's coming into the administration is having this kind of behaviour towards each problem on the island, how to quick-fix things. Because, look, there is a reason why they do that. The 5 or 4 years of the administration will show to the people what they did. And if they follow a bigger plan that has an overview, they will probably not have the time to complete it and have results, and if they don't have results the people will not vote for them again and then they will not be in the next administration. This is a political issue that leads to the practical issue of really solving problems. The water issue is an issue that really has to be broken down to, which resources do we have, how can we design these in the a wy that everybody gets water, as equally as possible and how are we going to distribute water to the nature, which is also needed. But this needs to be a system that somebody really needs to think and research and observe and put things down and create a good system of management.

Something that cannot happen right now with these people who do not have this overview of things. The water issue is a very important issue and it is simple and complicated as well. It drives all the other issues. It is economic, political, social, ecological - all the things. So to me, what happens right now is just a series of bad quick fixes. One after the other failed and we got into a labyrinth of strange thinking, strange solving thinking of the current, let's say, water technicians. They have their own way. For example, it is really strange and weird that there is only this one plumber that knows, in his own mind, how the water system is going on in Samothraki and this guy is old. In the last years there is Nikos Koutsouris who is following him and trying to understand what is going on, so that there is someone left behin with some knowledge but still there are two people knowing all the water system - I mean if these goes away for some reason then nobody knows how to actually do things! There is nothing like this written down, I think, there's nothing, no system, no design not even a blueprint, it's only in the mind of people.

Q: Yes, many people referred to the map in the head of Yiannis, the plumber. From the outside - from my perspective - now it is easy to talk, the hard thing is to do something. But it seems that there is a lot of potential laid out in this issue as well. Like, there are so many interested people in the issue there, so many people who are trying to understand what's going on. There are so many different small steps, people like you, or also the recycling initiative, working with younger generations towards changes in the mentality. I think there is so much potential, it is just a question if it translates into action, as well.

A: Yes, I say that we need a bigger plan, but for sure it is not like something that easy. It needs somebody from the administration, a mayor or someone who is determined actually to find a permanent way to solve the issue and not dedicating all of his time to quick fixes. It needs the intention of of somebody, but even if somebody had the intention, you never know if you're going to get elected again. And this intention is going to fly away, you know.

Q: Maybe just as a last word, also to alleviate our minds a bit from the whole discussion and so on, do you have any favourite positive story connected to water in general on Samothraki.

A: Favourite positive story... Well, lately, one positive thing that is connected to water, that is coming out of a reality that is not so positive, meaning that the last months I was not drinking water from the tap anymore in Chora, because I have noticed that the taste is not really good. So I decided that I would go to the to the source of Palleapoli, you know, where it was this big Byzantine towers are there is a source that the people say, and I think also Nikos confirmed it, has the best water of the island. So I was going there, filled my bottles, taking them home and then drinking this water. And I do this trip every two days mostly to to fill fresh water and what I'm doing, some of our friends are doing as well, some from before and some because I'm doing it because I told them that, for example, I was drinking the water from the source for a month and then I tried one day to drink the water from the home and I was like, urgh, what's that?! And you know, if you drink it it's really good quality water. And did you compare the

water from the tap with Thessaloniki's water for sure is much better but still - for the water that we have here, Chora is now for me a no-go, and source water is yes. And so my partner was still drinking from the tap, so I said to her what, are you still drinking from that and she said, what you talking about? I've been drinking this all the time. But it has a weird taste, I said, she said come on, you are over reacting. So I suggested her to try for a week to drink from the source of water and then try to drink from the tap water again, and then see. She did it and now she also only drinks from the spring [laughs]. And I said that to Zofia, maybe you met her, she is our president in the cooperative, and then she did it and now she is also sending her partner to the source to drink from the source. There was a day, about a month ago, I was going to Therma and before that I wanted to stop by the spring in Paleapoli to to fill my bottles. When I parked my car I saw two more cars parked on the right side of the way to Therma and at the spring I saw people, talking, communicating, while putting water in their bottles. I stopped and it was Carlota, the ex-president from the Sustainable Samothraki association, and three other friends of mine. And they were talking, some chit chat, while waiting in the line to get some water, and so I got into the line as well in this really reminded me of the old times where people were connecting and communicating while they were in the process of fetching water for the house. And for me, this is.. all of this comes from a difficult story, I mean that you your tap water is not good, but it all goes back to community meeting at the source. So I still smile when I think of this moment when we met in the source, and were reminded of how important it is for water to be clean and to be full of aliveness, you know?

Q: Wow, this is a very positive story I think. Somehow it is not surprising that women and youth are very crucial for these things. Thank you so much!

A: What I would like to tell you, because also for the other research, the podcast, I am collecting sounds for many years now from water. For my more artistic experiments. So anyway, I am really interested into water and I would like, if you want, to kind of support you in this research if you are sticking to it - is it going to be your master's thesis? Yes? So what I could do, something that is interesting for me to, I mean, I am not only going to do it for you but for me and then share it if you are interested: Since I'm interested with water and with the old ways and the new ways I would really like to go and take some documentation of old channels and go to the rivers and see how the distribution works - out of personal interest with this subject. I would like to make this research and maybe talk to some people, that is going to be in Greek but then we see what we do with this. I was thinking to do this in the last days before we even talked, because I was motivated from the other research. So how does it sound to you?

Q: It is an idea I am also interested in general, plus it would be super supportive for the thesis to understand, because, of course, the infrastructure plays a role, not only the mentality and the decisions and so on. So it's very interesting to see the pictures, what is being used and what was used in the old days and so on. And also in general, I'm interested, also after the master's research, to understand more about the issue. The thing is that I am about to finish the thesis, and I need to hand it in quite soon. So of course I don't want

to put you under pressure - if you are taking pictures before I am handing in, I would be very happy to include some pictures. But if it is after the deadline still we can think of some way to work with it, because, you know, a master's thesis not many people are going to read it so I was thinking of writing an article that's much shorter and that maybe even could be translated to be more accessible. And some points from the thesis could be disussed there, in combination with our pictures.. and maybe we can think of some way of how to cooperate on that.

A: So I will see, I will check my.. power and see if I can provide you with some pictures until you hand in.

Q: I really like the idea but also if it is disconnected from the thesis.

A: Okay, that sounds good.

Q: Thank you, really, for this long talk and many interesting points!

A: And I hope I can continue to help you. If you need to know whether or not to have the pictures before you hand in let me know the time frame, and I will let you know whether or not I can do it. Think about it and let me know... Alrighty, thank you as well.

Q: Thank you, it really motivated me a lot, because I had many question marks in my head.

A: Okay. If you have any other questions, let me know.

10.5. NK

Nia Kaiser is a former resident of Samothraki, who left the island in her childhood but returns regularly for extended stays at her second home. The interview was conducted in German language and via phone on the 14th of February, 2021.

Q: How do you remember the water infrastructure of your early days on Samothraki?

A: I left Samothraki in 1960, as a young girl. As far as I remember, we had running water back then - it was just the beginning however, in the mid 50s... 1957 the first pipes were laid in Chora. So running water is a very remote memory. Then I left for Germany and returned 1964 for the first time. Beginning of the 60s they had running water in Chora, I do not know if this was the case for the whole island.

Q: Who organized the infrastructure installment? How was the water transported and where did the water come from?

A: The Municipality, they laid pipes, I guess under-ground. Do you know where the cemetry is? Just above it is a spring, this is where the water must have come from and from there it was distributed to the houses. I don't know if the same system is in place today. But currently there are problems I heard.

Currently, I only visit during summer. As far as I know, the previous mayor discovered in the course of the flood that the canalisation and water supply infrastructure had never been repaired or renewed. My brother still lives in Chora and from what I hear the situation seems to be very bad. After all these years, the system finally needs to be replaced.

It has been two years now that there has not been a single renovation I heard.

There are also some issues during summer. I live in Ano Meria, we always have sufficient water over there because this is the water-rich area. In Lakkoma, on the other side of the island, they are always struggling with water during summer.

Ano Meria has underground pipes for the drinking water and over-ground tubes to get water from the mountain for watering. The pipes are old, too. For sure we also will face problems with drinking water in the near future. Canalisation is not 100% safe either. If a mouse or some animal cadaver enters, there will be a problem. The system must be checked and renovated.

Q: How was the water provision in earlier times? The canalisation/pipe system as well as the tube system.

A: There were no tubes in former times, people also didn't have money for that.

I lived in Ano Meria as a child. There was a water man, Nerokopos, who carried a huge clock. He calculated how many hours of water access a family would get based on the size of their

property. This was the water used for watering. From this to that time, regardless of the hour of the time of day. Then he would say, hey, get up, water is coming.

He would accompany the water, to make sure it reached its goal and wasn't channeled off somewhere.

According to the property size, water would flow for hours, until everything was watered. Then it was the next one's turn. And so on.

Until it was your turn again, three weeks could pass, sometimes four weeks, depending on how much water was available.

If the flowers got thirsty, children were sent with jugs made of clay to fetch water from the streams.

It worked perfectly well. The system was quite strict. Everyone stuck to it.

If the beans would hang their heads, my mother used to say "One should not spoil the plants, anyway. They so tolerate some aridity" And I have to say, now I am surprised how, but it always worked out.

Every village hat a Kopos on its own. Our Kopos was staying close to the old school, but he was always out and about. With his big clock.

He would take naps while a garden was watered, but had to be active whenever the watering took turns, as the water flowed continuously. My mother would keep her gumboots close to the door cause she needed to be ready anytime. It could be our turn in the middle of the night, 3 or 4 am. The Kopos would keep everyone on track about roughly when one's turn will be, but you could never know exactly, and anyway other than the Nerokopos no one used watches. So he would come and wake us up, help my mother channeling the water to each patch of vegetables and flowers – corn, cucumbers, beans, olives, and whatnot. The smell of damp soil after weeks without watering still returns when thinking of it today.

Q: How long did this system persist?

A: I think well into the 60s. Actually… much later, about 10 years ago [around 2010, AB], I was visiting Kato Kariotes and an aunt of mine there said something interesting. They also use tubes for watering now, partly with integrated pumps. But she said, actually we should not lose the channel system. We should not withdraw from claiming this system, claiming our rights to water. So they re-activated the channels. I don't know exactly how, but they are agreeing on who is using the water at which hours by themselves. And everyone has to keep the channels on their property clean. There are not so many anyway.

In Ano Meria there were a lot of channels, there were several... districts, so-to-say, and each of them had two channels. Then in the springtime, there were joint actions to clear the channels. That used to happen as teamwork.

Q: Was it organized by someone in particular, was this also the Nerokopos' responsibility?

A: No, it was not organised explicitly. And the Nerokopos did not participate. From what I remember at least, you know, I was just a little girl back then.

The time to go to Ano Meria was in the spring, when the season to till the gardens starts. But school lasted until mid of June, that's why I had to stay at Chora. Only in the 1950s did all towns get teachers, and I could go with my grandparents to Anomeria and my grandfather no longer had to till the fields on his own. There were cucumbers, zucchini, tomatoes. Beans only from June onwards...

At the end of the 1950s, the beginning of the 1960s, this mass emigration did not yet take place. There were about 6000 people on the island and large classes in school. We lived a nomad life, moving from the towns in the center to the smaller villages during summer.

Q: How was water provided for in the towns?

A: Before they installed pipes in Chora, people used fountains to fetch water. It worked very well, I remember us children going to fetch water. The only problem was in winter when it snowed. In this case, pots were filled with snow and placed indoors to melt and turn to water. Running water only came later, towards the end of the 1950s.

You see, the problem was this: People left everything head over heels, for example when we went to Germany, we still had a house in Ano Meria and about 300 sheep and goats. We went to the Federal Republic of Germany to earn money. In my childhood, yes people were working constantly, but we always had sufficient food, not once did I suffer from hunger during childhood. The only thing we didn't have was money.

For example, there was a colonial goods store [Expression for convenience stores selling imported goods from (formerly) colonized regions, AB] on Samothraki. People went there from time to time to get colorful textiles for us children, also coffee, sugar, rice, etc. They would have it written down, and when my parents or grandparents made charcoal for winter, for example, or when we harvested our walnut trees – we had more than 10 enormous walnut trees in our garden – then no one came from the mainland to buy our produce, instead, the colonial goods traders bought it to square accounts with the debts we had accumulated. But they always calculated in a way that we were left with debts.

Then we heard that if you would emigrate to Germany or Belgium, you could make money, at least you are getting paid. Same we heard from women working in the tobacco industry.

So, our father went first, then I, my mother and finally my brother. My other brother stayed. Many families got ripped apart during these times. I now have children of my own, they still went to Samothraki, but the third generation does not go anymore. And from the children of those who stayed, also only a part of them stays. There is only a certain margin. We did have a wonderful time as children, though.

Q: Did any conflicts occur in regards to water?

A: Well, for sure, as a child I did not follow so much what was going on around me. But for sure there are always some people who think that noone will realize.. ... you know, everyone was in need for water. For sure they found a solution amongst each other. There also was no money to go to court or something. I cannot remember any bad conflicts, like someone having a spaten thrown at them.

Q: How was the Nerokopos reimbursed?

A: I don't know, I would have to ask my brother.

Q: And why do you think the channel-base/Neropkops system failed eventually?

A: Our property in Ano Meria was unlived-in for 40 years, so people put their sheep, their animals there, used the wood, harvested trees, put up fences and so on. Later we discussed with other families that actually it is the municipality's responsibility to restore property rights. Same for water access: In the beginning of 2005 they said, we do not have any money, install tubes of your own.

Some of the older infrastructure was still operatable. The channel close to Xiropotamos was beautiful, in a very good shape – we went there often to hike – but after the floods of 2017...

I think in general there is too little interest to reinstall the old system and a "leave me alone" mentality. The missing cooperative spirit I think is connected to weak interdependency. Instead of bothering to cooperate I can pay a few hundred of Euro and have my peace.

Q: How much does it cost to install tubes on your own, roughly?

A: You have to know that we really thought through our water system, so we paid 1.500 in total to install it. Initially we thought about cooperating with the others, to suggest buying cement and have someone restore the channels. But we were concerned about prejudices against Germans. Especially my husband who was German by birth. He experienced how, whenever he'd propose some impovement to the way things were done, people would take it as "the German" trying to tell them how to do things, interfering with their way of doing it. So he gave up and we bought tubes on our own, now water is flowing day and night. The overflow is redirected into the stream. So no more getting up at night.

A: The tubes have to be installed together with a couple of people initially, then afterwards it still is a lot of work, but it's something we could handle. Every year when we left we removed the tube from the stream and tied it to some trees, so when we came back we had to reinstall it, make sure there is no air inside, clean it and so on. It is an ardous task...

Q: Who did you do these works together with?

A: Usually my brother, cousin, and husband went together. Now, as my husband died and also the others are getting too old, we will have to gather some young people. But we also started preparations to install a pump. The stream surrounds our property so that it flows beneath the

gardens. Once we cannot take care of the tube system anymore, we will have to pump the water up directly from the stream on our property.

Except if the municipality agrees to install a irrigation system for our gardens.

They think that nowadays most are keeping gardens as a hobby only. But I need them. They are an integral part of our surroundings, an living in nature to me means having green gardens.

At the same time it is true that there is a drinking water problem for some towns. On our side this problem doesn't occur anymore since the 90s. It is on the other side, from Kamariotissa to Profitis Ilias.

But I don't know how they solve it. I just hear that there is a problem but I don't know who is taking surplus or where the problem is coming from otherwise. Because on the other side they in general do not have as much water as we have on our side. But there are olives, corn, wheat, everything that needs water and the water just is not enough for that.

The former mayor once installed a system for irrigation from Xeropotamos, but I don't know what stayed of that now.

Q: Is there a difference in how people approach water-related issues now and formerly?

A: In former times, people very aware of and careful with the natural surroundings. The considered each tree they were about to cut down. Nowadays, the ones who stayed on Samothraki think that they can appropriate everything. I just want to return and cultivate a little, feel well... in the beginning it was not easy. I had to reclaim our property.

Because meanwhile, others had let their animals in, installed tubes, had their pipes passing through our property etc.

So I find it good and correct that they introduced cadasdre 10 years ago. It is just very difficult because most of us cannot prove what is theirs.

Q: Thank you very much!