drawn when the subject is assessed in the city of Istanbul is the city's significant potential for the establishment of the defence mechanism. However, disaster risks, population surplus, restrictions on possible interventions to be made and great usage of private vehicles make it difficult to use the potentials efficiently and effectively.

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ID 1546 | DROUGHT RISK, FARMER COMMUNITIES' PERCEPTIONS AND PLANNING FOR RESILIENCE IN RURAL CRETE, GREECE

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ABSTRACT: Drought incidents may originate from both, manmade and natural factors and are characterized by uncertainty. The present paper attempts to shed light on the interrelations between exposure, drought perceptions and the adaptive responses opted by agents attempting to cope with drought risk and to provide insights into the planning processes implemented at the levels of the individual agents and the water management authorities. The choice of personal versus collective resilience strategies is largely a function of risk perception and the availability of resilience assets, but it is also a matter of power relations and alliance forging. The farming communities and the local self-government authorities of Messara plain in rural Crete provide the testbed on which the authors have attempted to scrutinize their initial assumptions by using appropriate questionnaires and interviews with key-staff of planning authorities.

1 INTRODUCTION: "DROUGHT", "DROUGHT RISK PERCEPTION" AND "PLANNING FOR RESILIENCE": THEORETICAL ASSUMPTIONS AND SCOPE OF THE WORK

Drought is often considered by the general public as the result of changes (more or less permanent) in the local prevailing climatic / meteorological conditions (basically in precipitation). According to the experts however, it is a phenomenon generated and influenced by both natural and manmade factors; even the natural factors may originate from the manmade component of Climate Change (CC). Drought is usually classified into five types or versions interconnected with each other: (a) Meteorological or Climatic; (b) Hydrological; (c) Agricultural; (d) Socio-economic and (e) Ecological. The present work focuses principally on hydrological, agricultural and socioeconomic drought in a rural territory since it is these versions

basically that affect and are affected by local farmer communities' Perceptions and Planning for Local Resilience and Sustainable Development.

Drought events are characterized by uncertainty, it is difficult to be predicted accurately (Keenan and Kranich, 1997). More importantly, the duration (start and end date) of drought incidents and their geographical range are not easily identified and monitored (Olcina-Cantos, 2007).

Agricultural Drought is manifested through insufficient soil moisture hampering crop growth and agricultural production. It is this type of drought that worries people in the grocery and meat business or people in farming communities who depend on agricultural income for their livelihoods. Hydrological Drought is the result of reduced precipitation or human interventions in the surface and groundwater catchments. It is visible in the reduced flow of rivers and lowering of the level of ground water catchments. Urban planners usually mean hydrological drought when they talk about drought, since water supplies and reserves are key components in managing urban growth. Socio-economic Drought is associated with the vulnerability of a community to long-term imbalances between water supply and demand. In this sense, the impacts of socio-economic drought depend on the ability of households, businesses and wider communities to adapt to the varying and deficient water availability (Olcina Cantos 2007). This is indeed why, Resilience to Drought –as the ability of a community to adapt to water shortages- plays a critical role in Drought Risk Reduction.

Resilience is the precondition for effective adaptation. What matters, is not only resilience of the concerned community as a whole but also resilience of individuals and the distinct institutions that make up this community (e.g. households, firms and agricultural holdings, agricultural corporations, water and planning authorities etc.).

Basic assumption of the authors is that both collective and individualized resilience depend on (a) the respective agent's Drought Risk Perception and (b) on the agent's accessibility to the necessary resources (natural, social, economic, political and physical) and consequent ability to engage these resources in appropriate adaptation processes. Davoudi et al. (2012) suggest that exposed and vulnerable agents are not a priori resilient, but instead that they struggle to become resilient. During this process, an agent reaches out for resources that might be available not only nearby and currently, but also at distant spatial and temporal scales, which other agents also appeal to (Sapountzaki, 2007).

The authors assume besides, that the form of adaptation to drought that is opted depends on the agent's initial exposure (real or perceived) and the resilience assets accessed by the agent. For example, the choice of farmers of a rural region to drill shared boreholes depends on their investing capability and their involvement in networks of collaboration with neighboring farmers (i.e. accessibility to economic and social capital). However, should a powerful sub-group of the above farmers achieve accessibility to extra water resources (e.g. to the water of a newly constructed dam and its reservoir) through political lobbying, this group will leave boreholes for a more effective and less costly adaptation to drought. It is evident that accessibility of this subgroup to political capital may deprive others (those who do not manage to connect with the dam's reservoir) from vital water resources. Agents with affluent resilience assets are in an advantageous position; they can select the most convenient for them adaptation solution. On the contrary, those deprived of resilience resources may have no opportunity for adaptation or only at great cost.

In the context of this paper, Planning for Resilience is considered as the process aiming at equitable accessibility to resilience assets. Equitable and just allocation of resilience resources depends however on power relations and is also a matter of Drought Risk Perception on the part of both the exposed agents and the planning and water management authorities. Hence, risk perception is important to planning for resilience at two distinct levels: (a) the level of the individual exposed agent, since it affects the agent's willingness and effort to become resilient and (b) the level of the planning and water management authorities since it affects their views on risk distribution and equitable allocation of the resilience potential. Perceptions matter a lot because (drought) risk does not represent an actual fact in the prevention stage but only an uncertainty about adverse consequences.

The role of perception in people's or social agents' preferences on how to cope with risks has been thoroughly investigated in the past (e.g. Slovic, 1987 and 2000, Tversky and Kahneman, 1974, Kaperson et al., 1988, Douglas and Widalsky, 1982, Renn, 1998).

More importantly, natural hazards are characterized by uncertainty and therefore are hard to perceive and comprehend. Thus, agents are forced to structure their adaptation process based on probabilistic judgements according to the alternatives they are aware of and which are available to them (Slovic, 1987). The social and institutional environment in which the agent operates influences perception of risk. Accordingly, the agent's willingness to adapt depends on the level of risk perception; low risk perception usually translates to no response and no or inadequate preparedness on the agent's behalf.

Individuals and/or institutions however do not perceive all natural hazards in the same way. Fear, new and unknown risks and stigmatized hazards affect perceptions. For instance, flood incidents occur rapidly, last over a short period and usually have a more devastating impact than drought events. It has been argued that the severity of consequences (experienced or imaginable) rather than the actual degree of exposure determines the respondents' perceptions. Risk perceptions are also associated with former experiences (recent or old-dated); agents located in a disaster-prone region but have never suffered any adverse consequences demonstrate lower risk perceptions and are more likely to be less resilient than agents of the same region who have encountered losses in the recent past (Wachinger et al., 2013).

In general, it seems that risk perception is affected by disaster experience, stigmatization of specific hazards, the assumed or imagined consequences and the frequency of occurrence. However, several queries remain open: How do risk perceptions of institutions and social agents interact influencing one another? How risk perceptions of institutions influence their strategies for Resilience Planning? How the latter affect accessibility of individual social agents to resilience assets? How risk perception of distinct social agents determine their option for adaptation and survival? Finally, what is the role of power relations in the allocation of resilience assets and prospects of adaptation? Above queries are at the focus of the present work and rural Crete, in particular the farming communities of Messara plain have been selected as the field of an experimental study to offer tentative answers. More specifically the study will shed light in the interrelations between Drought Risk, Drought Risk Perception and Planning for Resilience of Agricultural Businesses/Holdings to and the local economy Drought.

2 THE EMPIRICAL STUDY IN MESSARA PLAIN, CRETE: METHODOLOGY AND RESULTS

2.1 THE GEOGRAPHICAL AND DEVELOPMENT PROFILE OF MESSARA PLAIN

The Messara Plain is an agricultural region located in the south-western part of the Prefecture of Heraklion, Crete, Greece. Local development and well-being in the area are closely connected with land productivity and water availability. The plain is featured mainly by the Geropotamos River, which springs from the southern foot of Mount Idi (Psiloritis) and runs across the western part of the plain. In broader terms, the Messara Plain is located on an island (Crete) resembling a closed hydrological system with finite water resources.

As regards administrative structure, the plain is divided by the boundaries of two municipalities: the western part lies within the boundaries of the Municipality of Festos, while the central and most of the eastern part is administered by the Municipality of Gortyna. Total population of the Municipalities of Festos and Gortyna is 40,098 people (National Statistical Service of Greece, 2011). The main economic centres in the area are the towns of Moires and Tympaki, which comprise 25% of the total population (approximately 10,000 inhabitants) (Figure 1). About 50% of the area's total economically active population is employed in the primary sector of production and 40% approximately in the tertiary sector (mainly tourism) (National Statistics Service of Greece, Census 2011).

Most of the land in the Messara Plain is used for agricultural purposes. In rural areas, the cultivation of olive trees, citrus fruit trees and vineyards is very common; greenhouse agriculture has also been extensively developed. Near the town of Tympaki in the north-western part of the plain, there is an extensive cluster of greenhouse establishments producing fresh vegetables that are forwarded to domestic and international markets.

Water supply of the housing sector is provided by the respective Municipality, whereas irrigation is provided by the Local Land Reclamation Organizations (LLROs) in collaboration with the Municipality. The

LLROs were formed by the Greek Ministry of Agriculture and are responsible for the abstraction, management and distribution of water intended for irrigation. Today, the municipalities supervise the LLROs that operate within their administrative boundaries. In several cases, municipalities have ceded the operation of municipal boreholes to the LLROs. The Water Directorate of the Decentralised Administration of Crete, in cooperation with the Department of Hydro-Economics of the Region of Crete, is responsible for issuance of permits for drillings. Finally, the construction of large scale infrastructure works on the supply side of the hydrological system are planned and supervised by the Ministry of Agricultural Development and Foods. According to the hydrogeological and water resource management studies that have been carried out in the past (Decentralized Administration of Crete, 2014; Kritsotakis and Tsanis, 2009), approximately 95% of total water abstractions in the Geropotamos River basin is used for irrigation (50 million c.m. annually). Domestic uses account for only 4% approximately (2.7 million c.m. annually). The rest of the land use accounts for less than 1% and includes water consumption for livestock farming and industries (Decentralized Administration of Crete, 2014).

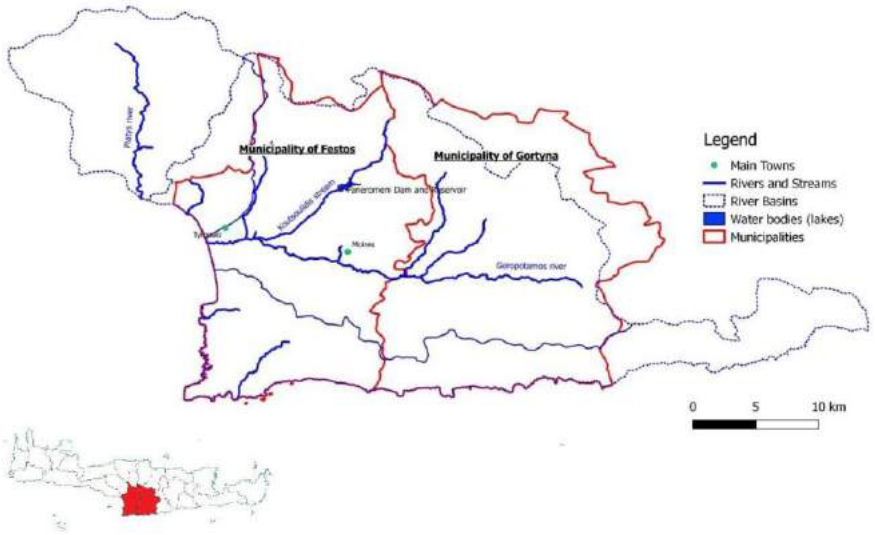

Figure 1: The boundaries of the case study area, the included municipalities and hydrological basins and the locations of main towns. Source: Geodata website. Accessed on 15h February 2017. (http://www.geodata.gov.gr). Map created by the authors.

2.1.1 RURAL DEVELOPMENT IN A DROUGHT-PRONE AREA: A RESULT OF OVERDUE AND UNCOORDINATED IRRIGATION AND LAND CONSOLIDATION SCHEMES.

The dynamics of rural development of Messara plain had been identified since the late 1960s. In 1972, the United Nations Food and Agricultural Organization (FAO) carried out extensive research on the potential exploitation of the aquifers of Messara and the introduction of irrigation schemes across the plain (Electro-Watt, 1972, Kritsotakis and Tsanis, 2009). According to this study, water abstracted from the alluvial aquifer located underneath the areas of Tympaki, Moires and Agioi Deka should suffice for the successful implementation of the planned irrigation schemes (Figure 2). Furthermore, the proposed construction of the dams of Faneromeni and Agia Galini would provide additional water supply to meet future demand for irrigation.

The irrigation scheme would be implemented in stages; priority would be given to the areas of Tympaki, Moires and Protoria[1] and would be followed by investments in the area of Gortyna.

Before the onset of the project however, implementation of an extensive land consolidation programme was proposed, in an attempt to boost agricultural productivity and increase the agricultural income. Land consolidation is a tool used by planners worldwide in locations and economies that rely on rural development. It is rather useful in cases where land tenure is fragmented and the net income of agricultural holdings is below par. Such projects aim at consolidating parcels to create enlarged and

[1] The current study focuses on the River Basin of Geropotamos and the Municipalities of Festos and Gortyna. The wider area of Protoria has not been included because it is located in a different river basin and a different Municipality as well.

undivided agricultural units, allowing for better management of water resources, increased productivity and optimal arrangement of drainage infrastructure. Ultimately, land consolidation projects may achieve the renewal of rural societies and a more efficient use of rural space (FAO, 2003).

In the 1970s and 1980s the State of Greece, regulated and implemented a land consolidation scheme in the western part of Messara Plain, aimed at increasing agricultural income, reducing costs per unit of production and reducing water demand per stremma[1]. Today, the scheme has been implemented only in the areas that were included in the FAO study. The areas that did not benefit from the process continue to face the same problems as they did before the initiation of the scheme.

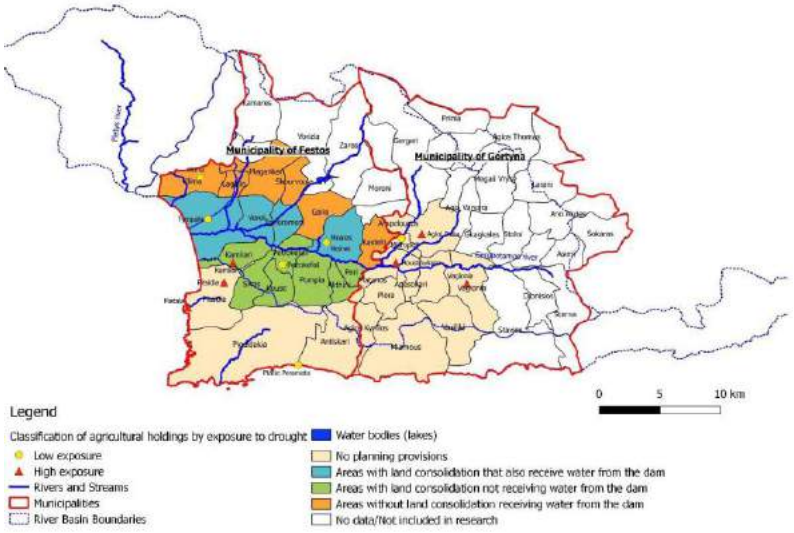

Figure 2: Distribution of land consolidation and water management provisions per local administration unit in Messara plain. Source: Geodata website. Accessed on 15th February 2017. (http://www.geodata.gov.gr). Map created by the authors, based on data collected from the questionaires and the legal documents regarding land consolidation projects in Messara plain.

The plan proposed by the FAO study, considered the construction of the dam of Faneromeni to be an integral part of the irrigation scheme. Significant delays in the initial schedule however, left the farmers' communities exposed to drought. Lack of adequate water resources as well as loose implementation of the legislative framework led numerous farmers to invest in private or shared boreholes in order to mitigate their vulnerability to drought.

It has been estimated that in 2007, more than 1.400 boreholes were used for water abstraction in the entire Messara plain, with the majority being located in the wider area of Moires and Tympaki, (Kritsotakis and Tsanis, 2009).These practices have led to overexploitation of the aquifers, with direct consequences on the quality and quantity of the accessible underground water. Salinization problems have been identified at locations near the coastline, whereas inland areas face the risk of water depletion. The increased risk of hydrological drought is also manifested in the reduced surface runoff of Geropotamos River. Before the implementation of the irrigation and the land consolidation schemes in the mid-1980's, the flow of Geropotamos River and its tributaries was perennial. Since the mid-1980's, water abstraction has increased to such an extent that the rivers dry out entirely during the summer months (Kritsotakis and Tsanis, 2009).

To a certain extent, the prevailing climatic conditions have contributed to this phenomenon. Analyses of rainfall patterns in Messara plain suggest that major meteorological droughts have a return period of 100 years. Nevertheless, droughts of shorter periods (observed as a deviation from the expected precipitation rates) have occurred at least four times during the past 40 years (in 1973-74, 1976-77, 1985-86 and 1999-2000) (Koutroulis et al. 2011). In Eastern Crete, precipitation is significantly less than that of Western Crete, mostly due to the mountainous terrain and the climatic conditions of the Eastern Mediterranean region. Climate Change is likely to affect the existing rainfall patterns, thus increasing the probability of

[1] In Greece, land area is measured by the unit of 'stremma' (plural: 'stremmata'), which is equivalent to 1,000 square metres (https://en.wikipedia.org/wiki/Hectare#Are, accessed 10th February 2017).

longer and more severe drought episodes in the future (Koutroulis et al. 2011). Such change might result in reduced potential for irrigation, which in turn will have a negative impact on the local communities and economies that depend on agriculture (Koutroulis et al. 2015).

Since 2013, the dam of Faneromeni and the respective reservoir have been in operation as an alternative method of water supply in the area but only for agricultural purposes because there are no water filtration services in place yet. The dam has been built on a tributary of river Geropotamos. The reservoir of the dam of Faneromeni serves only part of the Messara Plain, i.e. an agricultural land of approximately 40.000 stremmata located in the northern and western part of the Municipality of Festos (Decentralized Administration of Crete, 2014) (Figure 2). Since the full operation of the dam the pressures on the aquifers have been significantly reduced in the areas that are served by the reservoir. However, boreholes and wells are still being used as the sole method of water procurement in the areas that are not served by the dam, thus aggravating the stress on the local aquifers. Additionally, the extensive and occasionally unregulated use of fertilizers has resulted in the pollution of certain aquifers with nitrates.

During the past 20 years, the area of cultivated agricultural land in Messara plain has increased by more than 50%, from approximately 140.000 stremmata in 1991 to 240.000 stremmata in 2010 (National Statistics Service of Greece, 2010). Agricultural production has increased as well. In 2010, the total annual output of the agricultural holdings located in the Municipalities of Festos and Gortyna was approximately 212.000 tons (National Statistics Service of Greece, 2010). It is estimated that more than 20% of this quantity (i.e. approximately 44.000 tons) was produced in the greenhouse cluster located in the northwestern part of Messara plain (Figure 3). This output refers to water intensive cultivations such as cucumbers, tomatoes and eggplants.

The greenhouse hub of Tympaki is the principal employer in Messara plain. It has been estimated more than 2.000 employees work in the cluster, representing approximately 45% of the total agricultural workforce and 25% of the total economically active population of the Municipalities of Festos and Gortyna (National Statistics Service of Greece, Census 2011).

The agricultural holdings of greenhouse farmers range from four to fifteen stremmata. The greenhouse cluster of Messara is the largest cluster in the Prefecture of Heraklion and accounts for the highest share of the local agricultural gross domestic product (GDP). Indeed, most vegetables cultivated in this cluster have a high annual return. According to data from the Greek General Secretariat of Public Income (2014), in 2013, the average income for greenhouse tomatoes was estimated at 1.200 Euros per stremma and 650 Euros per stremma for greenhouse cucumbers and pepper plants. The products of the greenhouse holdings are forwarded directly to European countries (e.g. Germany, Russia, Italy, UK); they are also directed to the main Greek urban centres, principally, Athens.

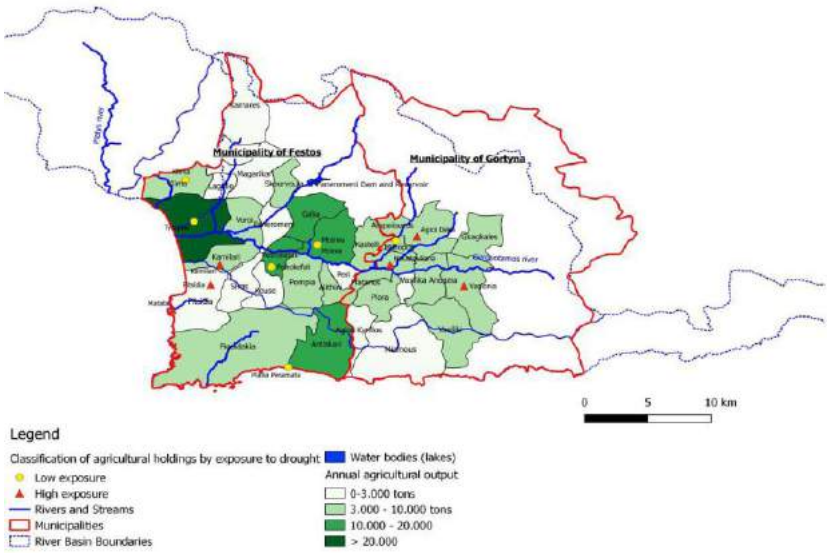

Figure 3: Annual agricultural output per local entity in tons, for the year 2010. Data source: National Statistics Service of Greece. Spatial data: Geodata website. Accessed on 15th February 2017. (http://www.geodata.gov.gr). Map created by the authors.

Rural (open-air) farmers mostly grow olive trees, and to a lesser extent, vineyards and citrus fruit trees. These cultivations account for an annual income of approximately 40 to 80 Euros per stremma. Although the total size of their agricultural holdings ranges from 10 to 150 stremmata, many farmers are obliged to cultivate a large number of small and isolated fields of less than two stremmata each, due to fragmentation of land ownership.

2.2 METHODOLOGY, DATA ANALYSIS AND FINDINGS: THE CHALLENGES OF PLANNING FOR RESILIENCE TO DROUGHT IN MESSARA PLAIN

2.2.1. METHODOLOGY AND DATA ANALYSIS

As mentioned the basic objective and scope of the present paper has been to investigate interrelations among (a) exposure to drought of agricultural holdings, (b) perceptions of the leaders of the exposed holdings and of the planning and water management authorities and (c) the planning decisions aimed at resilience and adaptation to drought. The methodology adopted consisted of four successive steps:

1. Selection of a sample of agricultural holdings in Messara Plain

The sample selected represents the various levels of exposure and vulnerability to drought. The basic assumption was that rural (open-air) and greenhouse farming present different degrees of exposure to drought and so do holdings of different size at different locations (enjoying different water provision services). Since the research is still ongoing, the agricultural units included in the sample will grow in number at a later stage. Currently, the authors have investigated a sample of thirty-six farming units, half of which were practicing rural cultivations and the other half, greenhouse farming. Furthermore, in order to 'capture' the repercussions of land use planning and water resource management policies implemented in Messara plain, the holdings were selected from a wide range of locations, eight in the Municipality of Festos and four in the Municipality of Gortyna (Figure 4). So far, the authors have been able to test their initial assumptions and identify some preliminary correlations between exposure, perceptions and resilience to drought. However, the analysis of the full-scale sample is expected to unveil more details regarding the examined interrelations.

2. Submission of a questionnaire to the sample of agricultural holdings

Information on risk perception of the leaders, the resilience potential of the holdings (accessed and contested assets) and the planned or implemented adaptations, were obtained through structured questionnaires that were submitted to the agricultural holdings. More specifically, the respondents were requested to:

a. Refer to their experience with respect to water shortages
b. Describe their perceptions about evidences of drought manifestation in their area and anticipated impacts.
c. Document the natural, social, institutional and financial resources that they sought or had at their disposal during the opted processes of adaptation
d. Reveal their current and future adaptation preferences
e. Recognise the actual and perceived impacts of these adaptations, to other holdings and the wider economy and community

3. Interviews with key-staff of planning and water management authorities

In addition to the above, structured interviews with key-staff of planning and water management authorities were carried out, in order to obtain information on drought risk perceptions of these institutions and their rationale regarding distribution of resilience assets and advocacy of certain forms of adaptation. At this stage, the interviewees selected represent the administrative authorities at the local level (i.e. the Municipal authorities and the LLROs) (Figure 6).

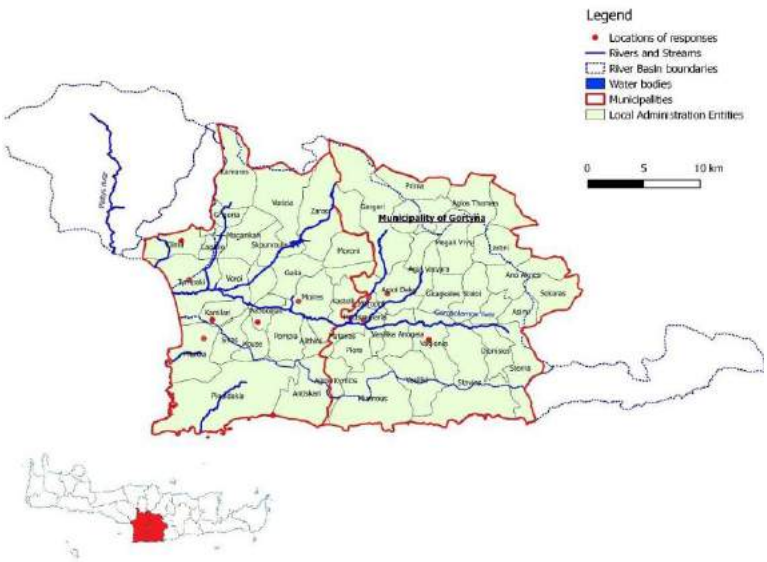

Figure 4: The locations of the responded questionnaires in Messara plain (www.geodata.gov.gr, 2016) (map created by the authors).

Respondent group	Number of responses
Group 1: Leaders of agricultural holdings practicing open-air farming	18
Group 2: Leaders of agricultural holdings practicing greenhouse farming	18
Total sum of responded questionnaires	**36**

Figure 5: Respondent groups and number of responses received from each category

Administrative authority	Interviewee
a. Municipality of Festos	The Mayor
b. Municipality of Gortyna	The vice-Mayor's assistant
c. LLRO of Tympaki	The President
d. LLRO of Moires	The President

Figure 6: Interviewed administrative bodies

4. IDENTIFICATION OF CORRELATIONS

In order to determine the correlations between drought risk perceptions and adaptation options or support of specific adaptive interventions, the authors assumed the factors that were relevant to each of these categories.

a. Real exposure to drought is related to current experience of water supply interruptions that besides hamper the productivity of the agricultural units.
b. Perception of drought risk is derived from the views on drought as existing threat, causes of drought events and anticipated losses/impacts. Losses include productivity reduction, loss of production, shrinkage of cultivated land, loss of international and domestic markets and loss of income.
c. The social, geographical and financial setting as well as political and institutional arrangements determine which resilience assets might be accessible (under certain conditions) to each agent at a given time (now or in the future).

The first step is to classify the sample by their exposure level (high and low), according to their experience of water supply interruptions.

In the next step, the prevailing drought risk perceptions and the preferred choice of adaptation for each exposure group have been estimated by the frequency of positive responses received in the relevant questions in the questionnaires. The objective is to address the impact of exposure on risk perception, of

risk perception on resilience preferences and of exposure on resilience/adaptation options, according to Figure 7.

Finally, in the third step, the responses received from the agricultural holdings were juxtaposed with the responses received by the institutions, in order to identify potential convergence or conflict of the drought perceptions and adaptation options.

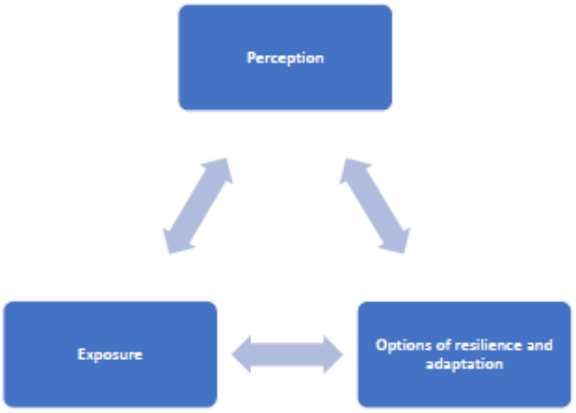

Figure 7: Interrelations between exposure, perception and options of resilience and adaptation examined in the current paper

4. A. IDENTIFICATION AND PROFILING OF GROUPS BASED ON THE FARMERS' EXPOSURE TO DROUGHT

The authors classified the agricultural units into two main groups, based on their exposure to drought risk (high and low exposure).

Low exposure group: This group covers the farmers cases who have not experience recently water shortages or interruptions. All members of the group are cases of high water demand and more than 80% of them maintain greenhouse cultivations. Almost 70% of the members are located in areas that are being served by the dam of Faneromeni and have also benefited from the land consolidation

schemes. Additionally, almost 90% of them have further mitigated exposure through boreholes. In most part, this group formulates a spatial cluster (Figure 2).

High exposure group: The group covers farmers who have recently suffered from water interruption. The vast majority of the members of this group are rural farmers maintaining fragmented agricultural holdings; they do not have accessibility to the dam of Faneromeni, have not benefited from land consolidation schemes and do not form a specific cluster.

	High Exposure	Low Exposure	High Exposure (% of total members in the group)	Low Exposure (% of total members in the group)
Total Number of Respondents	19	17		
Number of respondents in group using additional water supply through boreholes	8	15	42%	88%
Number of respondents with high water demand (more than 100 m3 per stremma annually)	4	17	21%	100%
Type of cultivation				
Farmers cultivating in greenhouses only	1	9	5%	53%
Farmers maintaining both, rural and greenhouse cultivations	1	5	5%	29%
Farmers maintaining only rural cultivations	17	3	89%	18%
Agricultural units that receive water supply from the dam of Faneromeni	1	11	5%	65%
Agricultural units that have benefited from the land consolidation scheme	4	11	21%	65%

Figure 8: Profiling of the high and low exposure groups. Data retrieved from the questionnaires.

4. B. INTERRELATIONS BETWEEN EXPOSURE AND RISK PERCEPTION

Both groups of high and low exposure are featured by high risk perception in the sense that all of them consider their area to be exposed to drought with adverse impacts on their agricultural holdings. This means that current exposure does not affect risk perception.

About 50% of the members of both groups think that drought events result from the combination of natural and manmade factors.

Low exposure group: About 40% of the low exposure group consider exposure to drought as the outcome of exclusively natural causes. This specific subgroup perceives drought as originating from reduced precipitation. A minimal proportion (12%) understand drought as an exclusive issue of insufficient coverage of their own water needs.

High exposure group: No one from the high exposure group believes that exposure to drought is only due to natural causes. It is interesting that half of them attribute exposure to only manmade reasons.

This is consistent also with responses to the query on the meaning of drought; almost 40% of them consider drought as insufficient coverage of their water needs.

Contrary to the former conclusion that recent exposure levels do not affect the perception of drought as an existing and imminent threat in the wider region, it seems that exposure influences the perception of drought causes. All high exposure farmers believe that drought and its impact on their holdings comes at least partly from unwise/discriminating/unfair water management by users and the authorities.

	High exposure group	Low exposure group
Meaning of drought		
Reduced precipitation	16%	41%
Insufficient coverage of water needs	37%	12%
Both	47%	47%
Cause of drought events		
Natural	0%	35%
Manmade	47%	12%
Both	53%	53%

Figure 9: Interrelations between exposure groups and drought risk perceptions.
Data retrieved from the processed questionnaires.

4. C. INTERRELATIONS BETWEEN RISK PERCEPTION GROUPS, MODE OF RESILIENCE AND ADAPTATION RESPONSES

The above analysis reveals three distinct categories of agricultural units regarding risk perception, (a) farmers perceiving drought as reduced precipitation, (b) farmers who consider drought to be a manmade risk and (c) farmers who identify drought to be the result of the combination of both, manmade and natural factors. Each group follows different trajectory as regards the perceived mode of resilience (personal or collective) and the adopted adaptation responses.

Group perceiving drought as reduced precipitation: The majority (70%) of the group that attributes drought to climate change relies on social collaboration options and water policies of the authorities. For this group, individual responses are not sufficient for problem resolution; the only option is trusting water authorities and social collaboration initiatives. However, despite the fact that this group considers collective resilience as the best response to drought, in practice, the majority of the respective farmers aspire to personal options of resilience such as upgrading of cultivation techniques, reduction/rationalization of water consumption and/or drilling new boreholes. Perception comes in contrast with adaptation practices.

Group perceiving drought as a manmade risk: As anticipated, this sub-group considering drought as originating from unwise-discriminating management on the part of the authorities and the other users does not put trust in social collaboration and the water authorities. The farmers of this sub-group prefer relying on their own response initiatives. This finding is supported by the preference that the farmers designate on the personal options of resilience.

Group perceiving drought as being both manmade and natural risk: This sub-group understands drought as the combined outcome of meteorological factors and the socio-economic patterns of water demand.

Contrary to the above sub-groups, the leaders of the agricultural holdings in this group opt for a wide range of adaptation responses involving both, personal and collective options of resilience.

In conclusion, if farmers consider as accountable for drought the water institutions and other farmers who deploy the same water resources, personal resilience becomes then the only option. Reversely, trusting the authorities and neighbouring farmers for collective resilience might be based only on perceiving drought to originate from "exogenous" factors such as climate change. In practice however, it seems that personal resilience is the predominant mode of resilience, regardless of risk perception.

4. D. INTERRELATIONS BETWEEN EXPOSURE GROUPS, MODE OF RESILIENCE AND ADAPTATION RESPONSES

Prevalence of personal resilience options over collective is supported further by the analysis of the interrelations between exposure, perceived mode of resilience and actual adaptation responses.

The high exposure group seeks after water authority activation and social collaboration to address issues of water scarcity, despite the fact that most members of this group consider that the water supply interruptions result from water mismanagement on behalf of the authorities and their fellow counterparts. This indicates that actual and severe exposure to drought may lead farmers to bypass issues of trust and resort to collective resilience options that foster the interaction among farmers or between the farmers and the authorities.

On the other hand, low exposure greenhouse farmers usually afford to proceed with personal resilience investments, particularly private boreholes, to be at the safe side in case of an extreme drought event. Their perceptions favour collective resilience but actions speak louder than words; in practice, they employ personal resilience while lobbying for a water policy favourable for them.

	High exposure group	Low exposure group
Actual adaptation responses	(frequency of responses %)	
Structural and technical resilience reducing demand (personal resilience)	79%	94%
New sources of water abstraction impacting on others (personal resilience)	37%	71%
Struggling for benefits from social and institutional resilience	74%	24%
Opted mode of resilience		
Individualised	37%	24%
Collective	47%	59%
Both	16%	18%

Figure 10: Interrelations between exposure groups, mode of resilience and adaptation responses

4. E. INTERRELATIONS BETWEEN DROUGHT PERCEPTIONS OF AGRICULTURAL UNITS AND INSTITUTIONS

The planning and water management authorities at the local level (i.e. Municipalities and LLRO's) demonstrate different drought risk perceptions.

Municipalities: Since both municipalities include in their jurisdiction areas with recent exposure to drought, both consider drought as a real and existing problem. As the Municipality of Gortyna is faced with more exposed holdings than the Municipality of Festos, the first local authority considers drought as an exclusively manmade issue, while the second attributes the problem to both natural and manmade causes. Perceptions of local authority institutions are on par with the perception of the most representative group of agricultural units in their area.

LLROs: The two LLROs that were investigated also demonstrated different perceptions regarding drought risk. Both LLROs are supervised by the Municipality of Festos, hence it should be expected that these

local institutions would share similar perceptions with their supervising authority. While this stands true in the case of the LLRO of Tympaki, the representatives of the LLRO of Moires believe that the area of Messara is not prone to drought incidents; water availability is sufficient. What considers the LLRO of Moires is the deterioration of water quality due to the extensive use of fertilizers. They thus recognize that any water scarcity issues are clearly due to insufficient management on the users' behalf.

It should be noted that most agricultural units located in the areas of Moires and Tympaki and that are served by the above LLRO's have been included in the low exposure group that perceives drought to be the outcome of reduced precipitation.

While Local Self-Government Authorities share the views of the farmers of their jurisdictional area regarding the origin and cause of drought problems, LLROs are featured by more technical, scientific views, which most probably are far apart from the farmers'. This is unsurprising since the locally elected representatives depend on their electoral clientele.

4. F. INTERRELATIONS BETWEEN ADAPTATION RESPONSES OF AGRICULTURAL UNITS AND INSTITUTIONS

The adaptation options of the institutions range from the provision of information to customers regarding the availability of water resources and advice on water saving techniques, to the enforcement of irrigation by turns, in the case of extreme water scarcity. Furthermore, these institutions use water pricing as the basic mechanism to regulate demand. To their most part however, both the Municipal authorities and the LLROs base their adaptation on accessing new waterbeds and increasing the available supply.

Predominantly, the institutions engage in the effort to increase supply, regardless of their risk perceptions. Although they consider that drought is the result of water mismanagement on behalf of the users, these institutions do not focus on regulating/controlling demand. In high exposure areas the intention is to increase supply; bankruptcy however, impedes the institutions from proceeding with the required investments (e.g. the Municipality of Gortyna). But not only there, water management institutions prioritize increase of water supply (through the dam and municipal boreholes) also in the areas where agricultural holdings are facing low exposure. One can hypothesize that such institutional adaptations aim to enhance water availability in order to reduce private boreholes that besides put the municipal aquifers under intensive pressure. As mentioned, the low exposure group consists mostly of greenhouse farmers producing vegetables of high benefit. This group of farmers is struggling to compete in the international markets; hence, water availability is a precondition to the economic sustainability of their businesses. Consequently, a second and sounder hypothesis is that institutional adaptations serve rather the survivability/economic sustainability of the local greenhouse sector than sustainability of water reserves. This second hypothesis is supported by the fact that prosperity of the local economy of Messara plain relies largely on the profitability of these agricultural units.

		Municipality of Festos	Municipality of Gortyna	LLRO of Tympaki	LLRO of Moires
Options aimed to increase supply	Drilling of additional boreholes	+		+	+
	Construction and procurement of water from dams and reservoirs	+		+	+
	Purchase/transfer water from neighbouring areas authority/institution			+	+
Options aimed to regulate demand	Increase in water price	+		+	+
	Informing customers on water availability and providing motives for water saving	+		+	+
	Enforce irrigation by turns and impose limits on consumption	+		+	+

Figure 11: Adaptation options for each institutional entity.
Data retrieved from the processes questionnaires. The preferred adaptations are highlighted.

The capacity/capability of the institutions to carry out the necessary investments to ensure increased supply as well as the timeframe for the completion of these investments may be crucial factors that determine whether the agricultural units will opt for personal or collective resilience. Unless the agricultural units appreciate the benefits of such investments on their productivity and long term economic

sustainability, it is unlikely that they will choose to adapt only through the collaboration with the institutions and other agricultural users. The willingness of each famer to follow the path of collective adaptation depends also on his/her holding's financial capacity/capability to plan and implement his/her individual resilience strategy.

3. FINDINGS: MULTIPLE PLANS FOR RESILIENCE COMPLEMENTING OR UNDERMINING ONE ANOTHER

There are multiple sustainability and resilience stakes in Messara plain:

a. sustainability and growth of the greenhouse sector,
b. survivability of the rural farming sector,
c. resilience to drought of the domestic sector,
d. resilience to hydrological drought,
e. resilience versus economic and political vulnerability of institutions responsible for water policy.

Some of these objectives converge while others are mutually antagonistic. Consequently, common or complementary survivability/domination objectives lead to the formulation of alliances. For instance, political persistence of the self-government institutions in Messara depends on the support and expansion/growth of the major employer in the area, the greenhouse sector. Reversely, satisfaction of the resilience interests of the latter depends on reinforcement of their political patron, the Municipalities.

Both agricultural holdings and water authorities plan for resilience, sometimes in a complementary way, other times by planning processes conflicting one another.

Exposure influences perception regarding the origin of drought problems and the degree of trust on the institutions has a strong effect on the selection between personal and collective resilience on the part of the agricultural holdings. In Greece, where institutions enjoy low levels of trust on behalf of the public and the economic agents, personal resilience is a widespread and predominant option. Notwithstanding, however beneficial for individual agents, personal resilience deprives planning institutions and water policy from vital resilience resources and the power to plan for hydrological resilience and the resilience of the entire socio-ecological system. All in all, the resilience objectives pursued refer by priority to the continuation and growth of the greenhouse sector and not the social-hydrological system. The identified conflicts between perceptions opting collective adaptive responses and the actual preferences on personal, are due to the predominance of the perceived economic risk faced by the greenhouse sector.

In accordance, the local authorities have further "fortified" greenhouse farmers by literally designing almost all the major planning interventions around the needs of this specific group. This informal alliance between the greenhouse farmers and the self-government institutions undermines the objectives for resilience of the rural farming sector and the hydrological system.

Such planning processes result in an increase of resilience disparities among the farming communities of Messara plain. While greenhouse farmers accumulate more and more resilience assets, rural farming holdings are always deprived from the necessary resilience assets and are always excluded from the planning scope of water policy institutions. At the same time, these same farmers are at the receiving end of the impacts of the adaptations attempted by their counterparts.

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