



Results of the Government Assessment Tool matrix
implementation in case studies

Deliverable 2.3

WP2: Systems Innovation Approach

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EXECUTIVE SUMMARY

Deliverable 2.3 (D2.3) provides a description of the governance in four case studies of the project ARSINOE. The target audience of this report are actors and institutions at all levels and scales of the decisional process regarding adaptation to climate change. It is dedicated to the multiple sectors impacted by climate change in the case studies such as water, agriculture, and environment. In particular, it is dedicated to all stakeholders who are interested in and have the power and capacity to initiate a bottom-up stakeholders' co-creation process for fostering more supportive governance towards transition.

The governance assessment in ARSINOE is part of the broader ARSINOE stakeholders' co-creation approach supported by WP2, serves the purpose of supporting the stakeholders' co-creation of bottom-up solutions to urge for more cross-sectoral collaboration, which in turn will contribute to improving sustainability in the case study regions. To this purpose, case study leaders were invited to participate to all interactions with stakeholders during interviews, focus groups and workshops and played a crucial role in identifying and engaging with the relevant stakeholders. Moreover, case study leaders contributed to have access to local information, local people and visit the case studies.

Part A of this report presents the methodological aspects of governance assessment. This part of the report gives details on the content and use of the Governance Assessment Tool (GAT). The GAT is a matrix composed of 5 dimensions of the governance (actors and networks, levels and scales, problem perspectives and goals ambitions, strategy and instruments, responsibilities and resources) and 4 criteria of quality (extent, coherence, flexibility, intensity).

Part B of this report presents the implementation of the GAT in the four project case studies which had the interest and possibility to implement it: Athens case study (CS1), Main River case study (CS3), Canary Islands (CS5) and Sardinia case study (CS9). After illustrating the data collection consisting of semi-guided interviews during field visits, with in person meetings sometimes complemented with on-line ones, with in addition some contextual information of the case study. The results are presented following the scoring (supportive, neither supportive nor restrictive, restrictive) of the matrix with following the evaluation of the capacity of the current governance system to urge for more climate change adaptation in the case study regions.

The results of the implementation of the governance assessment methodology is described for each case study. It permitted to identify the main barriers and the main levers for more supportive governance to climate change adaptation. These can be found at the end of each case study chapter along with the main concluding evaluation of the supportiveness of the governance in the case study region. Both barriers, levers and concluding evaluation are planned to be discussed with stakeholders engaged in each case study at the occasion of interactions with them planned for the next months.

The main findings and reflections on the overall investigation across the four case studies are described as lessons learned. First a reflection on the success of the methodology and the characteristics of its implementation in the case studies is presented. The context of ARSINOE and the support of the case study leaders is an important point of the implementation. It facilitates interactions with stakeholders and also asks the governance assessment team to explain the need to interview stakeholders case study leaders do not already interact with. Second, a preliminary analysis of the main similarities and differences among the case studies is presented. The state of the governance is far from reaching fully supportive targets to climate change adaptation in case studies. However, many levers could potentially be activated to provide solutions to accelerate the process of adaptation engaged in all case studies. For instance, all each case study is lacking environmental human resources at all levels and all scales, with a negative impact on the capacity to urge for more cross sectoral governance. However, financial resources are not always the main barriers. The

diversity of goals and ambitions can confuse the efficiency of some measures, mainly because of silo thinking. Thus, the work provided in Living Labs of the Systems innovation approach of ARSINOE can really bring coherence locally and increase the consistency of local actions to adapt to climate change.

Finally, the next steps for the co-creation process impulsed in ARSINOE case studies, in close collaboration with stakeholders, are announced as consisting in workshops to present and debate those results locally with stakeholders to codesign recommendations and solutions. All this is embedded in the stakeholders engagement roadmap designed by case studies.

PREAMBLE

The authors would like to thank the case study leaders of the Arsinoe consortium where the governance evaluation was carried out, in CS1, CS3, CS5 and CS9. We would also like to thank all the stakeholders interviewed for the time they gave us and the warm welcome we received in the field. For reasons of confidentiality, the names of the stakeholders do not appear in the document, but the number of people interviewed in each case study is indicated.

All texts in italics and in inverted commas are verbatims extracted from the interviews, all of which were recorded.

We were delighted to visit the case studies and talk to stakeholders, and we look forward to returning to continue the dialogue based on these findings to encourage faster adaptation.

The case study photos used to illustrate this deliverable were taken by Isabelle La Jeunesse, Claudia Cirelli and Ingrid Canovas during site visits.

Introduction

Deliverable 2.3 (D2.3) provides a description of a governance assessment study in the case studies of the project ARSINOE. During the first period of ARSINOE, case studies have been asked to confirm their interest for the governance assessment of the adaptive capacity of their system, following the work planned in the Work Package (WP) 2 of the project related to systems innovation approach and interactions with stakeholders in the case studies. Four case studies have asked for a governance assessment.

The target audience of this report are actors and institutions at all levels and scales in sectors impacted by climate change in the case studies such as water, agriculture, environment and who are interested in and have the power and capacity to initiate a bottom-up stakeholders' co-creation process for fostering transition towards more supportive governance to transition.

The governance assessment in ARSINOE is part of the broader ARSINOE stakeholders' co-creation approach supported by WP2, serves the purpose of supporting the stakeholders' co-creation of bottom-up solutions to urge for more efficiency in adaptation, which in turn will contribute to improving sustainability in the case study regions. To this purpose, case study leaders of the consortium of Arsinoe were invited to participate to all interactions with stakeholders during interviews performed for the study of governance and played a crucial role in identifying and engaging with the relevant stakeholders. Also, all the work done in the stakeholder mapping preliminary to the invitation of members to take part in living labs has been useful and used for the preparation of the governance analysis.

Governance is often said to differ from earlier developed concepts like government or policy in that it emphasizes the multi-level and multi-actor character of all forms of steering of any specified (sub)sector of society. In this deliverable, the approach to the concept of governance not only discerned the multiplicity of the levels and of the actors involved, but also applied the idea that the concept of governance assumes multiplicity to the dimension of the older concept of policy: goals, instruments, and the means to apply them.

Part A of this report presents the methodological aspects of governance assessment.

The first chapter illustrates the content and use of the Governance Assessment Tool (GAT). The GAT is a matrix composed of 5 dimensions (actors and networks, levels and scales, problem perspectives and goals ambitions, strategy and instruments, responsibilities and resources) and 4 criteria (extent, coherence, flexibility, intensity).

The second chapter illustrates the GAT implementation methodology, including the preparation of the interviews, the analysis of the data and scoring of the GAT matrix by the governance assessment team.

Part B of this report presents the implementation of the GAT in four case studies which had the interest and the possibility to implement it as it is time consuming: Athens case study (CS1), Main River case study (CS3), Canary Islands case study (CS5) and Sardinia case study (CS9). The governance assessment was adapted to the focus of the living lab of the case studies. In this purpose, one interview guide was developed for each case study and the four guides are presented in Annex.

After illustrating the data collection consisting of interviews during field visits, either in person or online with in addition some contextual information of the case study, the implementation of the governance assessment methodology is described for each case study.

Beyond describing the state of governance of adaptation and resilience in the study site investigated, the results of the analysis of the governance consist in the identification of the main barriers and the

main levers for more supportive governance to climate change adaptation. These can be found at the end of each case study chapter.

Those barriers and levers will then be used to work with case study leaders on possible recommendations. All these elements are then planned to be discussed with stakeholders engaged in each case study at the occasion of interactions with them to urge for more supportive governance to climate change adaptation in the case study regions. This represents the next steps.

Finally, the main findings and reflections on the overall investigation across the four case studies are described as the main lessons learned.

PART A: Methodology of the Governance assessment

The assessment of the state of governance applied to the adaptation strategy of the case studies of ARSINOE is embedded in the contextual interaction theory adjusted by Bressers (Bressers 2004, 2009, De Boer and Bressers 2011). This concept proposes to understand policy implementation as a multi-actors interaction process. There is a dynamic interaction between the key actor-characteristics that drive social interaction processes and in turn are reshaped by the process. The characteristics of the interactions are: their motivation, their cognitions (information held to be true) and their resources, providing them with capacity and power. There needs to be a sufficiently strong combination of motivation, cognitions and resources to enable the process to succeed (Bressers 2004) is what is assessed during the governance assessment method performed through the implementation of the governance assessment tool matrix.

After the description of the governance assessment tool matrix, the methodology performed to collect information on the case studies of Arsinoe is described.

1.0 The governance assessment tool matrix

1.1 Introduction to the governance assessment tool matrix

The GAT is made up of five dimensions and has four criteria as defined here below. The definitions are from Bressers et al. (2016). The five governance dimensions are:

1. Levels and scales: governance assumes a general multi-level and multi-scalar character of all steering.
2. Actors and networks: governance assumes the multi-actor character of the relevant network(s).
3. Perceptions of the problem and goal ambitions: governance assumes the multi-faceted character of the problems and ambitions.
4. Strategies and instruments: governance assumes the multi-instrumental character of the strategies of the actors involved.
5. Responsibilities and resources for implementation: governance assumes the complex multi-responsibilities' and resource bases for implementation.

Table 1 presents the main questions to be answered to cover the scientific dimension of the cell of the matrix.

To be able to systematically describe how these dimensions look like in each specific case, Bressers et al (2016) have developed an instrument in the form of a set of questions that can guide the analysis of documents and surveys and interviews with key informants.

Table 1 below gives an overview of this instrument. All five dimensions include a descriptive question regarding the time dimension – that is, 'Have any of these changed over time or are likely to change in the foreseeable future'. As the adaptation to climate change can face several deadlines in strategies and plans, it does help to know whether there are any visible coherence or differences or trends in the governance dimensions.

Table 1: Main descriptive questions (from Bressers et al., 2016)

Governance dimension	Main descriptive questions
Levels and scales	Which administrative levels are involved and how? Which scales regarding the issue studies (water, WEFE nexus, heat wave) are considered and in what way? To what extent do they depend on each other or are able to act productively on their own? Have any of these changed over time or are likely to change in the foreseeable future?
Actors and networks	Which actors are involved in the process? To what extent do they have network relationships also outside of the case under study? What are their roles? Which actors are only involved as affected by or beneficiaries of the measures taken? What are the conflicts between these stakeholders? What forms of dialogue between them? Are there actors with a mediating role? Have any of these changed over time or are likely to change in the foreseeable future?
Problem perspectives and goal ambitions	Which various angles does the debate of public and stakeholders take towards the problem at hand? What levels of possible disturbance are current policies designed to cope with? What levels of disturbance of normal conditions are deemed acceptable by different stakeholders? What goals are stipulated in the relevant policy white papers and political statements? Have any of these changed over time or are likely to change in the foreseeable future?
Strategies and instruments	Which policy instruments and measures are used to modify the problem situation? To what extent do they reflect a certain strategy of influence (regulative, incentive, communicative, technical etc.)? Have any of these changed over time or are likely to change in the foreseeable future?
Responsibilities and resources	Which organisations have responsibility for what tasks under the relevant policies and customs? What legal authorities and other resources are given to them for this purpose or do they possess inherently? What transparencies are demanded and monitored regarding the issue at stake? Is there sufficient knowledge on the issue available? Have any of these changed over time or are likely to change in the foreseeable future?

The questions addressed to stakeholders are adapted to each stakeholder and to the governance topic asked by the case study. In the first case study, the metropolitan area of Athens, the main issue addressed within Arsinoe is to propose heat waves adaptation by greening the city. In the third case study, the Main River, the issue to address drought and water scarcity is the multi-use of the resource in the water-energy-food-ecosystem nexus.

In the Governance Assessment Tool not only descriptive questions are asked, leading to an overview of important elements in each dimension of governance but also four quality criteria of the governance regime of what is studied are to be considered to assess the criteria for a supportive governance context:

1. Extent: are all elements in the five dimensions that are relevant for the sector or project that is focused on taken into account?

2. Coherence: are the elements in the dimensions of governance reinforcing rather than contradicting each other?
3. Flexibility: are multiple roads to the goals, depending on opportunities and threats as they arise, permitted and supported?
4. Intensity: how strongly do the elements in the dimensions of governance urge changes in the status quo or in current developments?

The ensemble of criteria is relevant to assess governance in its multiple aspects and is synthesized in Table 2.

Table 2: Main evaluative questions of the governance assessment tool (from Bressers et al., 2016)

Governance dimension	Quality of the governance regime			
	Extent	Coherence	Flexibility	Intensity
Levels and scales	How many levels are involved and dealing with an issue? Are there any important gaps or missing levels?	Do these levels work together and do they trust each other between levels? To what degree is the mutual dependence among levels recognised?	Is it possible to move up and down levels (up scaling and downscaling) given the issue at stake?	Is there a strong impact from a certain level towards behavioural change or management reform?
Actors and networks	Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?	What is the strength of interactions between stakeholders? In what ways are these interactions institutionalised in stable structures? Do the stakeholders have experience in working together? Do they trust and respect each other?	Is it possible that new actors are included or even that the lead shifts from one actor to another when there are pragmatic reasons for this? Do the actors share in 'social capital' allowing them to support each other's tasks?	Is there a strong pressure from an actor or actor coalition towards behavioural change or management reform?
Problem perspectives and goal ambitions	To what extent are the various problem perspectives taken into account?	To what extent do the various perspectives and goals support each other, or are they in competition or conflict?	Are there opportunities to re-assess goals? Can multiple goals be optimized in package deals?	How different are the goal ambitions from the status quo or business as usual?

	Quality of the governance regime
--	----------------------------------

Governance dimension	Extent	Coherence	Flexibility	Intensity
Strategies and instruments	What types of instruments are included in the policy strategy? Are there any excluded types? Are monitoring and enforcement instruments included?	To what extent is the incentive system based on synergy? Are trade-offs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the included policy instruments?	Are there opportunities to combine or make use of different types of instruments? Is there a choice?	What is the implied behavioural deviation from current practice and how strongly do the instruments require and enforce this?
Responsibilities and resources	Are all responsibilities clearly assigned and facilitated with resources?	To what extent do the assigned responsibilities create competence struggles or cooperation within or across institutions? Are they considered legitimate by the main stakeholders?	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the amount of allocated resources sufficient to implement the measures needed for the intended change?

It is important to note that some degree of “informed judgment” is inevitable when assessing the status of the four criteria. Therefore it will be important to make these judgments “inter-subjective”, that is in discussion between at least two and if possible more observers to prevent that the assessment overlooks important aspects, has a debatable weighting of observations or uses the concepts in a less than consistent way. This is the same for all cells of the matrix. This is explained in the next section.

1.2 Scoring of the supportiveness or restrictiveness of the governance

Finally, the GAT is an instrument to assess the quality of governance on its five dimensions. For each of the five dimensions of governance, the four criteria mentioned above are specified below with specific questions. This way the matrix is developed that forms the core of the Governance Assessment Tool. Together, these questions shed light on the **degree of supportiveness or restrictiveness of the governance context**. It is important to note that with the GAT you do not assess the functioning or success of an actor or a plan. What the GAT does is assess the entire governance context, where actors work in, to draw conclusions about the way this context supports or restricts work on needs of adaptation.

The scoring of each cell of the GAT matrix is finally done in two steps. First, the governance assessment team answers the main evaluation question of each cell (presented here in Table 2) based on the answers to the interview questions. Then, based on the answers to the main question, the governance assessment team gives a score using the scoring system presented in Table 3.

The *extent* is important since for instance actors that are left out might become unnecessary opponents or other gaps might leave potential instruments for adaptation unused. The questions that aim to assess the degree of extent differ from the descriptive questions in figure 2 in that they are not just making an inventory but assess the degree of completeness.

Coherence is important since lack of alignment of, for instance, problem perceptions might lead to contradictory measures of drought adaptation.

In complex and dynamic implementation processes a fair amount of *flexibility* is required to go around obstacles and to grab opportunities while they arise, as for instance to piggy back adaptation measures.

Lastly, this project starts from the idea that adaptation measures to climate change in Europe poses gradually more challenges and thus steady-state governance is inadequate. This is captured by the criterion of *intensity*.

To permit the process, the material from the interviews transcribed is used to fill the matrix which is then synthesized with the main elements of description and useful for answering the questions. Even if the interview is conducted following the questions of the matrix, the interview, which is more a discussion with stakeholders, can evolve in a different order and be completed by side-discussions while visiting the field. Thus, the first work is to gather all the information coming from exchanges with stakeholders and to organize it at the right place in the matrix. Some verbatims are included in the description of the results but remain anonymous.

At the end of the process the matrix is finally filled in with a synthesis of the interview data analysis produced by all the members of the governance assessment team. The score of each cell is agreed among all members of the governance assessment team.

A final score is attributed to each quality criteria for all governance dimensions. The final score is still based on qualitative assessment and not an average of the 5 cells' score.

Table 3: Quality of the governance regime

	Quality of governance system			
	Restrictive - Neither restrictive nor supportive - Supportive			
Governance dimensions	Extent	Coherence	Flexibility	Intensity of action
	The degree to which the current governance system includes relevant elements of the dimension	The degree to which the elements of the governance system are strengthening rather weakening each other	The capacity of the current governance system to provide different pathways towards the supportive ones	The capacity of the current governance system to urge more actions

Each quality is represented by a color in the cell of the matrix. Red for restrictive, yellow for neither restrictive nor supportive, green for supportive.

	Restrictive
	Neither restrictive nor supportive
	Supportive

The text providing a description of the situation of each cell justifies the quality of the cell and helps to qualify more in depth this classification, in particular by providing contextual elements showing a dynamic with a possible trend that can either improve or deteriorate the current governance, expressed by some adjective such as “moderately” or “highly”.

A final score by each column of criteria, named overall assessment, is then attributed to each quality criteria. This final score is an average of the 5 cells' score: as far as the score neither restrictive nor supportive is neutral, the number of cells with the score supportive or restrictive will provide the overall score. If they are more supportive than restrictive, then the overall score is supportive, and vice-versa. In case there is no possibility to provide a score, as for instance 3 neither restrictive nor supportive, 1 supportive and 1 restrictive, this is the result of expert judgement of the importance of each cell in the overall criteria's score that is provided to qualify the final score. In case it is really not possible to see a trend, the score mentioned can remain neutral with "neither restrictive nor supportive".

At the end, with the same principle of scoring, the governance regime of the case study is scored as supportive or restrictive depending on the final score of the 4 criteria, with an additional adjective than precise the trend of the restrictiveness or the supportiveness.

Thus, the framework of the GAT matrix is as follows.

Table 4: The governance assessment tool evaluative matrix

Governance dimensions	Extent	Coherence	Flexibility	Intensity
Actors and networks				
Levels and scales				
Problem perspectives and goal ambitions				
Strategy and instruments				
Responsibilities and resources				
Overall assessment	Supportive	Neutral	Supportive	Restrictive
Concluding evaluation	The governance system is supportive / restrictive / neither restrictive nor supportive			

1.3 The selection of stakeholders to be interviewed

The key informants are stakeholders of the case study identified as having both an interest and a potential impact in the decisional process. Thus, the work done during Task 2.1 of Arsinoe and presented in Deliverable 2.1 is used to identify, with case study leaders, the most informative stakeholders.

After 2 to 3 meetings with case studies, a list of about 20 stakeholders to discuss is proposed. Then the case study leaders are supporting the contact with people to book interviews during the field visit of the governance assessment team, usually planned to last one entire week.

2.0 The governance assessment tool implementation methodology

This section presents how the GAT is implemented in each case study. The main objective is to adapt the tool to the context of each case study and to each stakeholder interviewed, while maintaining the integrity of the tool and methodology developed.

2.1 Preparation of the visit of the case study

The GAT methodology requires conducting interviews with stakeholders of all sectors engaged in the issue agreed at the occasion of the living lab of the case study. The planning started 2 months ahead of the visit. The WP2 members of the University of Tours and case study partners discussed over 2-4 preparatory meetings the stakeholders to interview. Furthermore, the governance assessment team members asked for a visit of the case study, in order to have a better representation of the geography and the contextual characteristics of the case study.

2.2 The selection of stakeholders to be interviewed

The key informants are stakeholders of the case study identified as having both an interest and a potential impact in the decisional process. Thus, the work done during Task 2.1 of Arsinoe and presented in Deliverable 2.1 is used to identify, with case study leaders, the most informative stakeholders.

After 2 to 3 meetings with case studies, a list of about 20 stakeholders to interview is proposed. Then the case study leaders are supporting the contact with people to book interviews during the field visit of the governance assessment team, usually planned to last one entire week. The interviewees were selected through a combination of purpose sampling and snowball sampling (Bernard, 2008).

The purpose sampling was based on the criteria that there should be at least one interviewee per sector concerned by the focus of the case study across different scales (national, regional, local) and that the public, private and NGOs sectors should be represented across these sectors and scales. This criterion was applied to each country involved in the case studies. From the point of view of selecting the stakeholders to be interviewed, we did not ask case study leaders and team members to adopt a real gender approach in selecting the stakeholders, that is to say to target an equal number of women and men in positions of responsibility. However, depending on the availability of stakeholders, an attempt was made to respect a gender balance. And, when needed, some additional interviews were carried out on-line. Without a truly oriented approach to a gender analysis of governance it is difficult to interpret these data. This is certainly a factor to be considered in future analyses.

The selection of the person to interview within a specific stakeholder group was made by the case study partners, depending on their knowledge of the case study context, their network and their capacity to reach out to specific individuals. Overall, 15 to 20 stakeholders were interviewed per case study.

2.3 Adaptation of the guide to each case study

An interview guide structured around 20 main questions was used to frame the interviews, was followed during the interviews. Interviews are generally conducted in English. When the interviewee does not speak English or their English is not very fluent, translation is used, either by local colleagues (as for the Case study 3, main River) or by a translator (as done for Case study 1, Athens). Whenever possible, interviews are conducted in the local language. This was the case for Case study 5 (Canary Islands) and Case study 9 (Sardinia) where the interviews were conducted respectively in Spanish and in Italian, because some members of the WP2 team speak Spanish and Italian. The possibility of

conducting interviews in the interviewee's mother tongue is undoubtedly an important advantage, especially when the interviewee's level of English is insufficient, but not only. In fact, from a formal point of view, not only do the interviewees feel more comfortable and the exchange is more fluid, but the fact that the interview is conducted in their own language creates a situation of greater trust and empathy. From a content point of view, interviews are richer in detail and analysis and allow for a better understanding of the context and nuances of certain situations.

The guiding principle of the interview was to explore some aspects of each dimension and each criteria of the GAT with every interviewee. The discussion was therefore tailored to each stakeholder, depending on professional position and activity, specific case study circumstances, how the discussion developed and time constraints. A minimum of 1.5 hour was required for each interview, and even more when translation was needed.

2.4 Composition of the governance assessment team

Studies show that bringing together diverse knowledge and scientific disciplines into a transdisciplinary team provides a significant advantage in understanding sectorial interlinkages, related problems and solutions. This is because in transdisciplinary team people can understand different perspectives, embrace varied logics and values, build a common language, appreciate and negotiate different solutions, and reshape power dynamics between disciplines and between scientists and practitioners. Following this logic, the GAT itself was designed to be implemented by an interdisciplinary team (Bressers et al., 2016, p. 61). This governance assessment team was composed of a minimum of 2 and a maximum of 5 people and the composition of the team per each case study investigation was decided between WP2 members realising the assessment and the case study leaders. As much as possible, case study partners contributed to identify the interviewees, participated to the interviews, helped with translation when needed, and contributed to the reflection on the results. The inclusion of case study partners proved already crucial to maximize the impact of ARSINOE as they have established relationships with the relevant and also new stakeholders.

Per each case study the governance assessment team:

- planned the interviews
- participated to the interviews
- participated to the team discussion at the end of the interview campaign
- analysed the data and provided feedback on the results (case study partners).

2.5 Face to face interview process

Interviews were conducted in the case study face-to-face.

Each interview started by briefly introducing the governance assessment team in the context of the ARSINOE project and its goals. This was done by the case study partner or by the lead of the governance assessment team from the University of Tours. The interview was framed as a discussion with local stakeholders to be continued for the duration of the project. Then the stakeholders were invited to sign the consent form (cf. Annex) for the interview and to be engaged, if they wished, in the project activities. The consent form is translated into local languages when needed. At this point the interviewee was invited to introduce himself, including his background and professional position and activity within the organisation.

After the field visit, when some complementary interviews with new stakeholders were needed to cover additional sectors or levels and scales, and when this was possible, those were planned on-line.

PART B: Results of the governance assessment in the case studies

After the first workshop of the Living lab, the case studies have been asked to confirm their interest and availability for a governance analysis in their territory. A focus on the main problem to work on during Arsinoe as highlighted by the stakeholders was planned to be studied regarding its governance. Four case studies were asking a governance analysis: CS#1, CS#3, CS#5, and CS#9

The governance assessment was performed on those four case studies between June 2023 and November 2023.



Figure 1: Localisation of the four case studies where the governance analysis was performed

1.0 Athens case study (CS1)

In their workshops, the stakeholders of the living lab of the case study 1 of Arsinoe have decided to tackle the following problem statement to create more resilience: *“Athens is becoming increasingly hot with significant impacts on health, society and the local economy. What is our vision for dealing, together, with this imminent and invisible threat”* with facing extreme heats as the central theme. (For more detailed information, see Deliverable 6.5, La Jeunesse et al., 2023).

Accordingly, the study of governance was focusing on heat waves. The interview guide has been adapted to this topic (See Annex).

1.1 Context and case study description

The Greater Athens Area (GAA) is the capital of Greece and the biggest urban area in the country, which has a total area of 2,928.717 km² (Figure 2). It is located in a basin that is surrounded by mountains. The central portion of Athens is characterized by its large and densely populated surrounding areas. The Greater Athens Area, which extends beyond the city limits, covers a surface area of approximately 43Km². It is still expanding at an accelerated rate (Founda, 2015).

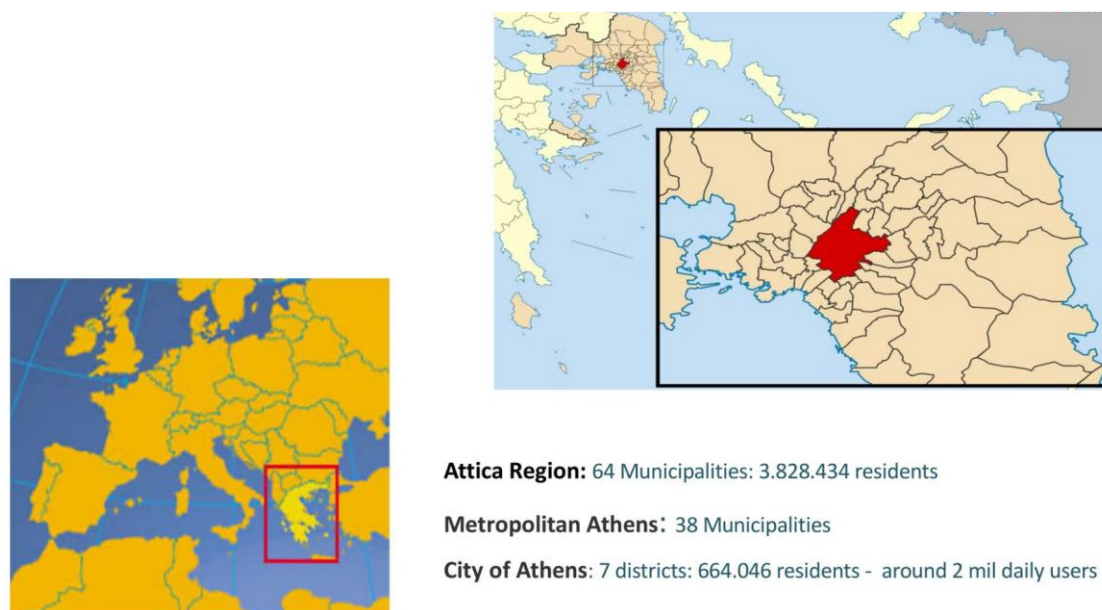


Figure 2: Localisation of the Metropolitan Athens in the Attica Regions and main data related to the municipalities and residents

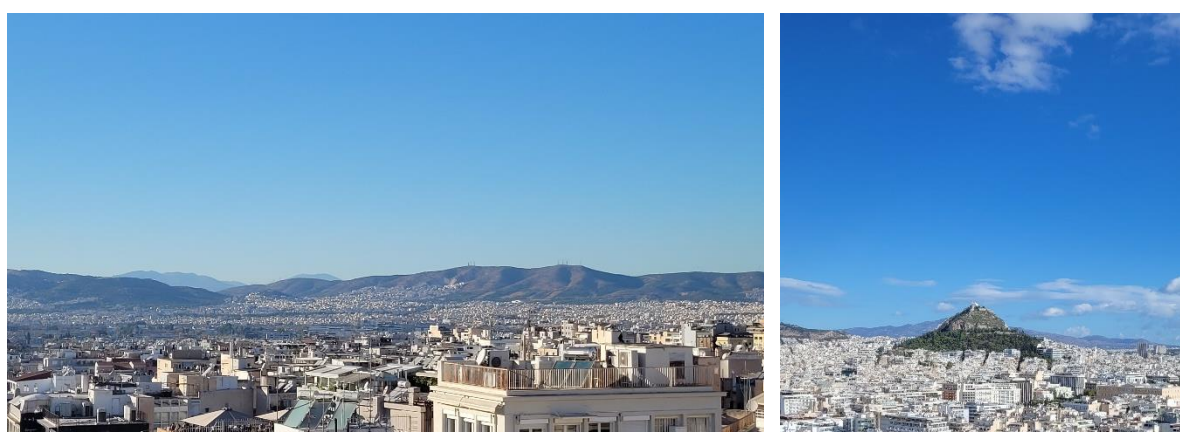


Figure 3: Photos of the mountains surrounding Athens. On the right is the Lycabettus Hill. (La Jeunesse, Nov.2023).

A Mediterranean climate with more frequent heat waves

The city is at a transition point between the Alpine and Mediterranean climatic zones. As a result, most of the precipitation is expected to occur from October to April. The city's northern suburbs have a

slightly different climate, with lower temperatures and more snowfalls in winter. The maximum temperature in Athens during the summer season is usually around 32°C. During the hot periods from July to August, temperatures reach over 46.2°C with expectations to increase due to climate change (HNMS, 2022).

Climate projections and scenarios predict a rise in temperature that will intensify the urban heat island effect and therefore lead to an increase in energy demand for cooling, particularly in the regions of Thessaly and Central Macedonia (Hellenic Republic, 2022). Recent studies indicate that is very likely for extreme temperatures like those experienced in 2021 to become more frequent in these two regions in the coming decades. Fire risks could be exacerbated by the combination of droughts and predicted extreme temperatures (Founda et al., 2022).

According to climate projections, the dense urban centre of Athens, which has few green spaces and limited tree canopy cover, in particular in the city-centre streets, will see temperatures increase in urban heat islands. The very dense city centre is in fact characterised by built-up areas that trap heat. It is likely that these city-centre hot spots will intensify due to extreme episodes linked to climate change and reach other parts of the city as the city expands into suburbs on the hillsides.

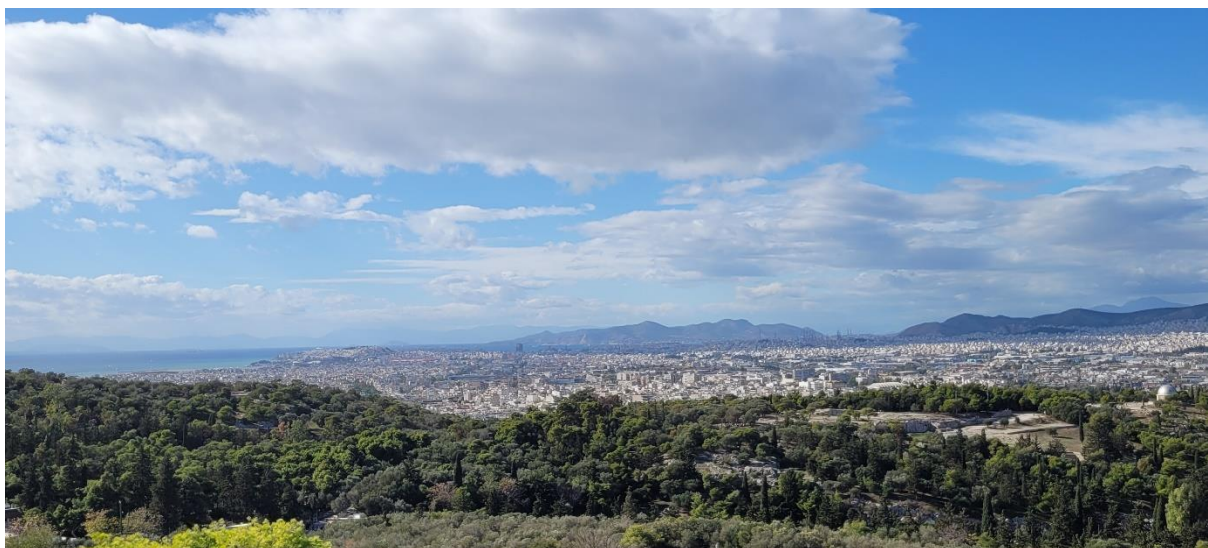


Figure 4: View from the Acropolis in the direction of the Mediterranean Sea and the Piraeus Port, in the west part of the picture (La Jeunesse, nov. 2023)

Water resources for the city

The basin of Athens is mainly shaped by the Kifissos and Ilissos river networks. Due to the dry conditions of the river system, small amounts of water can be found running off through the ephemeral streams. The flow between the surface and groundwaters is severely affected by the presence of impermeable soil surfaces. This is due to the urbanization and high levels of soil sealing (Diakakis, 2016).



Figure 5: Location of one last part of the river in Athens uncovered yet (La Jeunesse, nov 2023)

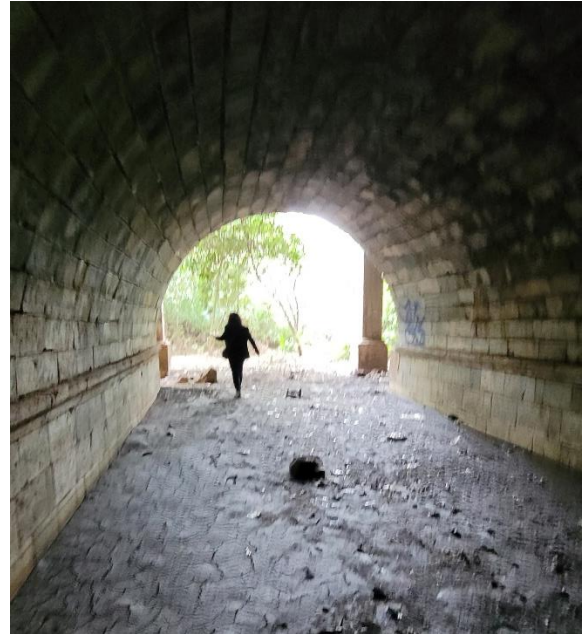


Figure 6: Location of one last part of the river in Athens uncovered yet (La Jeunesse, nov 2023)

Due to the lack of reliable water sources, the metropolitan area of Athens is served by external water sources and reservoirs to keep a water level to sustain the transfer of water, and which are located in the region of Attica (Koutsoyiannis, 2017)¹:

- The Lake Marathon, which is close to the city, has an operational capacity of approximately 34 million cubic meters. It is a water regulation tank. It was tapped through the Boyati tunnel in 1931 ;
- The Lake Yliki, which is 60 kilometers away from the capital, has an operational capacity of about 590 million cubic meters ;
- The Mornos reservoir, which is about 192 kilometers away from Athens, has an operational capacity of over 670 million cubic meters ;
- The Evinos reservoir, which is about 60 kilometers away from Athens, has an operational capacity of over 113 million cubic meters. It was constructed in 2001 and is linked to the Mornos Reservoir ;
- Since it takes a long time to pump large amounts of water through the mountains and long distances, the Athens Water Company is one of Greece's largest electricity customers.

Also, in order to meet the demands of its growing population and provide reliable water supply, the Athens water supply and sewerage company (EYDAP) has more than hundred boreholes. Private wells also exist.

In order to store rainwater, the city of Athens had started to use underground cisterns a while ago, but those were finally abandoned. The Hadrian aqueduct was repaired in 1870 and its water supply was restored at that time. Now, there is a project to use this water for irrigation.

¹ The water utility, EYDAP, describes this in more details
<https://www.eydap.gr/en/TheCompany/Water/WaterSources/>

Institutional context for climate change governance

To start with, the Greek economy experienced its most serious economic crisis, with four consecutive years of recession, from 2009 until 2013. As a result, Greece received financial and technical aid from other countries in the eurozone and the International Monetary Fund under three memoranda of understanding (2010; 2012 and 2015) to tackle the high deficit and public debt to be repaid. Along with the memoranda of understanding, numerous economic and structural changes were adopted, which significantly affected the standard of living of Greek citizens and the operation of Greek administrations.

The highest level of government is the national government, the ministers of which are appointed by the Prime Minister. The ministries prepare and implement national legislation. The Ministry of the Environment and Energy (MEEN) is the main government body responsible for developing and implementing environmental policy in Greece, while the other ministries are responsible for integrating the objectives of the environmental policy into their respective areas of competence. The MEEN is the competent authority for matters concerning climate change. The Council of Ministers is responsible for the final approval of climate change policies and measures.

In September 2021, the Ministry for the Climate Crisis and Civil Protection (MCCCCP) was created, grouping together the General Secretariat for Civil Protection, the Hellenic Fire Service and some of the responsibilities of the MEEN related to climate adaptation and change. Climate change mitigation is within the scope of the MEEN. The MCCCCP and the environment and regional planning departments of the 13 regional authorities manage the implementation of the national adaptation strategies and regional action plans. The national climate law also provides for the possibility to adopt policies and measures to increase resilience in every sector of the economy, the natural environment and biodiversity. Adaptation measures are mainly financed by national and European funds.

Regional administrative organisation

Following the implementation of an administrative reform in 2011, Greece has a two-tier governmental structure: central government and local governments, “Kallikratis” Program 2011. The first reform, “Kapodistrias” Program, dates from 1997 and it is this reform that modernised the architecture of the local government system, particularly by reducing local fragmentation without giving solid powers to the municipalities (Ioannidis 2016). This was achieved with the 2011 reform which, additionally, institutionalised the region as the second tier of local government.

1. Central government, which exercises its power at national level (ministries and government) as well as at the level of decentralised administrations (7) and
2. Local governments: the regions (13) and the municipalities (325). The regions are divided into regional units (74 in the whole country), which are in turn sub-divided into municipalities.

The seven decentralised administrations² are units of state and their heads are appointed by central government. They are made up of two or three regions (except Attica and Crete). They report to the Ministry of the Interior and have general responsibility in state affairs. These decentralised administrations are not part of local government. The former 52 prefectures were either abolished and divided up, or transformed into regional units, making up the administrative and territorial parts of the 13 new regions created with the 2011 reform.

² <https://rm.coe.int/1680746eed> The structure and operation of local and regional democracy, Greece. and https://joinup.ec.europa.eu/sites/default/files/inline-files/eGovernment_in_Greece_2018_0.pdf

The regions are responsible for the administration of affairs in their district. They shape, plan and implement policies at regional level as part of their responsibilities, taking national and European policies into account.

The municipalities are responsible for the administration of local affairs. They manage and regulate all local matters in accordance with the principles of subsidiarity and proximity.

Between the two levels of local self-government there are no relations of control and hierarchy, but of cooperation and collaboration, which are developed according to the law, common agreements, as well as with the coordination of joint actions.

In order to address supra-local problems in a uniform way, the metropolitan region of Attica and the metropolitan unit of Thessaloniki (Region of Central Macedonia), in addition to their regional responsibilities, may exercise metropolitan responsibilities in the following areas: Environment and quality of life; Spatial planning and urban regeneration; Transport and communications; Civil protection and security beyond the municipal administrative boundaries.

1.2 Results of the governance assessment

The field visit took place in November 2023 with the interviews performed from the 20th to 26th. It was completed by visits to some green areas and the ancient river course down town Athens.

Public and private sectors concerned by the impact and the management of heat waves or its mitigation have been interviewed: the Heat office, several departments of the city of Athens (green areas, planning), the water management structures, the Green fund, academics, the ministry of Environment, the ministry of civil protection and climate crisis, the Institute of Mediterranean Forest Ecosystems, the Region of Attica, Hospitals, and NGOs for environmental protection. A total of 13 interviews were conducted. Those permitted to engage discussions with a total of 24 stakeholders.

Table 5: Overview of stakeholders involved in interviews of governance analysis in the Athens case study

CS#1 ATHENS Governance analysis Field visit	Number of stakeholders interviewed	Number of Men	Number of Women	Men (%)	Women (%)
20/11 - 26/11 2023	24	11	13	46%	54%

The next paragraphs of this section are describing the assessment of each cell of the governance assessment tool matrix as described in the first point of the methodological section (Part A).

● Extent

Actors and networks

To address heat waves, an ad hoc administrative structure has been set up on the scale of the city of Athens.

A department – the Resilience and Sustainability Department – was thus created in the city's organisation chart in 2016, attached to the Directorate of Strategic Planning, Resiliency, Innovation and Documentations, to deal with the challenges of climate crisis. In 2021, following the signing by the city of Athens of the Urban Nature Declaration³, heat wave management took concrete form with

³ The Urban Nature Declaration, nowadays known as The C40 Cities Urban Nature Accelerator, is a joint commitment from 39 mayors to expand urban nature and nature-based infrastructure in their cities. Signatory cities pledge to increase and enhance nature in their urban environments by 2030, making sure it is equitably

the creation of a Heat Office entirely dedicated, as its name suggests, to heat wave issues. It is important to emphasise here the role that Athens' participation in the international networks working to combat the risks associated with global warming has played in institutionalising the issue of heat waves in urban policy. The creation of the Heat Office is (also) the result of the participation of Athens in the international networks on resilient cities, in which it has been involved since 2013 and 2019 respectively (*100 Resilient Cities-100RC*⁴ initially, which later became the *C40 network*⁵). One of the first actions recommended by the specifications for member cities is the creation of a Heat Officer. The first person who was in charge of this new office in Athens is now the Global Chief Heat Officer to UN Habitat, with the purpose of building and consolidating resistance to heat in cities all around the world. The Resilience and Sustainability department in Athens is designed as a cross-cutting structure within urban administration, which works with the various city departments involved in managing extreme events (Green areas ; Road Construction ; Sewerage and Public Spaces ; Health ; Urban Planning and Environment) in order to promote the actions envisaged.

The current manager of the department and the Heat Office describes her role as *"a connection between the previous situation and the future situation"*.

At central government level, the Ministry of Health and, to a lesser extent, the Ministry of Labour, plays a fundamental role in tackling heat waves during a crisis. Based on an alert issued by the Hellenic National Meteorological Service in the form of a red-level emergency weather report (the highest on a three-scale level: red, amber and yellow), the Ministry of Health sends the measures that need to be taken for a given alert level to civil protection services and other stakeholders, such as hospitals. The alert is generally issued a few days in advance so that the hospitals can get organised. At times of high temperature, the Ministry of Labour calls for companies and authorities to give priority to remote working; in addition, inspections are planned to check that no workers are working on building sites in the full sunshine during these periods.

The General Secretariat for Civil Protection was recently upgraded from a Secretariat of State to a Ministry – the Ministry of Climate Crisis and Civil Protection (MCCCP), centralising responsibility for dealing with extreme weather events such as earthquakes, floods and fires, and also the adaptation to climate change, a role that was previously exercised by the Ministry of the Environment. The creation of the Ministry of Climate Crisis and Civil Protection is partly explained by the people we interviewed as a response to the context of repeated extreme events over the past two years (in particular severe flooding and fires). This new structure does not play a role in heat wave management.

Since the creation of the new MCCCP, the Ministry of the Environment and Energy – MEEN – will only be in charge of climate change adaptation until the end of the current national adaptation plan. The MCCCP is set to take over this role. Therefore, the MEEN would keep only the mitigation aspect of climate change phenomena in connection with the carbon footprint and greenhouse gas emissions. However, to date it does not intervene directly in heat wave management, instead it only intervenes

distributed and publicly accessible. https://www.c40knowledgehub.org/s/article/C40-Urban-Nature-Accelerator-Planned-actions-to-deliver-commitments?language=en_US

⁴ Network pioneered by the Rockefeller Foundation since 2013.

⁵ The C40 Climate Action Implementation Programme is funded by the UK's Foreign, Commonwealth and Development Office (FCDO). C40 also receives critical core funding from philanthropic partners. The City of Athens is also a core member of the Extreme Heat Resilience Alliance-EHRA, created, launched, and led by Arsht-Rock (The Adrienne Arsht-Rockefeller Foundation Resilience Center). EHRA supports local, regional, and national governments with reducing the risks and impacts of extreme heat to their residents. <https://onebillionresilient.org/project/extreme-heat-resilience-alliance/#about-EHRA>

in cases of fire risk (often linked to high temperature phenomena). In fact, heat waves are a phenomenon which, in the critical phases, is considered to primarily be a health issue. This is why it comes under the scope of the Ministry of Health, as already mentioned.

Another participant with an important role in managing heat waves is The National Observatory of Athens, which produces and provides temperature data and indicators and which, with the city of Athens, has developed a digital heat wave warning program and application available to residents via personal computers or smartphones⁶.

Concerning regional stakeholders, the regional health units (seven in the country) are mobilised to provide operational support to health establishments and centralise the medical information of patients admitted to hospital.

More generally, environmental scientists believe that they should be taken more into account by public authorities.

The heat waves governance system involves all relevant stakeholders, which is supportive.

Levels and scales

The country is organised at two administrative levels, national and local: central government exercises its power nationally (ministries and government) and at the level of the decentralised administrations (7 - *apokendromeni diikisi*) and local governments, in turn organised at the level of the regions (13 - *Periferia*) and the municipalities (325 - *dimos*)⁷. The decentralised administrations are not part of local government. Between the two levels, region and municipality, there are no relations of control and hierarchy, but of cooperation and collaboration, which are developed according to common agreements and joint actions. In order to address supra-local problems, the metropolitan regions of Attica (in which the urban area of Athens is located) and Thessaloniki (region of Central Macedonia), in addition to their regional responsibilities, may exercise metropolitan responsibilities in the following areas: environment and quality of life; regional planning and urban regeneration; civil protection and security beyond the municipal administrative boundaries, and transport and communications. The region of Attica (and the city of Athens) alone constitutes one of the seven decentralised administrations of the State - Decentralized administration of Attica. Given that almost 40% of the national population lives in this region, of which 3.6 million in the metropolitan area of Athens alone (ELSTAT 2023), the stakes are high.

The climate policy is implemented at national, regional and municipal level. Every level must develop its strategy and its instruments (see § Extent/Strategies and instruments).

To manage heat waves, although decision-making and coordination are centralised within the Ministry of Health, therefore at national level, actions are implemented locally by health establishments, as well as by local civil protection structures and the social services in the communes. At regional level, the country is divided into seven health administrative regions. During a crisis, when temperatures reach alert levels, they provide support in disseminating information and coordinating the establishments in their perimeter to meet patient care needs. They also centralise the medical information of patients admitted to hospital.

As we saw in the previous paragraph, a structure dedicated to heat waves has been set up at city level in Athens - the Heat Office -, designed as a cross-cutting structure for managing heat waves at the

⁶ The application gives information to the user such as the current temperature in their current location; whether they are in danger or not depending on their age and health, and how to reach a cool spot if they are in danger.

⁷ The regions are sub-divided into 74 units, which in turn are sub-divided into municipalities. The former 52 prefectures (nomarchies) were either abolished and divided up, or transformed into regional units, making up the administrative and territorial parts of the 13 new regions created with the 2011 reform.

level of administration of the city and the metropolitan area. The action plan for mitigation and adaptation measures is developed at this local level. The new distribution of powers at national and central government level concerning mitigation and adaptation between two different ministries (energy and environment, and climate crisis and civil protection respectively) should not have any effects on local management of heat waves. However, some parks on the mainland are also under the national responsibility of the MEEN or the Attica region. Therefore, this Heat Office will not be able to coordinate actions at the level of all the city's parks and green spaces, but will have to work in consultation with other levels of decision-making.

The city of Athens, in view of the administrative scales and levels involved - region, metropolis, municipality and also decentralised units of central administration (involvement of the Ministry of Culture for the strong cultural dimension that the city also possesses) - is therefore the area where several stakeholders with the ability to act will play a role in implementing policies to tackle the extreme effects of climate change.

According to information gathered, the various stakeholders involved in the heat wave management system consider that the system works well and that the organisation is on the right scale for dealing with extreme heat waves in terms of response and solutions proposed during the crisis period (opening of air-conditioned places in the city, information systems, water distribution, etc.).

The heat waves governance system involves all relevant levels and scales, which is supportive.

Problem perspectives and goal ambitions

In the interviews conducted, heat waves did not emerge as the main perceived problem of the city of Athens. The problems that the interviewees consider the most important for the city are, on the one hand, the fire risk, which increases during heat waves. Then there is the risk of run-off due to heavy rainfall, which was formerly evacuated by the watercourses that used to run through the city and have now been channelled and sometimes even covered over, no longer able to carry the same quantities of rainwater. As a result, this water flows away from the minor riverbeds, causing flooding. Another problem raised, although not systematically, is the poor air quality. For the MCCCCP, the main risk is that of an earthquake.

In the event of a fire risk, having the parks closed off by the authorities as a safety measure during extreme heat events is not contested and is not perceived as a measure that would reduce the possibilities for the population to access cool spaces, particularly in the evening when the sun sets. In fact, in the event of a heat wave, the advice is not to go outside and instead to cool off in places where there is air conditioning.

However, the lack of green spaces is also considered to be a factor that contributes to and exacerbates the urban heat island phenomenon. Additionally, a new demand from citizens emerged following the Covid-19 pandemic and an increase in the use of urban parks by residents, some of whom discovered the existence or need for them when dealing with periods of confinement. Increasing the tree canopy cover in the city and, more generally, green spaces, is now seen not only as one of the solutions for the city to respond to extreme heat and improve the well-being of residents, but also as a response to a need brought about by new urban practices.

The dense urban centre of Athens offers little space for the creation of new green spaces, and the very make-up of the city (buildings, roads, very narrow pavements) makes it difficult to even create tree canopy cover to provide shade for the streets. New, very small green spaces, just a few square metres in size, called pocket parks, have been created as part of a public/private initiative. These small urban green spaces are created, in particular, in the most densely populated neighbourhoods at the initiative

of citizen groups to take over wasteland and neglected urban areas and transform them into “little green lungs”. This project is part of the wider programme called “Adopt your city”⁸ organised by the Municipality of Athens and private stakeholders - citizens and entrepreneurs - with the aim of improving public spaces through actions such as street cleaning, lighting and increasing urban vegetation (trees, in particular). The programme is funded by private donations.

There is little room for manoeuvre for urban authorities when it comes to implementing policies to green the city against a background of rapid urbanisation, high land use, an uncontrolled property market, pressure from the tourism sector on property in central areas and a risk of delays due to the existing underground heritage. The Urban Planning and Environment Department of the city of Athens is fully occupied with dealing with problems related to compensation for properties that have been expropriated and are still pending. These developed plots, although registered as green spaces in the land register, represent an important lever for the rehabilitation of small green spaces throughout the city, and in particular in the most densely built-up areas. However, the urban planning department does not have an overall and, above all, exhaustive view of the current expropriation status. It is therefore not possible for the city to assess the amount of compensation that expropriations represent in order to budget for them in the short and medium term.

The issue of water for cooling down and greening the city, whether for vegetation or the creation of fountains, is barely raised as a possible dimension to consider or that could be an important factor in the greening of cities. For all participants interviewed, the availability of water does not seem to be a problem. The perception that “the city of Athens does not lack water” (water company, ministerial environment departments, various urban administration departments) prevails, without being questioned much, and is taken for granted without being doubted, even in the light of climate change. The water supply resource for the urban area comes from the neighbouring region of Central Greece. The water is stored in two reservoirs located 270 km from the capital (Mornos, Evinos) and in another, closer one, the Marathon reservoir, just 40 km from Athens and mainly used to store water for the transfer system (see the case study description).

When those interviewed do not refer to the availability of surface water transferred from the Central Greece region, they refer to the availability of low-cost, local underground sources that they will use without any thought about the connection between water availability and climate change, and more particularly heat wave management.

The links and interdependencies between the availability of water resources and the completion of projects to green the city are not taken into account when representatives of the various city departments present us with projects that the city would need to ensure more vegetation and green spaces. Those interviewed consider that the issue of greening the city is more an issue of availability of land than water.

A major problem highlighted for carrying out any project or initiative related to heat waves is the lack of resources, particularly human. Staff retiring from public institutions, whether municipalities or ministries, are not replaced. Thus, everyday management is understaffed and even for structures created on an ad hoc basis to deal with heat waves, such as the Heat Office in the city of Athens, the lack of staff is reported as an obstacle to taking action.

In addition, the effects of the economic crisis at the end of 2009 (result of the global economic crisis of 2007-2008) and the implementation of severe austerity policies and measures throughout the 2010-2020 decade leading to massive budget cuts for local authorities and therefore for public works, are still weighing heavily on the availability of resources. Greece continues to be the subject of “enhanced surveillance” by the European Commission due to the burden of its public debt and its

⁸ <https://adoptathens.gr/en>

commitments to pursue structural reforms. Repayment of public debt was reported to us as weighing on funding received from the EU to implement projects. For example, according to the representatives interviewed from the Green Fund (see also the following paragraph and § Intensity/ Responsibilities and Resources) and other institutions, only between 4 and 7% of the funds allocated are actually invested in the projects financed, with the rest reserved for repaying debt.

Stakeholders do not take into account all points of view concerning the effects of heat waves, which is neither supportive nor restrictive.

Strategies and instruments

In terms of climate policy, heat waves do not have the same rank as dangerous extreme events such as fires, earthquakes and floods. Heat waves are centrally managed by the Ministry of Health (see § Actors and networks of Extent criteria), which can trigger health alerts.

The institutional provisions for climate change are written in the national climate law. The National Strategy for Climate Change (2016-2026) defines the general objectives, guidelines and tools for implementing the necessary climate adaptation measures required at national, regional and local level. The national strategy for adapting to climate change has identified the most vulnerable sectors (agriculture, tourism, water resources, etc.), but it does not analyse the necessary sector-based policies in depth, nor does it decide on the feasibility or priority of adaptation measures at local/regional level. These issues come under the scope of regional adaptation plans (see below).

All central government departments have to include adaptation to climate change in sectoral strategies and plans.

Still on a national scale, the country now has a Hub⁹, the purpose of which is to provide tools and resources to help decision-makers in the various stages of the adaptation policy: raising awareness, promoting good practice, approaches. It also includes an interactive web-based climate projection tool to improve understanding of the impacts of climate change.

This national strategy is implemented regionally via the Regional Adaptation Action Plans (RAAPs). There are 13 of these, one per region. As of the next plan, in around 2026, the implementation of the NAS and RAAPs will be managed by the new Ministry of Climate Crisis and Civil Protection (MCCCP) and the environment and land planning departments of the 13 regional authorities.

The main sources of funding for its implementation are European funds - European structural and investment funds, the LIFE programme, the Horizon Europe programme, the Interreg programme; the national recovery and resilience plan "Greece 2.0" (Next Generation EU) and national funds such as the Green Fund, to name the most important.

In Attica, the RAAP was published in 2022. It took time for it to take shape, but those responsible for it believe that the outcome, resulting from a long consultation period, is highly satisfactory. The consultation was initially carried out by groups of scientific experts on a number of themes (National Observatory of Athens, the Academy of Athens and the Agricultural University of Athens). Meetings were then held with these experts and the region, and the outcome of these exchanges, in the form of a draft plan, was presented at public meetings and then submitted to the Ministry and the Attica advisory board for consultation. Following the strategic environmental assessment, the Regional

⁹ National Adaptation Hub - Climate projections' tool. <https://geo.adaptivegreecehub.gr>

Council finally approved the plan in December 2022. Once approved, the municipalities can introduce actions in their region in line with the measures recommended in the plan. But this plan is not binding.

However, the strategies to deal with heat waves are mainly implemented at city scale. The decision by the city's authorities to join the C40 network (previously 100 RC -100 resilient cities) thus gave real impetus to taking the effects of extreme events such as heat waves into account. Following an application submitted by the city itself (like other cities that belong to the network), Athens was selected to take part in the 100RC Initiative in 2014, which later became C40. The city thus followed the standardised process¹⁰. In particular, the process included the creation of a Chief Resilience Officer (CRO) and an Office of Resilience and Sustainability, which in Athens received official status as part of the mayor's office¹¹ in 2016. The preliminary assessment of 2017, called the Athens Resilience Strategy, was written and discussed with the Mayor of Athens and the other decision-making entities (the municipal council, the municipal executive committee), and then published and subjected to a public consultation process.

In this strategic document, the emphasis is on climate issues. In fact, in recent years, the region of Attica and the city of Athens have been affected by a number of flash floods and heat waves (in particular in 2017 and 2018), contributing to an exacerbation of wildfires, such as the very serious one that hit the region of Attica in 2018. The preliminary analysis for drafting the resilience strategy identified "climate change-related shocks" (heat waves, flash floods, poor air quality) as among the most important shocks and stresses for the city after earthquakes. Further, if we look at the resilience strategy, nearly half of the recommended actions concern climate-related matters, both mitigation and adaptation measures (Figure 7). These concern in particular pillar 2, "green city" (Figure 9 ; Figure 8), which is almost entirely devoted to combating climate change, but also pillars 3 and 4 (Proactive City and Vibrant City respectively): measures such as green urban corridors or expropriation and planting of derelict land (Figure 10, Figure 11), dismantling old buildings, etc.

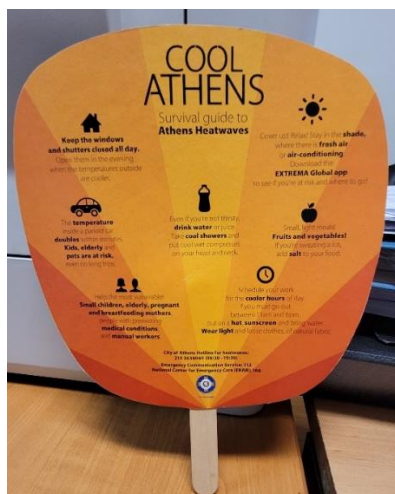


Figure 7: One tool proposed by the Heat Office to communicate on Athens Heatwaves

¹⁰ According to the semi-standardised process introduced by the 100RC initiative, every city had to involve a wide range of stakeholders, covering a broad spectrum of groups and areas of expertise in the different phases of the resilience reinforcement process. The stakeholders' commitment is considered crucial at every step because it allows the resilience teams to adopt different perspectives to define both critical problems and innovative visions for the future development of cities (Galderisi et al., 2020).

¹¹ Journal officiel 3812/B/28-11-2016



Figure 8: Visit to a pilot site for green spaces irrigated with water from wastewater treatment plants



Figure 9: Existing green areas in the Metropolitan area of Athens

The Athens Climate Change Adaptation and Mitigation Action Plans (or Climate Action Plan) from 2017 is an essential part of the resilience strategy identified as part of the C100, to begin with, and the C40 Cities subsequently. The plan includes short and long-term actions for adaptation and mitigation:

- For adaptation: maintaining and increasing green spaces as well as other planting methods, such as vertical planting and the use of aquatic elements in urban planning; the use of sustainable materials, such as cool pavements, and also public information and awareness-raising campaigns, particularly on the heat-related risks they face and on the measures to take to protect themselves from heat-related illnesses and death, as well as increasing the preparedness of municipal services (#Cool Athens, the plan implemented in Athens for heat waves).
- For mitigation, the Climate Action Plan aims to reduce energy consumption in municipal buildings and facilities, the consumption of fuel in municipal buildings and vehicle fleets, raise public awareness of rational energy use and promote sustainable forms of transport and better management of biodegradable waste. Although these very general measures are still struggling to be set up (during our visit we noticed that all restaurants are fitted with outdoor heaters and shops heat their premises while doors are left open), the city has begun to implement the following actions: installation of green roofs, installation of NFC (Near Field Communication) tags on municipal buildings to provide information on urban temperatures, cool spots and an application for personalised risk assessment during heat waves; pilot projects to green school playgrounds or, the most ambitious project, called Eleonas, to rehabilitate an industrial zone to the west of the city to create new accommodation and services, as well as a green space of approximately 20 hectares to help reduce the urban heat island phenomenon. Among the measures to make the city greener is the “Pocket Parks” initiative (see § Extent/Problems and perspectives).



Figure 10: Example of derelict houses in the historic centre of Athens



Figure 11: Example of derelict land in the historic centre of Athens

In addition, among the solutions that could help in decision-making, several stakeholders (various city administration departments, hospital, associations) are calling for access to a map of the urban areas most vulnerable to heat waves. Apparently, these maps exist, but they are not distributed among the various stakeholders.

Both an instrument and resource, the Green Fund¹², a public law entity established by a law in 2010 (law 3889/2010) provides for the wide distribution of funds to targeted environmental conservation programmes. Working under the aegis of the Ministry of the Environment and a national point of contact for the LIFE programme, the Green Fund also translates the European legal framework into national legislation. It operates on annual funding from environmental taxes, fees for environmental damage and the auctioning of EU-ETS allowances, etc. This fund plays a leading role in funding public bodies through launching calls for projects and monitoring the projects financed. A large number of the funded projects concern biodiversity; around 40% are dedicated to climate change; others concern energy transitions, while others still fund environmental actions within the framework of urban planning. However, none of the projects presented and funded concern heat waves.

¹² <https://www.adaptivegreece.gr/en-us/the-project/beneficiaries-co-financers/green-fund-grfu>

The governance system has developed several and different tools (legal and policy frameworks, strategies and plans, etc.) to deal with and to manage the effects of heatwaves, which is supportive.

Responsibilities and resources

Concerning heat wave management, according to those interviewed, the responsibilities assigned are clear, particularly for the phase of dealing with prolonged temperature increases. As we wrote earlier (see Extent/Actors and Networks), the Ministry of Health plays a fundamental role at central administration level during the crisis, and to a lesser extent the Ministry of Labour. The health administrative regions also link the information received and are responsible for coordinating health establishments. More generally, as noted above, the Ministry of the Environment and, the N.E.C.C.A. – Natural Environment and Climate Change Agency – which is responsible for all NATURA 2000 sites (protected areas) in the Country and works in collaboration with MEEN to implement actions of the climate policy decided by MEEN. For heat waves, their responsibility comes into play when it comes to fires.

At local level, while the creation of an ad hoc body – Heat Office – (see § Actors and Network), responsible for implementing measures and actions in the short, medium and long term, is a given, the lack of human resources in the department hinders the Heat Office's ability to act (see below), and more generally, to build a common working framework between the various departments potentially involved in implementing adaptation measures. In an ordinary administration situation, it is the responsibility of the Heat Office to develop the Climate Action Plan and implement measures.

In the phase of extreme heat, the city is also responsible for implementing a series of measures to protect the population (the *#Cool Athens* plan, which provides information to the population on how to behave, a city hotline especially for heat waves, cool spaces in the city, distribution of water).

For now, it is not clear to what extent the new division of responsibilities for the mitigation and adaptation policy between the MEEN and the brand new MCCCCP respectively will affect the management of this phenomenon at local level.

As for available resources provided to facilitate the missions for which the various entities are responsible, the stakeholders interviewed seem to think that the availability of financial resources is not the main issue. For projects related to climate change, there are various European and national funds (LIFE, Green Fund). Instead, the issue is a lack of personnel to use the financial resources available. The view of the representative of the environment and climate directorate of the Attica region differs on this point, in that she considers there to be a lack of financial resources to support administrations in the intermediate phases of implementing the climate policy. In addition, the national and regional funds (ESPA - European funds managed by the central government and the regional fund, POR) often seem to be greatly reduced due to debt repayments.

The lack of personnel was reported by all interviewees – public and private, institutions and associations, at national, regional and municipal level – as the main obstacle for implementing projects, activities or simply carrying out ordinary tasks. Since the 2009 crisis, staff who have retired have not been replaced. The lack of human resources is a definite barrier to operations in every administrative department we interviewed. Even the manager of the Heat Office, despite being the spotlight of the Athens climate policy, hopes to have at least three people in the near future to make the mission possible. Further, she reports having technical requirements that have not yet been covered.



Figure 12: Entrance of the Ministry of Climate Crisis and Civil Protection (MCCCP) visited with interviewees



Figure 13: Citation of Dionysios Solomos, a grec poet¹³, written on the wall of the MCCCP

Still in the area of resources, but more from the point of view of expertise, according to the people interviewed (Green Fund), the municipal administrations (this is not always the case for the capital or large cities in the country) lack environmental expertise, which has a significant effect, for example, on their ability to respond to a call for projects launched by the fund. In the same way, the green spaces department of the city of Athens believes there is a lack of qualified personnel to deal with environmental issues.

The responsibilities assigned are not always clear and supported by resources, especially human resources, which is neither supportive nor restrictive.

Conclusion

The system shows a degree of comprehensiveness in terms of actors, scales, perceptions of problems, existence of instruments and provision of resources for dealing with heat waves, which is supportive.

• Coherence

Actors and networks

The people interviewed say they interact regularly, and networks allow for more fluid communication: in the environmental field, some civil servants know each other personally, which facilitates exchanges and creates points of contact in the various administrations. They also put forward that informal exchanges – without having to go through all the bureaucratic procedures red tape – allow information to circulate more smoothly and, above all, more quickly. Bureaucratic red tape and inflexibility are mentioned as obstacles to action and to making progress on cases.

However, situations of interpersonal conflict or power games between departments, which are said to occur sometimes, can be a blocking factor when it comes to action: *«People can block the system... it's easy if they want to do it. It can happen ...You are in a city, in a dynamic system...You will have to deal with a good vocation and a bad vocation. You'll be dealing with someone who thinks about these things and someone who doesn't think about these things. And the person who doesn't think, who doesn't want to think about these things, can be in a very high position and can be difficult to*

¹³ "Always open, always watchful the eyes of my soul."

penetrate. So it depends on your flexibility and your understanding of the nature of the city system” (Interview, November 20th 2023).

The creation of the Ministry of Climate Crisis and Civil Protection is probably the result of a political decision made in the wake of the Covid crisis and the dramatic floods and fires that have hit the country in recent years. However, this decision was seen by the interviewees as a unilateral initiative on the part of the Greek government.¹⁴

Public sector employees from the Ministry of the Environment and Energy who were interviewed say they found out about this once the decision had been made. They are therefore cautious about this new entity. For the time being, the departments of the Ministry of the Environment continue to conduct their business as usual. The new adaptation strategy in 2026 will be run by the new Ministry of Climate Crisis and Civil Protection. The same caution has also been adopted by the public sector employees interviewed from the new ministry for whom the climate change adaptation measures will be a whole new field of action. It is too early to assess the impact of these changes on the organisation of the national administration on adaptation policies and possibly on heat wave-related measures, which continue to be managed centrally by the Ministry of Health and locally by the urban authorities.

The regional stakeholders in charge of climate change collaborate with research institutes, such as the National Observatory of Athens, on the application of models to the Attica region.

The academic stakeholders and associations we met are calling for greater consideration of their knowledge of heat waves by the public authorities, to create synergies between the academic world or associations and decision-makers. In particular, for wider circulation and dissemination of climate data and forecasts.

The majority of interactions between stakeholders and networks are institutionalised. However, stakeholders report problems concerning the stability of the system and a lack of confidence, which is neither supportive nor fully restrictive.

Levels and scales

In crisis situations, the different levels and scales are said to work together and trust each other *“when we are informed of the alert level, we know what to do”* (Interview, Athens, 21 November 2023).

More generally, the administrative public sector employees interviewed consider that the new law (Climate change national Law, 2022) and National Strategy for Climate Change 2016-2026 allow for more interactions between the different levels and administrative services. One of the aims of the strategy is: *“to increase the capabilities of national, regional and local authorities’ personnel to interpret adaptation, integrate climate risk into project design and implement adaptation measures and policies”* (Interview Athens, 20 November 2023).

Additionally, some instruments, including the climate hub created by NECCA, were intended to be a means of creating *“synergies between the different levels”* (Interview, Athens, 20 November 2023).

The different levels and scales involved in heat waves management work together acknowledging interdependences and trust each other, which is supportive.

¹⁴ A sequence of extreme events in 2012, 2016, 2018, 2021, 2022 and particularly 2023, which was probably one of the most catastrophic years, representing not only the longest heat wave in the history of Greece since records began, but also very violent flooding in winter 2023, which hit the town of Volos twice. This is particularly true for the region of Attica where the city of Athens is situated:

<https://perspective.usherbrooke.ca/bilan/servlet/BMAAnalyse/3303>

Problem perspectives and goal ambitions

While the perception of heat wave-related problems between residents and authorities may coincide when it concerns defending a need for green spaces and vegetation in the city, disagreements may arise when it comes to finding solutions. For example, the Urban green areas department is faced with resistance from the population when it wants to modify and renew the tree species in the city in order to adapt to climate variations. Typically, pine trees, identified as a high-risk species in the event of fire, are emblematic of the local landscape. In response to the fire risk, against a backdrop of more and more heat waves, the Urban green areas department is planning to replace pine trees with other species within 20 years. However, there are no plans to purely and simply replace every pine tree that currently exists. The suggestion is to wait until the pine trees become damaged and dry out and then gradually replace them with varieties that are less vulnerable to fire and have foliage that provides more shade to help lower the urban temperature. However, residents, who are culturally attached to the pine trees, a species symbolic of the city's image, do not agree with this solution. Therefore, despite scientific criteria put forward by the green areas department to justify replacing the species, the representation of residents generates strong resistance to change. These residents, whose demands are sometimes defined as “extreme”, justify their action in the name of “nature in the city”. *“Residents think that the issue of green spaces is a quantitative one, but it is above all a matter of quality, of creating small ecosystems rather than large parks with few species”* (interview with the City of Athens - Department of Urban Green Areas & Urban Fauna, 21 November 2023).

Also, there appears to be a contradiction (which is fully accepted by the authorities involved) between opening parks as a measure during heat waves to offer city residents areas in which to cool down, and closing them as a measure against the risk of fire.

As we mentioned earlier (§Extent/Problems and perspectives), concerning adaptation measures, in particular greening the city, the issue of water availability does not seem to be considered as a major problem. The majority of the stakeholders do not consider that Athens lacks water. Only scientists and environmental protection scientists mentioned this problem when interviewed. According to EYDAP, the Athens water supply and sewerage company, new water resources such as reusing treated wastewater and water from Hadrian's aqueduct are a compromise for the greening of the city's practices. Consequently, studies are under way to create two additional networks: one for treated wastewater from wastewater treatment plants to be reused for watering green space; and one for untreated water from the Hadrian aqueduct for irrigation of green spaces and private gardens. These networks are scheduled to open in five years' time.

As for public sector employees in the Civil Protection department, their view of the problems associated with the extreme events linked to climate change remains very focused on managing and solving crises rather than looking ahead to the longer term. Their expertise is above all crisis management. There appears to be a discrepancy, therefore, between short-term solutions in response to crises and adaptation and mitigation solutions which require longer-term planning and very different measures than the short-term ones. Above all, long-term measures concern sectors other than crisis management, thus more directed to the ministry of environment.

The perspective of the problems and the ambitions of the objectives of heatwave management do not, in fact, always reinforce each other, which is neither restrictive nor supportive.

Strategies and instruments

The stakeholders have found different strategies and instruments to tackle heat waves. In the city of Athens, the creation of a Resilience and Sustainability Department and a Heat Office seems to have created an opportunity to promote multi-sectoral cooperation and collaboration (green spaces, urban

planning, urban civil protection, health, water management) between the various local authority departments. Adopting a resilience strategy makes it possible to systematise actions already provided for in other planning tools: creating green and blue corridors, increasing green spaces and tree canopy cover in the city, soft forms of transport, extending pedestrian zones, energy saving projects (municipal buildings and public lights), public information and awareness about heat waves (*#coolAthens*) by framing them in a more cross-cutting and shared vision through the Climate Change Adaptation Plan.

However, there is still the issue of implementing the recommended measures and of how to create synergies between the various instruments, namely how to include the issue of adaptation in the various plans, for example the National Energy and Climate Plan or the National Strategy for Biodiversity.

As clearly stated by the manager of the Athens Heat Office *“the heat office at the level of Athens has been created and launched as a transversal structure, in order to urge for more actions. One remaining problem is the operationalization of measures”* (Interview, Athens, 20 November 2023).

Concerning the decision to create the MCCCCP as a government response to recent serious climate events, the creation of this new ministry does not seem to be unanimously supported by the administrations concerned. According to one of the representatives of the Ministry of Civil Protection interviewed and who previously worked for the Ministry of the Environment, the transfer of responsibilities in terms of adaptation reinforces the links between disaster risk management and adaptation, and thus improves consistency between the two policies. However, for the other representatives of this new ministry who were interviewed and who belong to the staff of the former Civil Protection secretariat, the consistency of this political decision has not yet been fully proven. Further, they say that they are not involved in risk analysis, although this would be important.

As for the instruments, for now, although adaptation plans are mandatory at national and regional level, this is not the case at municipal level. However, some mayors are willing to be supported by international funding bodies (LIFE project, for example) in implementing good practice through pilot projects. There is demand for climate-related projects from local areas, which are also supported on the basis of consistency with the objectives of the national strategy.

Climate models for the national and regional levels are used to forecast changes in maximum temperatures in the summer and minimal temperatures in the winter, the number of hot days and nights, the number of days with rain and dry days, the number of days with frost and vegetation periods.

As part of the LIFE-IP AdaptInGR project, regional climate models have been used to develop future climate projections and study the effects of climate change in Greece.

Networks are being formed at national and regional level to manage climate data and implement actions at local level (the very recently created Climattica network, for example)¹⁵ as well as the country's participation in European networks such as Climate Adapt.

¹⁵ The Climattica network, created in 2023, which federates regions and municipalities on climate change, has 26 members (four regions, 21 municipalities and one institution). Its main purpose is to formulate public policies and trigger actions to shape the urban environment, adapt the agricultural sector, infrastructure, water management and conservation of nature and biodiversity. It also aims to create connections between levels of governance, sectors and stakeholder groups, to create city-to-city, city-to-region, local-to-national and global connections. It aims to connect local, national and European stakeholders, political commitments and initiatives, strengthen action at every level to support sustainable urban development and address the climate crisis (<https://oknews.gr/perifereies/g-patoulis-perifereia-attikis-chtizoume-ena-viosimo-mellon-gia-ta-paidia-mas-i-1i-synantisi-tou-diktyou-perifereion-climattica/>).

The system allows for synergies between policy instruments, and there are some uncertainties about how to integrate adaptation, which is neither restrictive nor supportive.

Responsibilities and resources

In terms of consistency, the creation of the Ministry of Climate Crisis and Civil Protection and the new division of responsibilities seem to create uncertainty in terms of managing climate events (adaptation by the new Ministry of Climate Crisis and Civil Protection, mitigation by the Ministry of Environment and Energy). Further, the new ministry will be responsible for writing the next adaptation strategy in 2026. However, the stakeholders interviewed claim that it is too early to make an assessment. They are divided between an optimistic opinion of this new structure and its capacity to act, in particular in terms of giving impetus to climate change policies, and more sceptical opinions that see the creation of this ministry purely as a political act and believe that the structure is destined to disappear.

What is clear and blunt, however, is the inconsistency between the decision to create structures to address heat waves on the scale of the city of Athens and the lack of human resources to operate the new structure. In fact, for the stakeholders interviewed, the current institutional system for tackling and responding to heat waves does not yet have everything it needs to function properly. For now, at urban administration level, it remains to be seen to what extent the new municipality, which won the local elections in October 2023, and the new mayor will take up the challenges and support the Heat Office, which needs staff to operate “...*the difficult part is that we run a small department. So I hope that the importance of this position and this department will be prioritized in the way that it should be. So I really hope that I get more people working with us and doing what we have to do*” (Athens, interview 20 November 2023).

In general, the city departments that participate in implementing heat wave management measures seem to share the same problem: lack of qualified personnel (Heat Office, Urban green areas department, City planning and urban environment department). This chronic lack of personnel seems to contradict with the creation of an ad hoc structure to address heat waves. In the field of the environment, particularly in the event of an environmental accident, according to one person interviewed, it is difficult to identify responsibilities. In some cases, only when legal action is taken is the division of responsibilities clearly revealed.

Responsibilities are not sufficiently backed by resources, particularly human resources. In addition, new decisions concerning adaptation are not always shared by all stakeholders. This is restrictive.

Conclusion

While there is a degree of interaction in the institutional network, this does not always result in coordination. Further, the responsibilities and resources of the various stakeholders or organisations which have to contribute to applying the policy are not sufficiently stable or sufficiently backed by adequate resources. Thus, the degree to which the elements of the governance system are strengthening rather weakening each other is neither fully restrictive nor supportive.

- **Flexibility**

Actors and networks

In Athens, the system of stakeholders in charge of heat waves has recently been set up. When it comes to dealing with crises, the system has a top-down operation and the stakeholders involved carry out the instructions given by the Ministry of Health. There is no margin to act outside of the protocol.

The implementation of adaptation and mitigation measures to address heat waves is affected by a lack of resources, in particular human, set out in the preceding paragraphs. This significantly slows down the involvement of public stakeholders in new actions, which damages the system's flexibility. However, the participation of resident groups in creating pocket parks, one of the flagship measures of the "Adopt your City" programme, has allowed the involvement of non-institutional stakeholders. Thus, while it is difficult for public stakeholders to invest in new actions due to their lack of time, the involvement of external stakeholders is not hindered by the existing governance system.

Some institutional arrangements facilitate the inclusion of new actors, but not the ones from the public sectors to new initiatives, which is neither restrictive nor supportive.

Levels and scales

Heat waves are addressed centrally during a crisis by the Ministry of Health, following an alert given by the Hellenic National Meteorological Service. However, this takes place at several levels: regional (at the level of the health administrative regions and the administrative regions (*periferia*) and, more locally, with urban administration (through local civil protection services and social affairs) and finally in the hospitals. The top-down operation ensures a rapid and direct response, but also encourages horizontal collaboration between various ministries, including the Ministry of Health and the Ministry of Civil Protection for the dissemination of information, in particular the alert.

Concerning climate change adaptation measures, the governance system provides that the framework is set at central government level, but that measures are proposed and implemented at regional and local level.

The system allows engaging different levels depending on the heatwaves problem degree, which is supportive.

Problem perspectives and goal ambitions

The unilateral decision at national level for a new ministry, namely the Ministry of Climate Crisis and Civil Protection, shows the ability to review the objectives and ambitions of long-term climate crisis management to protect residents during climate crises. However, this decision, following a reassessment of priorities, is still political and has not yet been accompanied by a complete reorganisation of services or an increase in staff to enable these new objectives to be achieved, as one of the interviewees said *«I must say, that the last three, four years, these problems were not very mild. I must say that the communication and from funding to implementation was very, quite bad... for the bureaucracy, let's say.... but it was a leading priority to all of them. So if it's leading political priority in these things, it can facilitate a lot of things»* (Athens, interview November 20th 2023).

The stakeholders interviewed and involved in crisis management are not invited to take part in developing longer-term strategies. Thus, their ambitions are only short term. Likewise, some greening actions carried out without any scientific monitoring of their impact do not allow their long-term importance to be measured.

Therefore, hospitals are not aware of the medium-term vision supported by the Heat office such as the resilient city or the 15-minute city. While the crisis management issue is shared, the medium and long-term ambitions are not.

The challenges and objectives may be reassessed, but the current governance system does not make this easy, which is neither restrictive nor supportive.

Strategies and instruments

The nature of the heat wave phenomenon calls for a combination of different strategies, instruments and time frames in the resulting measures.

On the one hand, there is a crisis when there is a heat wave and the system has to respond quickly following a well-defined and strict protocol involving the implementation of public warning systems, raising public awareness and preparing ready-to-use systems in medical and social centres. The aim is to reduce the effects on the health of the general population and the most vulnerable individuals in particular, but also to limit or prepare for the risk of fire.

On the other hand, there is the medium and long-term issue which involves measures to mitigate and adapt to the conditions that encourage urban warming and the phenomenon of urban heat islands.

Public authorities can count on national and local strategies (National Strategy for Adaptation to Climate Change, Regional strategy for adaptation), on meteorological observations (by the Institute of Mediterranean Forest Ecosystems and Forest Products Technology, National Observatory of Athens or the Hellenic National Meteorological Service, for example); climate projections and services, adaptation portals and platforms (National Adaptation Hub - Climate projections' tool, the MEEN's GIS Maps Portal - Climate Change section)¹⁶, and on various sources of funding. The creation of an online National Adaptation Hub pools together adaptation-relevant data, information, good practices and approaches. The country does not yet have indicators and methodologies for monitoring, reporting and assessing.

The institutional arrangement provides the opportunity to combine and uses different instruments and actors can make choices in a pragmatic manner, which is supportive.

Responsibilities and resources

The heat wave response system during periods of crisis has proved its worth in terms of distributing responsibilities and allocating adequate resources. Crisis management takes place following an alert issued by the civil protection department following national meteorological information. The alert is directly received by the Ministry of Health at national level and decentralised to the regions. Resources are then pooled, particularly in terms of medical staff (from the various hospitals in the country or region affected) so that they can be mobilised in the establishments and areas that most require them. As for responsibilities in a top-down local-level decision-making system, several stakeholders share responsibilities and resources between local civil protection, the police, social services and, of course, health services.

In the prevention phase, which involves adapting to and mitigating the effects of heat waves and urban heat islands, the ability to reallocate responsibilities and resources, although under way with the creation of this new Ministry of Climate Crisis and Civil Protection, is difficult to estimate due to the novelty of the decision. However, other non-institutional stakeholders, such as citizen groups,

¹⁶ <https://geo.adaptivegreecehub.gr> ; http://mapsportal.yopen.gr/thema_climatechange

associations or foundations, can be mobilised to set up adaptation measures ("pocket parks" for example), which demonstrates a form of flexibility in the allocation of resources.

Also, according to interviewees, the municipalities and regional authorities, on the basis of local priorities, can have the possibility to escalate projects to national level to receive funding via the Green Fund. This same fund can also be used in emergency situations, particularly by the municipalities which can request funds following a disaster that has affected their area. This offers funding flexibility depending on the action programmes proposed by the Green Fund.

Finally, it was explained during interviews that under the Greek constitution there are "no limits" (Interview of 23 November 2023) on the resources that can be implemented in the event of a disaster. Therefore, it is possible to allocate funds at every level, in every sector, without going through various possible blockages, which induces a great deal of flexibility.

It is possible to pool partially some of the assigned responsibilities and resources to other ones, but with no official rules, which is neither restrictive nor supportive.

Conclusion

The capacity of the current governance system to provide different pathways towards the supportive ones is neither restrictive nor supportive.

- **Intensity**

Actors and networks

The stakeholders and networks in charge of heat wave management seem to be pushing for real change in the urban planning policy: the true task of the Athens Heat Office, an ad hoc unit set up to address heat waves, is to provide a vision and new knowledge to the various city departments involved in implementing adaptation measures. This department is pushing hardest for the implementation of actions linked to a more resilient vision of city, like sponge cities or the 15-minute city. These medium-term visions of the city of Athens are reinforced by the creation of a Resilience and Sustainability Department and by the City's participation in international networks (C100 initially, and C40). They have played an important role in stimulating local policy to address heat waves and in exerting a degree of influence with urban authorities. It is interesting to stress here that the first manager of the Athens Heat Office is now the Global Chief Heat Officer to United Nations Habitat. This shows the extent to which the Athens urban authority is involved in international networks related to the issue of heat waves on a global scale. National government is also involved, via the Ministry of Health, which publishes circulars on public health measures to adopt in the event of extreme weather conditions, and in particular instructions aiming to protect public health and reduce losses caused by heat waves. Circulars are also published on the growing threat of epidemics, as the increase in temperatures linked to climate change can increase the emergence and spread of infectious illnesses. Funding programmes are planned to improve the energy performance and comfort of public buildings, such as hospitals.

The EU, via the LIFE-IP AdaptInGR project, is one of the stakeholders in the scheme that strongly supports the implementation of adaptation measures to fight heat waves.

Thus, relevant stakeholders and networks are heavily involved in the fight against heat waves, which is supportive.

Levels and scales

The level most likely to give a boost to encouraging heatwave governance is the urban administration, and therefore the local level. The European and international levels, via the integration of the country in international networks and bodies (UN Habitat), also play an important role, particularly through funding opportunities.

At national scale, the recent creation of the Ministry of Climate Crisis and Civil Protection, with the transfer of responsibility for the adaptation policy from the Ministry of the Environment and Energy, raises questions about how urban planning measures to adapt to heat waves will be handled in the medium and long term, as this ministry does not currently have the powers to deal with these matters.

Further, time-consuming red tape is still said to be very much an issue that slows down or even makes it impossible to take initiatives. Going back and forth between various departments or administrative levels involved is “*a nightmare*”, according to one of the people interviewed.

All levels are striving to bring about change in the field of urban adaptation to heat waves and management of their effects but with concerns about the near future, which explains why, in this analysis, the scoring is supportive.

Problem perspectives and goal ambitions

Representatives from the health sector are an exception to this, with none of the people interviewed considering heat waves to be the biggest environmental problem at urban level, despite the number of hot days recently experienced all over the country, and which is regularly reported as set to increase almost everywhere in Greece (Hellenic National Meteorological Service 2023). These parameters are closely linked to the possible increase of the spread of disease and the greater impact of air pollution on health.

The warning system or the implementation of measures, such as cool spots in the city, water distribution, stopping outdoor work or closing access to tourist areas (the Acropolis, for example), seems to be sufficient to cope at the time of the crisis.

All people interviewed agree that heat waves are a problem that needs to be dealt with on different timescales and according to different intervention plans. First, during the crisis, but also according to the prevention plan, then according to the adaptation plans, particularly with regard to reducing urban heat islands. For the latter, it involves the implementation of different measures, such as cooling down the city by increasing the surface area of green spaces, both in the public area and in public buildings, including schools and administrative buildings. There are also plans to take action on building insulation with building construction methods, but also roadways, by using materials that accumulate less heat in order to help mitigate the effects of heat and thus reduce the need for air conditioning.

However, a sectoral vision of the problems and solutions seems to persist. Except for one person, none of the people interviewed mentioned, for example, water-related developments as being able to offer a solution to heat waves (for example, the impacts of buried and concreted rivers), or the impact of the massive use of outdoor heaters on restaurant terraces or leaving shop doors open while the heating or air conditioning is working indoors.

Further, and more generally on the environmental issue, for the associations and environmental protection experts interviewed, the public authorities do not have any real ambition in the environmental field, and too many problems are inadequately considered and dealt with, in particular waste management and pollution. They also emphasise a general lack of environmental awareness among the population and the lack of environmental education, including among children, with difficulties in teaching environmental awareness at school. However, within the framework of the

LIFE-IP project, AdaptInGR, concrete actions to support integration and adaptation in academic programmes have been introduced.

While heat waves represent an important urban threat, solutions to adapt to them and to mitigate them still suffer from too slow development, which is restrictive.

Strategies and instruments

Among the most important instruments to roll out the Climate Change policy, the National Adaptation Strategy aims to strengthen Greece's resilience to climate change on the basis of five main objectives backed by legal (law), planning (adaptation plans at all levels) and financial instruments:

- (1) the systematisation and improvement of short and long-term decision-making for adaptation;
- (2) the link between adaptation and a sustainable development model via regional and local action plans;
- (3) promotion of adaptation measures and policies in every sector, and in particular in the most vulnerable sectors;
- (4) introduction of a monitoring mechanism to assess and examine adaptation policies and actions; and
- (5) strengthening Greek society's capacity to adapt through awareness-raising and dissemination initiatives.

In relation to these objectives, the governance assessment showed that measures have been implemented for the systematisation and improvement of short and long-term decision making for adaptation, with the creation, particularly for the country's capital, of a Resilience Department and a Heat Office. In the same way, regional plans have been defined and the initial experiences of local plans are backed by international funds (e.g. the LIFE-IP AdaptInGR). Pilot projects are already being introduced.

Yet, there are no tried and tested monitoring mechanisms for assessing and reviewing public policies and adaptation initiatives.

For the stakeholders interviewed, actions to raise awareness of the population to climate issues should be stepped up.

Strategies and instruments do exist, which is supportive, but which are not implemented yet, which is restrictive. Thus, the capacity of the strategies and instruments to urge for more adaptation to heat waves is neither restrictive nor supportive.

Responsibilities and resources

All interviewees stated that the lack of resources, in particular human, was an obstacle for introducing actions. In all public administration services, the lack of staff is the main factor raised as hindering the institution's ability to deal with the actions associated with its responsibilities.

The main funding sources for the adaptation policies are linked to EU funds. In particular, the Green Fund, already mentioned, is a very important fund for financing environmental projects. The largest NGOs in the country use the Green Fund, which claims to encourage and support local authorities so that they can benefit from available funds. However, the interviews reveal that local elected representatives, in particular in small towns, are unaware of available funds. Therefore, according the stakeholders interviewed, only 4 to 7% of the Green Fund total would be actually allocated to

programmes and calls for projects, which is particularly low. The rest is allocated to repaying debt. Furthermore, the Green Fund's human resources are not sufficient and it is therefore not possible to process all the projects proposed, even though it would be possible to finance more, so it would seem that the budget is not being fully utilised.

The municipalities and regional authorities, on the basis of local priorities, can escalate projects to national level to receive funding via the Green Fund. At the governance system level, this represents a means of reassessing the priority of land-use planning and management objectives through the funding of projects considered to be priorities at different levels. This same fund can also be used in emergency situations, particularly by the municipalities which can request funds following a disaster that has affected their area. However, some interviewees also told us about the difficulty of obtaining funding due to bureaucracy “...Sometimes, in Greece, there is a big problem because there is a huge bureaucracy behind of getting the fund. You can get the fund, but you cannot get the money easily (Athens, interview 23 November 2023).

And, according to stakeholders, it is possible to allocate exceptional funds, which can increase the intensity of actions associated with crises.

Even though resources may be significant during crises, the resources allocated, particularly human, are insufficient for implementing the measures required to take on the responsibilities assigned, which is restrictive.

Conclusion

The capacity of the current governance system to urge more actions is restrictive.

1.3 Concluding evaluations

The governance system to face heat waves is moderately supportive (

Table 6).

The current heat wave governance system is moderately supportive because:

- there is a disconnection between short-term solutions in response to crises and medium and long-term adaptation and mitigation solutions,
- changes brought about by institutional stakeholders and the various government levels come up against systemic responses that weaken their impact (bureaucracy, resistance linked to knowledge gaps, political inconsistencies),
- the responsibilities and resources of the various levels that have to contribute to applying the policy are not sufficiently stable (recent creation of the MCCCCP) and financially supported (Heat office), which also affects the ability to support ambitious objectives,
- the degree of interaction of the various institutional stakeholders involved in managing heat waves does not produce sufficiently stable coordination or relationships of trust,
- there is little interaction between climate change adaptation instruments and strategies and other strategies and national action plans,
- environmental awareness is insufficiently developed in society in general.

But the governance assessment shows that the system has potential to move forwards with the ability to identify the relevant elements of a heat wave policy and to envisage their implementation; and the ability to be flexible to suggest different pathways to manage heat waves.

Table 6: Matrix of the overall scoring in the Athens Case study

	Quality of the governance regime : criteria			
Governance dimensions	Extent	Coherence	Flexibility	Intensity
Actors and networks				
Levels and scales				
Problem perspectives and goal ambitions				
Strategy and instruments				
Responsibilities and resources				
Overall assessment	Supportive	Neutral	Neutral	Restrictive
Concluding evaluation	The governance system is moderately supportive			

1.4 Identification of barriers and levers at the case study level

The main barriers and levers identified at the Athens case study level are as following:

Barriers

- Lack of human resources at all levels and scales of administration,
- Limited power of the Heat Officer to green the city,
- Bureaucratic red tape,
- Drastic austerity measures which still today weigh heavily on the use of funding sources (debt repayment),
- Lack of environmental expertise among staff in local authorities,
- New distribution of roles between the Ministry of the Environment and the Ministry of Civil Protection for climate change adaptation without additional human resources, which undermines the visibility of the objectives of this reorganisation at national level,
- Low environmental awareness of the population according to interviewees.

Levers

- Dynamic ad-hoc heat wave management structures with a global, cross-functional vision,

- System completeness in terms of stakeholders, scales involved and relevant instruments for dealing with heat waves in real time (at the time of the crisis),
- Integration of the city of Athens, and more generally of the country (United Nations, EU with programmes such as Green Deals and Life, etc.), in international climate change adaptation networks,
- Cooperative inter-professional networks (particularly in the field of climate change).

2.0 Main River case study

In their workshops, the stakeholders of the living lab of the case study 3 of Arsinoe have decided to tackle the following problem statement to create more resilience: *“Climate change poses major challenges in the region and is likely to exacerbate competition for water, land and energy resources. This will have considerable consequences for agriculture, forestry, water and energy management. Governance does not address challenges in holistic ways at present and might not do so in the future unless processes are revised.”* (For more detailed information, see Deliverable 6.5, La Jeunesse et al., 2023).

Accordingly, the study of governance was focusing on water-energy-agriculture-ecosystem nexus. The interview guide has been adapted to this topic (See Annex).

2.1 Context and case study description

Geographical information

The ARSINOE case study focuses on the Bavarian section of the Main river basin. Figure 14 shows the whole river course. The border between Bavaria and neighboring federal states i.e. the border of the ARSINOE case study is included as a thin grey line.

The Main River is the longest right tributary of the Rhine River, with a length of approximately 527 km. The geology of the area is dominated by sedimentary rocks, particularly sandstones, shales, and limestones. The pedology of the area is characterised by a variety of soils, including rendzinas, brown earths, and alluvial soils. The morphology of the area is shaped by the river and its tributaries, with a generally flat landscape interspersed with hills and valleys. Land use in the area is dominated by agriculture and urbanisation, with approximately 64% of the catchment area used for agriculture and 17% for urbanisation. The hydrology and hydrogeology of the area are complex, with a mix of surface water and groundwater resources. The climate of the area is classified as temperate continental, with mean annual temperatures ranging from 7 to 10°C and mean annual precipitation ranging from 600 to 800 mm (Uehlinger, Arndt, Wantzen, & Leuven, 2009).

The Main river basin is closely linked to the Danube river basin through an artificial structure for water transfer. While the south of Bavaria has a balanced and abundant water supply, unfavorable geological conditions and low precipitation in northern Bavaria lead to water shortages there. In consequence the river basins of Danube and Main were connected. There are two means through which water is transferred: The Main-Danube-Canal connects the Danube and the Main directly, leading from Kelheim in the south via Nuremberg to Bamberg. Additionally, water from the Altmühl – a river in the Danube basin – is transferred via a set of large artificial lakes. By transferring water from the Altmühl and Danube, the low water levels of the Rednitz, Regnitz and Main rivers are improved. In addition, flooding in the Altmühltal was reduced. The two systems complement each other. If a transfer from the Danube cannot be justified water is transferred from the lakes. In addition to improving water availability in the Main river basin the canal serves as an important waterway connecting the North

Sea and the Black Sea. The creation of the lakes for the water transfer from the Altmühl to the Main river basin has improved the flood management along the Altmühl and the artificial lakes have affected the economy in the region e.g. by creating tourism (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz, 2000)¹⁷.

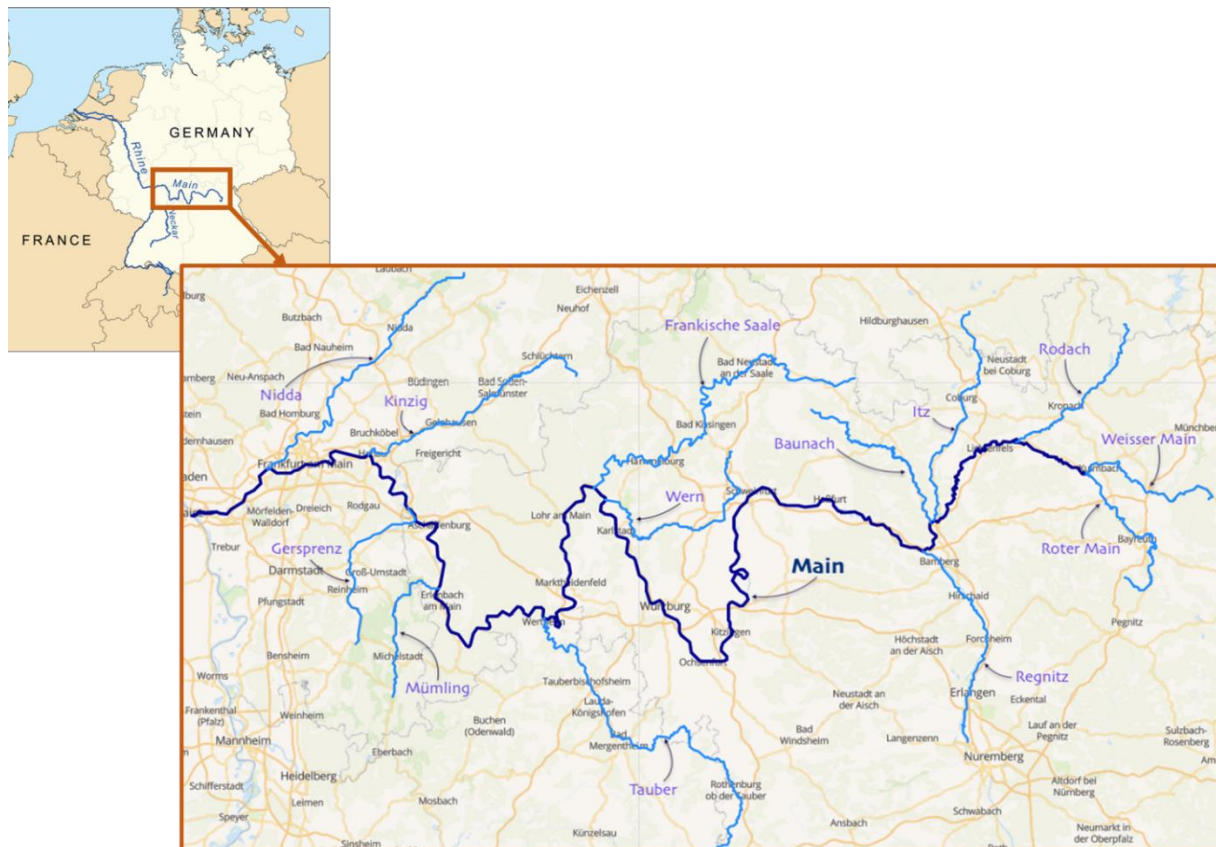


Figure 14: The Main River¹⁸

Socio-economic information

The Main River in Germany is not only a natural waterway but also a region of significant socio-economic importance. The river basin is home to approximately 5.5 million people, making it a densely populated area with diverse economic activities and cultural attractions (Destatis, 2022). The region along the Main River (Figure 15) is known for its thriving industrial production, with a focus on machinery, chemicals, and pharmaceuticals. The cities situated along the river, such as Aschaffenburg, Würzburg and Schweinfurt serve as major industrial centers and contribute significantly to the national economy (Britannica, 2023).

Agriculture

Agriculture is an important economic activity in the Main River basin, particularly in the upper and middle sections. The region is known for producing high-quality crops, including wine, fruits, and vegetables. However, intensive agriculture practices, such as the use of fertilisers and pesticides, have negative impacts on water quality and aquatic ecosystems in the river.

¹⁷ Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (ed.) (2000). Wasser für Franken. Access via: https://www.wwa-an.bayern.de/ueberleitung/system/doc/broschuere_wasser_fuer_franken.pdf

¹⁸ Source of data: https://upload.wikimedia.org/wikipedia/commons/4/4c/Bassin_du_Main.png



Figure 15: The Main River in Würzburg and its famous castle (La Jeunesse, June 2023)

Climate change is expected to impact agriculture in the region, with increasing temperatures, changes in precipitation patterns, and more frequent extreme weather events potentially affecting crop yields and water availability (ESA, 2017), as drought that is now occurring more and more often in the area with real impacts on productions.

Energy

The Main River basin has an important number of power plants (Figure 16, Figure 17), including coal-fired, natural gas, and hydropower facilities. These power plants contribute to the region's energy production and provide electricity for both industry and households (McDonnell, Molnár, Harty, & Murphy, 2020).



Figure 16: Small hydropower plant visited (La Jeunesse, June 2023) and its solar panels (on the right)



Figure 17: Outputs of the water from the small hydropower plant visited and its fish pass (La Jeunesse, June 2023)

Industry

A significant number of industrial facilities are established in the Main River basin, particularly in the lower sections of the river comprising mechanical engineering, chemical and electrical industries. Industries such as chemical production, paper and pulp manufacturing, and metal processing can have negative impacts on water quality and aquatic ecosystems in the river.

Water management and ecosystems

Water management is a critical issue in the Main River basin, particularly with respect to maintaining adequate water supplies for industry, agriculture, and drinking water. The river is home to a number of important ecosystems, including wetlands and riparian forests, which provide important habitat for wildlife and help to maintain water quality in the river. Climate change is expected to impact these ecosystems, with changes in temperature and precipitation potentially affecting the distribution and abundance of certain species (Thober, Marx, & Boeing, 2018). In addition, the river is an important resource for the tourism industry, particularly for recreational activities such as swimming and boating. However, climate change is expected to impact water availability and water quality in the region, potentially the viability of certain recreational activities.

Public water supply for drinking water and other purposes:

Central parts of water management such as the supply of drinking water, the collection, treatment and disposal of waste water are considered basic public services in Germany. The provision of these and other basic public services is safeguarded by the German constitution (GG Art. 20 (1)). Bavarian ordinances build on these constitutional principles and give the responsibility for providing these basic services to municipalities (BayGO Art. 57). Municipalities are free in deciding how to provide public services because of the principle of local self-government (GG Art. 28; BayGO Art. 86-96).

Because municipalities can vary significantly from one another, they use the freedom granted to them by this provision to organise water management in a way that best fits their abilities and the needs. For example, municipalities may decide to ensure water supply directly and become water suppliers. Alternatively, they can set up municipal enterprises and transfer the task to them. Supplying water can be the only or one of many tasks of this enterprise. They can cooperate with neighbouring municipalities and supply water together e.g. if they are very small (ATT, BDEW, DBVW, DVGW, DWA

& VKU, 2020)¹⁹. An overview of the German water sector published by industry associations highlights: „The specific regional and local framework conditions determine the local supply and disposal conditions. The production, treatment and distribution of drinking water as well as the collection and treatment of wastewater are directly dependent on climatic, geological, hydrological, topographical, and settlement-geographic conditions, whereby the specifics of these conditions vary widely on a regional and local basis.“ (ATT et al., 2020, p. 21)²⁰. As these factors impact local supply structures, there is great diversity in the water sector.

According to information from the Bavarian Environment Agency there are about 2.232 water supply companies in Bavaria. Most are small and only supply few households and supply small water quantities. In contrast, is a very small number of large water suppliers that supply large quantities of water and many households. They are usually located in large urban areas. The law mandates that water for public water supply usually stems from nearby sources (WHG § 50 (2)). This decentralized structure is intended in part to increase the resilience of the system overall. Long-distance water suppliers serve as a support for local supply structures: They were established to supply areas where the climatic or hydrological situation does not permit the water supply from nearby sources. Most long-distance supply structures exist in northern Bavaria and the case study region. Long-distance water suppliers do not supply end users directly, but deliver to local suppliers, which then distribute the water to households. Long-distance water suppliers are also municipal enterprises. In Bavaria most water supplied by public supply companies (>90%) comes from groundwater and can usually be consumed without or with very minor treatment. (Bavarian Environment Agency, 2016)²¹.

Institutional and legal context

Water management is the responsibility of the state. Therefore, German institutions for water management and the legal context will be introduced briefly. The Main River case study is located in Germany, a federal parliamentary republic, with a multi-party system. Federalism is one of the leading organizational principles of the German state and the reason why it is divided into three levels: There is the national or federal level (Ger.: “Bundesebene”). Regions are organized in federal states (Ger.: “Bundesländer”) and subdivided into municipalities (Ger.: “Kommunen”). Figure 8 illustrates those levels in white, yellow and brown. Large area states like Bavaria are divided further into governmental districts (shown in Figure 19). On the municipal level districts (Ger. “Landkreise”), municipalities (Ger.: “Gemeinden”) and urban districts (Ger.: “Kreisfreie Städte”) can be distinguished (OECD, 2017).

Responsibilities and functions as well as expenditures in/for water management are distributed among the federal level, the federal states and the municipal level (Figure 18).

¹⁹ ATT, BDEW, DBVW, DVGW, DWA & VKU (2020). Profile of the German Water Sector 2020. Access via: https://www.vku.de/fileadmin/user_upload/Verbandsseite/Publikationen/2020/FINAL_brachenbild_ENGL_wasserwirtschaft_2020_DIN_A4_15032021_1.pdf

²⁰ ibid, p21

²¹ Bavarian Environment Agency (2016). Öffentliche Trinkwasserversorgung - Wasserversorgungsunternehmen. Access via: https://www.lfu.bayern.de/wasser/trinkwasserversorgung_oeffentlich/wasserversorgungsunternehmen/struktur/index.htm

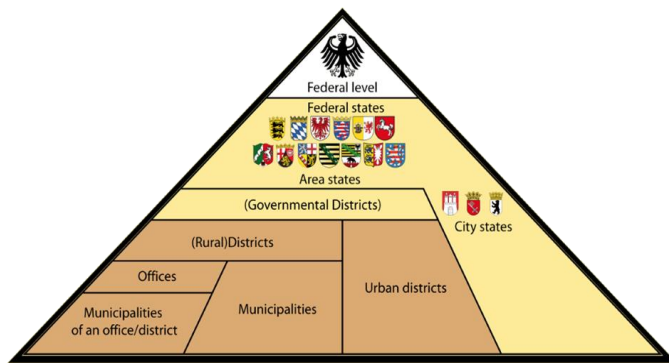


Figure 18: Administrative divisions of Germany



Figure 19: The federal state of Bavaria and its governmental districts

Responsibilities and institutions on the national/federal level:

The Federal Government has the right to enact general provisions concerning water resources management (framework competence). This means that the Federal Government is empowered to specify a general legal framework for the Federal States. The Federal States must replenish such general laws of the Federal Government by enacting their own laws at Federal State level, and they may also enact supplementary regulations. Administrative enforcement of all the provisions relating to water including the Federal laws, and hence the fulfilment of public functions in water resources management, are a matter for the Federal States. An exception to this are the development and maintenance of the Federal waterways, which are exclusively under the control and administration of the Federal Government. In this function, the Federal Government is required to safeguard the concerns of land improvement and water resources management in agreement with the Federal States. The Federal Government is also active in the fields of research and data collection.

The central body for water management on the national level are the Federal Ministry for the Environment Nature Conservation, Nuclear Safety and Consumer Protection. In executing his tasks in the field of water resources management the Federal Environmental Ministry is assisted by other Federal authorities and research institutions such as the Federal Environmental Agency (UBA) and the Federal Nature Conservation Agency (BAfN).

Proposed legislation on environmental protection, like all legislation proposed by the Federal Government requires agreement between the different Federal ministries. Environmental projects, comments, programme aspects etc. are discussed with the Federal departments concerned. The principal partners of the Federal Ministry for the Environment Nature Conservation, Nuclear Safety and Consumer Protection with to some extent independent tasks in the field of water resources management are the Federal Ministry for Food and Agriculture, the Federal Ministry of Health, the Federal Ministry of Transport, Building and Housing and the Federal Ministry of Education and Research (BMU & UBA, 2018).

Responsibilities and institutions of the federal states:

The implementation of water resources management regulations is the responsibility of the Federal States and the municipalities.

To coordinate water management across federal states and with the federal government the German Working Group on water issues (Länderarbeitsgemeinschaft Wasser LAWA) was created. It was set up to discuss detailed questions arising in the areas of water management and water legislation among

the federal states and to formulate solutions and to put forward recommendations for their implementation. In addition, topical questions in the national, supranational and international sphere are also adopted, discussed on a broad basis and the findings are submitted to the relevant organisations (LAWA, 2022)²².

Institutions for and rules for water management can vary between federal states (Bundesanstalt für Gewässerkunde, 2002). Due to these differences between federal states it is necessary to consider Bavarian institutions in particular. In Bavaria institutions for water management are distributed across three different levels as illustrated by Figure 20.

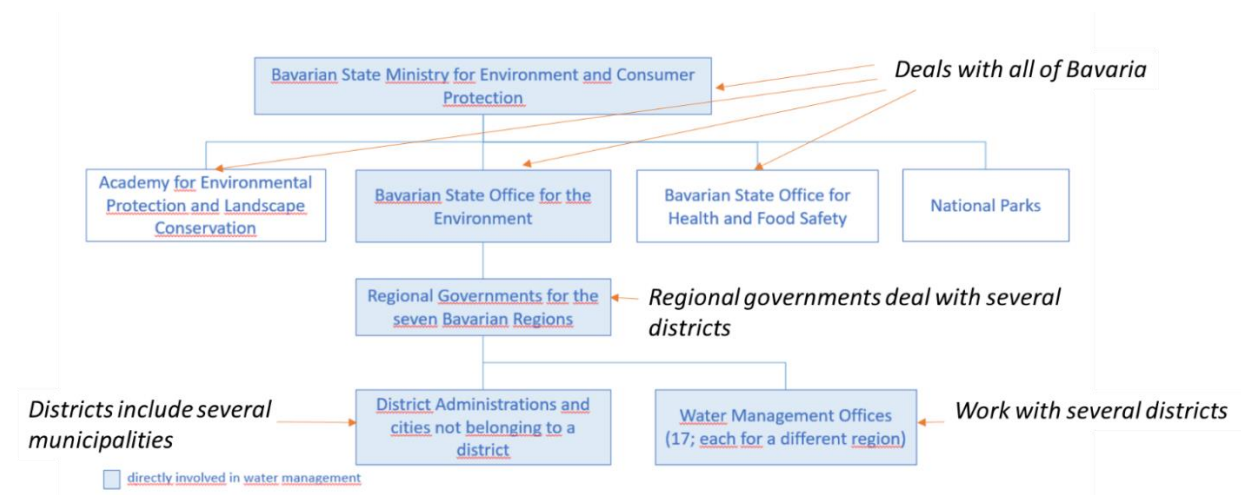


Figure 20: Structure of water administration at Bavarian level²³

The Bavarian Ministry for the Environment and Consumer Protection serves as the supreme water authority of the federal state. The Bavarian Environment Agency is the central scientific-technical authority responsible for fundamental water management issues throughout Bavaria. The Bavarian Environment Agency advises the Ministry and acts as a technical-scientific service center for authorities and institutions in water management.

The seven regional governments each have departments for water management responsible for regional water resource management planning, important procedures under the water acts and administrative procedures. They are the „middle layer“ in the Bavarian water administration. They are responsible for coordination and bundling developments within the respective administrative district and ensure the uniform implementation of laws and ordinances by the lower state authorities (Figure 21, Figure 22).

The 17 water management offices (WWA) are technical authorities at the lower state administrative level responsible for supporting and advising the governments and district administrative authorities in the execution of water management tasks. They are responsible for the development and maintenance of the state's waterbodies and associated properties, the hydrographical measurement and the technical supervision of waters and the support of the municipal level in relation to wastewater disposal, water supply and the management of water bodies that are not the

²² LAWA (2022). About LAWA. Access via: <https://www.lawa.de/English-About-LAWA.html>

²³ Own figure based on: Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (2024). Wasserwirtschaft in Bayern – Organisation. Access via: https://www.stmuv.bayern.de/themen/wasserwirtschaft/wasserwirtschaft_in_bayern/organisation.htm;

responsibility of the federal state (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz, 2024²⁴). Figure 11 shows the spheres of influence of all 17 water management offices.

The Table below presents the main responsibilities and entitled at the EU, State and Regional level.

Table 7: Principal legal provisions of water resource management²⁵

Level	Regulations					
EU	Water Framework Directive (WFD)	Urban Wastewater Treatment Directive	Drinking Water Directive	Nitrates Directive	Flood Risk Management Directive	Marine Strategy Framework Directive (MSFD)
	Groundwater Directive (GWD)	Industrial Emissions Directive (IED)				
	Environmental Quality Standards Directive (EQSD)					
National	Federal Water Act (WHG)	Federal Water Act	Drinking Water Ordinance (TrinkwV)	Fertilizer Act (DüngG)	Federal Water Act	Federal Water Act
	Groundwater Ordinance (GrwV)	Waste Water Charges Act (AbwAG)		Fertilizer Ordinance (DüV)		
	Surface Waters Ordinance (OGewV)	Waste Water Ordinance (AbwV)				
	Ordinance on Installations for Handling Substances Hazardous to Water					
Länder	Federal states' legislation (laws/ordinances, licences, notices, monitoring)					

The role of the municipal level

Central parts of water management such as the supply of drinking water, the collection, treatment and disposal of waste water are considered basic public services in Germany. The provision of these and other basic public services is safeguarded by the German constitution (GG Art. 20 (1)). Bavarian ordinances build on these constitutional principles and give the responsibility for providing these basic services to municipalities (BayGO Art. 57). Municipalities are free in deciding how to provide public services because of the principle of local self-government (GG Art. 28; BayGO Art. 86-96). Because municipalities can vary significantly from one another, they use the freedom granted to them by this provision to organise water management in a way that best fits their abilities and the needs.

Legal framework

Water management in Bavaria is impacted by legal provision from the European and national level as well as rules and regulations formulated on the Bavarian and the municipal level.

Table 7 gives a brief overview of the legal provisions passed by the EU and national level that shape water management in Germany. It shows which national laws and ordinances were created or changed to implement the EU directives. It is only about water resource management. There are other

²⁴ Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (2024). Wasserwirtschaft in Bayern – Organisation. Access via: https://www.stmuv.bayern.de/themen/wasserwirtschaft/wasserwirtschaft_in_bayern/organisation.htm; Last access: 21.08.2023

²⁵ Source: BMU/UBA (eds.) (2018). Water Resource Management in Germany. Fundamentals, pressures, measures. Dessau-Roßlau. page 8. Access online: www.uba.de/en/water-resource-management

legal provisions which implement water management, its quantity or quality such as legislation on climate change mitigation or adaptation, industrial or agricultural policy. They are not included in this overview. The graphic excludes non-legislative acts such as the zero-pollution-action-plan on the European level or the German Water Strategy on the national level (UBA & BMU, 2018).

The water-related provisions of the federal states complement the national provisions and serve to implement them. The federal states have made varying use of the right to deviate from national law granted to them by Article 72, paragraph (3) of Germany's Basic Law. On the Bavarian level the Bavarian Water Act (BayWHG) shapes water management. It is complimented by several ordinances and non-legislative acts.

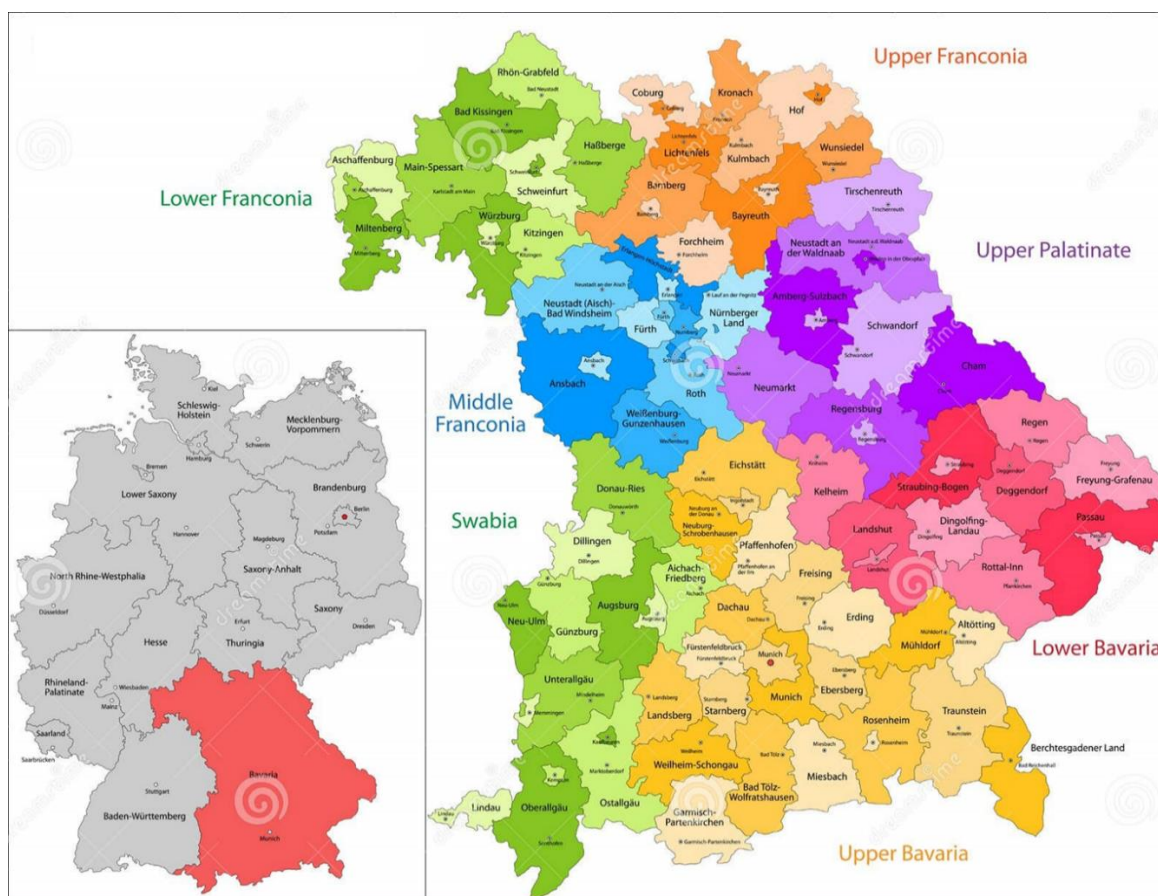


Figure 21: Cities and districts in Bavaria²⁶

²⁶ Source of map: <https://www.dreamstime.com/illustration/bavaria.html>



Figure 22: Local water authorities. The one concerning the Lower Franconia are Aschaffenburg and Bad Kissingen

Implementation of the Water Framework Directive in the Main river basin

The implementation of the Water Framework Directive illustrates the complex relationship between different levels of governance.

Following the logic of river basin management as introduced by the Water Framework Directive, the Main is officially part of the Rhine river basin (see Figure 23 on the left). The Rhine river basin however spans several federal states because geographical and political/administrative boundaries are not identical. Each federal is responsible for the implementation of the Water Framework Directive within its borders. In consequence, the Bavarian authorities are responsible for implementing the directive and ensuring compliance.

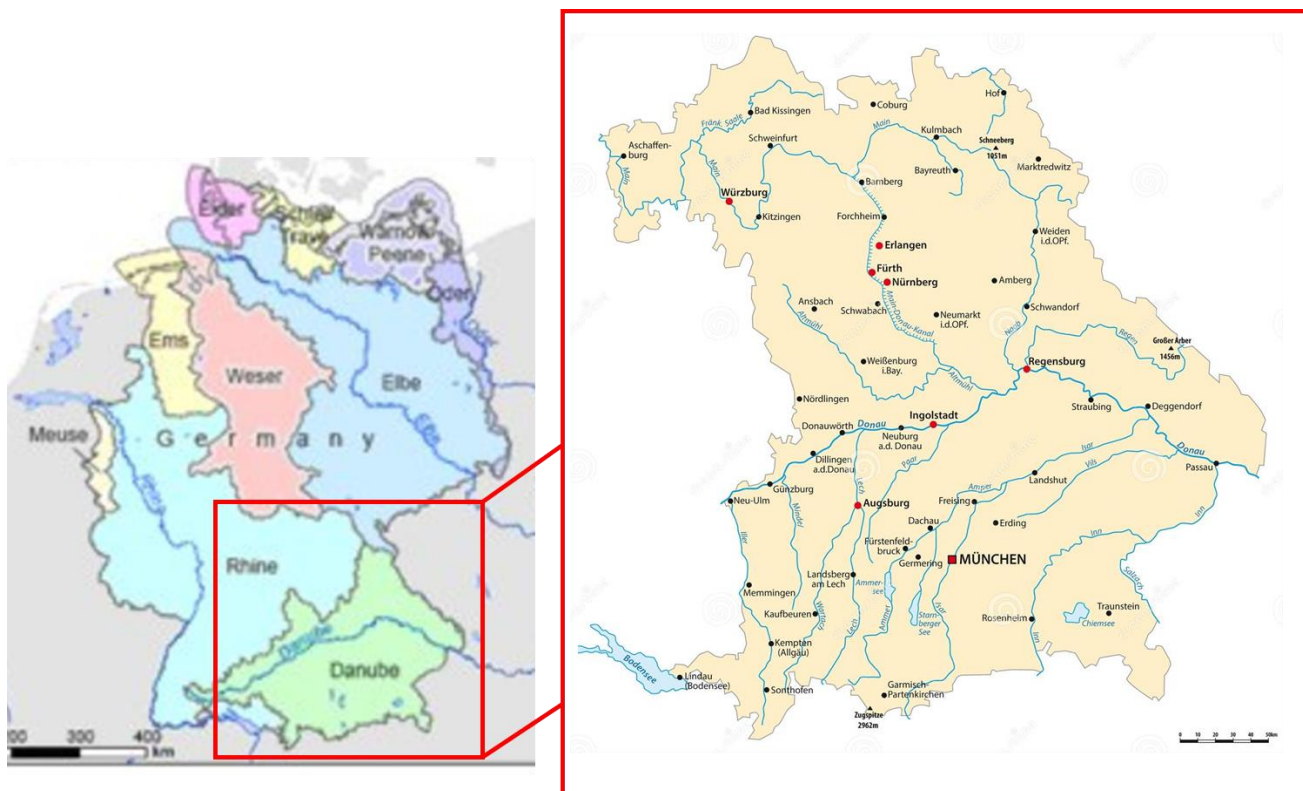


Figure 23: The Main and Rhine river basins for the implementation of the Water framework Directive²⁷

2.2 Results of the nexus governance assessment

The field visit took place in June 2023, from the 24th to the 31st, with interviews conducted during the week. During the field visit, we met 13 stakeholders (Table 8) from different sectors and levels of governance:

- Water sector:
 - o Municipal level: City drainage company (wastewater treatment) and Water supply company (water works) ;
 - o Governmental District: District Government of Lower Franconia - Department of Water Resource Management;
- Ecosystem sector:
 - o District(s) or region: Department of forestry (Office for Food, Agriculture and Forestry)
 - o ; Environmental Association
- Agriculture sector:
 - o Geographical region (covering three governmental districts: Lower Franconia, Upper Franconia, Middle Franconia): Franconian Association of Viticulture
 - o Local : Organic vegetable farm

²⁷ Sources of images, on the left:

https://ec.europa.eu/environment/water/participation/map_mc/countries/germany_en.htm and on the right: <https://www.dreamstime.com/vector-map-state-bavaria-major-cities-germany-image182210067>

- Government - All sectors:
 - Municipality: Mayor
 - Federal state: Members of Bavarian Parliament from three parties (CSU, SPD, Bündnis90/Die Grünen)
 -

Table 8: Overview of stakeholders involved in the interviews for governance analysis in the Main River case study

CS#3 MAIN RIVER Governance analysis Field visit	Number of stakeholders interviewed	Number of Men	Number of Women	Men (%)	Women (%)
26-30 June 2023 and on 5 July 2023 (remotely)	13	11	2	85%	15%

The next paragraphs of this section are describing the assessment of each cell of the governance assessment tool matrix as described in the first point of the methodological section (Part A).

● Extent

Actors and networks

The River Basin Management Plan (RBMP) is drafted on the federal state level. This process involves a diverse range of stakeholders, including water users, environmental NGOs and other NGOs, municipalities, and members of Parliament, highlighting the collaborative and multi-sectoral nature of water management in Bavaria.

City drainage companies, municipal supply companies, and local water suppliers are not directly involved in designing the RBMP. They could be represented by their associations, as for other categories of users, but this was not mentioned by the stakeholders we met. As water users, they must comply with regulations. For example, when applying for water rights, they must consider consequences on the neighbourhood, river water level, fauna, flora, and nearby water bodies, even if from the legislation perspective the RBMP does not directly impact water rights or the application process.

Nevertheless, according to one interviewee, the RBMP does not mandate an environmental impact assessment, but water users understand the process, including compliance with regulations.

As for water companies, farmers, winegrowers (Figure 24, Figure 25), and related associations (or “clubs”) are not directly involved in the RBMP and to its drafting occurring at the federal state level. They could be represented by their interest groups however and could be invited to comment after this, on the implementation of measures locally. They are part of the Water Alliance (a Member of Parliament’s initiative), contributing to water-related discussions and issues. The forest department, which covers more than one district, while not directly involved, has interlinkages with water and is included in climate change adaptation strategies.



Figure 24: Vineyards in the Main River catchment areas (La Jeunesse, June 2023)



Figure 25: Examples of wine trademark produced in the area (La Jeunesse, June 2023)

Environmental NGOs actively participate to the RBMP process and have a consultative role in the Water Framework Directive. They contribute to the implementation of plans, especially for the renaturation of smaller water bodies, and are part of environmental impact assessments. Environmental authorities (Würzburg, LfU, Bund Naturschutz, Wasser am Limit) and animal protection (Wild hamsters' population) are also involved in debates regarding other sectors' concerns, depending on the issue at stake.

Municipalities are responsible for third-order water bodies ("Gewässer 3. Ordnung"), addressing renaturation programs and nitrate issues. They act as moderators among different sectors and try to balance conflicting interests.

Some members of Parliament actively participate in water discussions inside and outside of parliament. Within parliament water policy is primarily discussed in the parliamentary committee on the environment and consumer protection. Additionally, some parliamentarians work on questions of water management outside of parliament. Some have created a working group called a "Water Alliance" others are participate regularly in conferences such as a regional "water forum" organized by the governmental district. Parliamentarian's role is to bring local ideas and issues to both the Bavarian Government (representing the federal state level of decision) and the Government of Lower

Franconia (representing for us in this governance analysis the regional level) as well as influencing their parties stance on water policy and related issues.

At national level (Parliament), the RBMP is circulated between ministries, including those for the Environment, Agriculture, and Consumer Protection, for approval. The approved RBMP is then submitted to the International Commission of the Rhine.

To conclude on the extent of actors and networks, all the water users are involved and all can comment on the draft of the RBMP when it is formulated by the federal state. For this, they are usually represented by their associations/interest groups, but not in a “formal way”, because there is no official committee or water board established. Some actors participate to the Water Framework Directive process and some rather organise themselves depending on their interests, opportunities, or individual initiatives: water alliance, water neighbourhoods, consultative boards, official or informal round tables, “clubs”, etc. With regard to other resource-related issues, new collaborations or alliances are created: involvement of environmental authorities or animal protection to support ecosystem management, farmers support on renewables, etc.

The water governance system involves all relevant stakeholders, which is supportive.

Levels and scales

Bavaria's water management involves collaborative efforts across various levels, with an emphasis on complying with laws, regulations and ordinances of the EU, the national/federal level and the federal states and adopting a holistic approach to address water-related challenges. Decision-making authority regarding water rights rests with the state. However, civil society organisations and private sector organisations are active with their own initiatives and projects. For example environmental NGOs play a significant role in advocacy and education alongside other governmental and non-governmental entities. On the municipal level water suppliers have organized in “water neighborhoods” for ensuring a reliably high level of water management.

The organisational structure for addressing water issues has been described in the section on the description of the context of the case study. These water authorities are divided into two departments, one for technical issues and the other for legal matters. The institutions for water management always act within their administrative boundaries, with some authorities being responsible for the whole of Bavaria, some being responsible for governmental districts and other being responsible for one district or in the case of the water management offices several districts. However, a watershed-level perspective (*“considering the Main River as a whole”*) is still missing and has been suggested to address water-related issues holistically, because *“there is no regional nor local solution”*. A watershed-level perspective is only taken in the implementation of the Water Framework Directive. River Basin Management Plans consider the river basin as a whole. Following the formulation of the RBMP the tasks connected to its implementation are within the responsibility of the listed institutions. Consequently, a watershed-level perspective has little effect on daily choices.

Responsibility for water management ultimately lies with the government and parliament. There is no authority at lower levels, and the State is responsible for groundwater and rivers. Water rights are delivered by local water authorities but need to be authorised by the State which is in fact the only one to decide on water rights. Applicants usually apply for water rights to their administrative district's water office. The administrative district consults the water management office before deciding if a water right can be granted. In deciding about water right applications the administrative district's water office has to consider the rules and guidelines for processing applications for water rights. Those are formulated by the government for the federal state for the whole of Bavaria. Additionally, the districts water authority consults the water management office responsible for the district. It offers a

technical opinion on the application. Ultimately, the district water authority decides if water rights can be granted. In doing so it may consider local conditions, the technical opinion and applicable guidelines and laws. Local decisions align with state rules, and the State has a significant influence: *“if the State says: “no more water rights”, there won’t be any”*.

In contrast to water authorities, forest authorities handle both technical and legal issues in a single department. The multi-districts forest department's main contact is with other environmental departments, not directly with water. They are actively involved in climate change strategies and discussions, collaborating with upper forest administrations and institutions (Landesanstalt für Wald und Forstwirtschaft).

Finally, implementation of national laws, including those related to water, is crucial at the local level. Private forest owners and municipalities must comply with relevant rules, emphasising the importance of local action in adhering to national regulations.

Additionally, civil society organisations such as interest groups and associations are active on different levels.

Environmental NGOs are structured similarly to the government, with national, federal, regional and district levels. They have political interests at the national level, a consultative role in procedures at the federal level, and provide information to upper levels and work actively with municipalities at the local level. They act as interest groups, are involved in resource conservation projects and offer environmental education, but these efforts are not exclusive to NGOs; the city, State, and other associations are also involved.

At the local (municipal) level, around 70 water neighborhoods (non-official administrative level, somewhere in between municipalities and districts), operate on a voluntary basis. A “water neighborhood” is a group of several (technical) staff members of municipal water suppliers within a district. Each group is led by one member who serves as a contact point for the groups from other districts. To connect all Bavarian water neighborhoods an association was created. It funds an office that disseminates information and addresses questions, particularly related to new legislation and requirements. Once a year the leaders of all water neighborhoods meet to discuss pertinent topics in their field. The water neighborhoods are considered a valuable tool for knowledge sharing by the municipalities, Bavarian government and industry associations from the water sector. Therefore, water neighbourhoods are supported by industry associations from the water sector and the state (e.g., Ministry for the Environment, Health Ministry). Stakeholders from other sectors such as farmers are not included because these neighbourhoods primarily deal with water supply and wastewater issues. They focus on quality thresholds, capacity building, and relevant water-related topics. Each neighbourhood has a representative, and there is a governing board that meets annually. An office structure disseminates information and addresses questions, particularly related to new legislation and requirements. Water neighbourhoods include associations, state agencies (e.g., Ministry for the Environment, Health Ministry), but farmers are missing. These neighbourhoods primarily deal with water supply and wastewater issues.

In conclusion, the river dimension is not present at the case study level. The different administrative levels are existing and concerned by the process of complying with the WFD goals, but some are deciding (at the federal state level) while the local level has to implement what has been decided at upper levels. The way the WFD is implemented without any local or federal board does not permit an official important extent of levels and scales. This is probably explained by the fact that the Main River is embedded in the Rhine, which has an international board, while receiving waters from the Danube and crossing the region of Bavaria. And, in fact, the local level role is to implement the federal state’s level requirements.

There governance system does not easily involves all levels and scales, which is restrictive.

Problem perspectives and goal ambitions

Each sector of water, energy, agriculture and the ecosystem faces specific issues: water rights and issues of quantity and quality, changing agricultural practices, local, regional and federal strategies, land use and landscape change, forest management and extraction issues.

Local water suppliers (Figure 26) are facing challenges with a lengthy, complex procedure for water rights, urging a need for streamlining. Water quantity and quality regulations exist, but there is a lack of monitoring and control, especially in the field (e.g., fertiliser use). Local water authorities (district water authorities and water management offices) are suggested to take responsibility for controls. Decision-makers lack technical knowledge, and water usage from the Main River and groundwater lacks organisation.



Figure 26: A reservoir of drinking water of a local water supplier (La Jeunesse, June 2023)

The interviewees mentioned that there is no experience with irrigation for vegetables in Germany because they didn't need it so far. They did the opposite by focusing on drainage. According to them, as a result, agriculture now needs to adapt to water storage due to changing needs induced by climate change impacts on water availability. Groundwater levels are decreasing, and Water Framework Directive (WFD) measures are not meeting 2027 goals, because of poor performance on the goals for water quantity and water quality. The wine-growing sector adapts better to heat than to drought, but water shortages have become a major concern over the last 3 to 5 years. To be able to adapt, farmers declared to suffer from a lack of local water intake control due to data privacy concerns.

To overcome these difficulties, efforts at all levels are made to adapt agricultural such as revegetating soils, preventing erosion, limiting drought and reducing water requirements. The case study region is in fact a hotspot for drought and water scarcity according to meteorological information, faced with falling water tables, increased use of water by agriculture and problems of nitrate concentrations now reaching the thresholds of 50 mg/L. Consequently, water authorities worry to have more problems fulfilling WFD goals due to low water recharge. As a result, water managers interviewed mentioned to need better knowledge and control of user needs, but authorities do not yet monitor or share data. In addition, all levels have expressed a general political reluctance to tackle new issues, partly due to excessive commitments.

Locally, landscape and land use changes are predominant, impacting biodiversity and increasing pressure on lands. The development of special cultures (e.g., corn for biogas) affects ecosystems and land availability (e.g., investors are looking for lands to develop renewable energies). Consequently, balancing the ecosystem, energy production, and food production is more and more a challenge.

Forest drying out requires watering newly planted trees, a new challenge for the forestry sector as declared by interviewees. Moreover, forest management is complex due to fragmentation (complicated legacy rules) and different ownership shares (30% State, 20-25% municipal and 45-50% private). In addition, peatland extraction creates a conflict between the Ministries of Agriculture and the Environment, both of which lack the instruments to resolve it. Besides this, 95% of peat zones are in poor state, which highlights the need for water to restore them.

Stakeholders share their points of view concerning the effects of climate change on the water-energy-agriculture-ecosystem nexus in their sectors, which is supportive.

Strategies and instruments

The region has a number of strategies and instruments in place to tackle water-related challenges, including local pacts, municipal plans, irrigation initiatives and attempts at a holistic approach. Challenges include conflicts between different administrative bodies and the need for more local and better funded measures to complement wider frameworks such as the Water Framework Directive.

The Bavarian Ministry for the Environment and Consumer Protection has formulated a “Water Strategy 2050”. It is built on five pillars: Storing water, distributing water, protecting water, valuing water and taking a holistic approach to water. Some interviewees were under the impression that the strategy strongly focuses on water transfer from the South to the North and is based on the principle that taking water from elsewhere reduces the priority to care for local water. Additionally, there are voluntary strategies, like a water pact between agriculture and water sectors, that aim to go beyond WFD demands. New initiatives were proposed, with the use of water from wastewater treatment plants but because of financial burdens it is not clear on how to finance them. Finally, they remained pilot projects only due to too costly last treatment stages, and also because of a lack of demand for treated wastewater.

Farmers can benefit from the support of associations or clubs (Bewässerungsverein irrigation club) that focus on transitioning from groundwater to securing inter-seasonal water storage. These clubs pool resources of multiple farmers to facilitate irrigation. In a rural district in the case study region where water-conflicts have been pertinent in the past, a study is underway with funding from the local water authorities and the Ministry for the Environment of Bavaria with the goal of finding a sustainable solution to the conflict between irrigation, ecology and water supply. Regarding drought, farmers explained us the lack of insurance systems for vegetable crops to compensate for their losses.

Local municipalities have water development plans for rivers according to the WFD. These plans mainly provide for the renaturation of rivers and the reduction of nitrate concentrations. To complete these local plans, some municipalities decided to gather, and create corporations, like the one among 10 municipalities in the north of Würzburg, which allows them to learn from each other’s experiences.

A Member of Parliament even initiated a commitment at its level for a holistic approach, including groundwater extraction, industry, farming, land use changes, and water retention. But the initiative is facing tensions between environmental and agricultural administrations, leading to its discontinuation.

The WFD and its implementation process aim to connect different sectors in a network. However, drought management is not clearly part of the WFD implementation through a list of measures, reducing its effectiveness in addressing drought-related issues. Local authorities call for more localised measures with appropriate funding rather than relying solely on the WFD: *“WFD is not truly the right tool here, rather general and unspecific while more local measures with appropriate funding are necessary”* (interviewee, June 2023).

According to interviewees, a full environmental impact assessment is not mandatory for all projects, but some companies opt for it to ensure legal security, especially in case of legal challenges. As for farmers, they cooperate voluntarily for decades in water protection areas, with a support scheme providing compensation.

The forest Department explained us how it collaborates with upper forest administrations and institutions (Landesanstalt für Wald und Forstwirtschaft) for research and strategies in forestry. They focus on adapting to climate change scenarios, such as introducing new species above 1.5°C temperature thresholds.

In conclusion, the WFD is not a tool which permits the decisional process to deal with drought. There is the existing Water strategy 2050 which is of help but which concerns water transfer (from the South to the North). The current existing agreements between sectors (agriculture and water - water pact), or cooperation within sectors (agriculture - water protection areas) are set without any legal framework. They build on voluntary measures and may be discontinued if one or more partners revokes their commitment. The environmental impact assessment is not mandated as part of the implementation of the WFD even though it provides legal security.

The governance system has developed several and different tools (legal and policy frameworks, strategies and plans, etc.) to deal with climate change impacts, which is supportive.

Responsibilities and resources

The challenges include a lack of expertise, clear responsibilities, and financial resources at various levels, impacting the ability to address climate change-induced issues effectively. The dependency on higher levels for funding and the reluctance to control water needs pose significant obstacles, emphasising the need for more coordinated efforts, public awareness, and political support.

On the one hand, local councils lack in-depth knowledge of projects, and municipalities have limited funding. Indeed, they depend on support schemes from higher levels (Bavarian, national, EU) for project funding, even though they are often facing challenges with allocated funds becoming insufficient when project costs evolve over time. On the other hand, local projects lack clear responsibilities and decision-making structures. However, small rivers and streams under the WFD are the responsibility of municipalities, but financing remains a challenge.

Moreover, decision-makers, both at local and higher levels mentioned to lack technical knowledge and expertise. Actually, expertise is locally available, but former closures of local water authorities led to a shortage of experts, especially for monitoring water consumption and flow conditions. The expertise on water needs estimation and climate change impacts is also limited, and there is an urgent need to find experienced scientists. Indeed, some interviewees claimed that researchers often learn from farmers due to the lack of studies on irrigation, drought-resistant vegetables, and certain crops. Besides, only big companies can afford irrigation facilities.

Similarly, some of the initiatives that were proposed, like the wastewater treatment funding scheme, had to stop due to costly treatment stages.

Within the Bavarian government and within administrative bodies interests are competing: environmental (water management) vs. business (food production). Water management is the responsibility of one section of government and the administrative bodies but touches on the interests of other sectors – especially food production. Policy for food production and agriculture however is drafted by a different section of government and implemented by administrative bodies. Conflicts between water management and business/food production can continue if they are unaddressed. The State remains reluctant to control water needs due to staffing constraints and concerns about farmer reactions and public opinion. Yet, decisions on adaptation and strategic approaches are at the government or parliamentary level. In addition, the district offices “see themselves as ministries”, which complicates the implementation and monitoring of water abstraction.

For its part, agriculture needs clear rules and orientation from the State, except for wine-growing, which is well-organised and autonomous (e.g., exchange of knowledge, expertise, techniques, etc.)

Nevertheless, the implementation of forest and water laws follows clear processes with assigned responsibilities. However, the distribution of resources among institutions remains unequal, which may hinder achieving climate change-related goals.

Finally and more generally, the region is facing a lack of awareness, knowledge, and reflection in the population. Consequently, there is an urgent need for more political support to enhance education on climate change impacts.

In conclusion, the responsibilities are clearly assigned, and all the processes are clear and known. At the federal level, they have the resources and are funding studies. At the local level (municipalities and district associations), they have the knowledge, but they don't have enough staff and money to implement any changes. They rely on the upper levels. Finally, and more generally, they are all lacking expertise and technologies to tackle climate change issues in the long run.

The responsibilities assigned are clearly assigned and supported by some resources, which is supportive.

Conclusion

In the complex field of water management, the participation of water users in the River Basin Management Plan (RBMP) process stemming from the absence of an official committee or water board. This absence prompts stakeholders to navigate the waters of collaboration and decision-making within the context of the Water Framework Directive (WFD).

Participation in the WFD exhibits a diverse landscape, with stakeholders organising themselves based on individual interests, seizing opportunities, or initiating personal endeavours. This decentralised approach creates collaborations and alliances that extend beyond conventional boundaries. Environmental authorities, animal protection groups, and farmers championing renewables find common ground in addressing resource-related issues, without declaring doing this in the context of the WFD.

At the case study level, the river dimension takes a back seat, overshadowed by administrative adherence to WFD goals. Decisions emanate from the federal level and cascade down for local implementation. The lack of formal local or federal boards hampers the comprehensive implementation of the WFD, a limitation potentially influenced by the international context of the Main River within the Rhine and also connected to the Danube through channels and water transfer.

The Main River basin faces a whole series of challenges, ranging from control and monitoring to issues like hamster conservation. Water protection areas and the reallocation of water rights pose additional complexities, compounded by complex procedures. There are key issues around reducing water use

and identifying sources of extraction, as the Water Framework Directive does not explicitly address the issue of drought.

Agreements between sectors, particularly in the areas of agriculture and water, lack a legal framework, while cooperation within sectors has no structured basis. Environmental impact assessments play a crucial role in providing legal certainty in the midst of this ambiguity.

Responsibilities are clearly delineated, with federal levels funding studies, yet local levels grapple with insufficient resources, relying on upper levels for implementation. This imbalance highlights a critical deficiency in expertise and technologies across all levels, hindering the formulation and execution of effective, long-term strategies to address the pressing challenges of climate change in the water management landscape.

The system shows a degree of comprehensiveness in terms of actors, scales, perceptions of problems, existence of instruments and provision of resources for dealing with heat waves, which is supportive.

- **Coherence**

Actors and networks

Stakeholder relationships at various levels involve cooperation, challenges, and conflicts. There is a need for improved communication, understanding, and collaboration among stakeholders, especially in addressing complex issues like climate change and water management.

Water suppliers play a regional role and are regulated by the Bavarian Environmental Agency for long-distance water suppliers because they are active in more than one administrative district and sometimes in more than one governmental district. Water suppliers cooperate with the administrative district water office on water use permits, but are strategic in their communications. Indeed, even though they all share the common goal of protecting water, this often results in more requirements and bureaucracy. For example, when they contact the water management authorities to clarify certain aspects, they can respond with higher demands or stricter restrictions, rather than solving the problem or answering the question for which they were contacted. In this way, conflicts can arise and lead to more requirements and bureaucracy, which hampers problem solving.

At the regional level (Franconia region), the wine-growing association is one of the first addressing climate change issues. It collaborates with the agency on the wine estate and with other wineries (outside of Franconia) and are in contact with the Government of lower Franconia and the local water authorities. Their aim is to strengthen "water and land - soil associations" in Bavaria and the wine growing sector pushes for this. These associations are set up to facilitate the creation of large-scale irrigation infrastructure for a group of agricultural businesses. To this end, the Bavarian State Institute for Viticulture and Horticulture (Bayerische Landesanstalt für Wein und Gartenbau - LWG) with wine growers associations frequently travel to Sicily (for adapting viticulture to drought and water scarcity), Israel (for water reuse technologies) for knowledge transfer. Speakers from abroad also take part in the relevant conferences. Other wine associations also exist at Bavarian (federal state) level, which engage with politicians more effectively than at national level.

Within the farmers' club, the members meet regularly to discuss new technologies and exchange knowledge (irrigation, crop choices, etc.). Scientists are permanent guests and water representatives participate in discussions (Bavarian State Institute for agriculture - Bayerische Landesanstalt für Landwirtschaft (LFL), municipality, and local water authority). While farmers generally cooperate, interviewees mentioned there is also competition over water in detail. Otherwise, they have good

contacts with the district administrative authority, local water authority (WWA), politicians of all parties, agriculture authority. In general, the farmers are on the same page but in reality, there is a competition for water.

The forest department interacts with the regional department for water management, local district authority, and environmental departments. They are connected to water-related issues (e.g., the creation of water protection areas and flooding) and collaborate with municipalities for maintaining Bavarian municipal forests. As for the environmental associations, they collaborate with authorities, communities, and other stakeholders in reference to the RBMP. They also work with farmers and the forestry sector for advocacy and solutions (e.g., as declared by an interviewee *“is irrigation the first or only option?”*). Additionally, they are engaged in environmental education, including joint efforts with farmers.

The Water Alliance, at the governmental district level, is supported by a Member of Parliament and involves mayors from small cities and focuses on greening and cooling cities, and *“learning from other countries how to use our water”* (interviewee, June 2023). For instance, one village (Kastell) decided not to give their sewage water away but to hold it as a potential water resource for irrigation. They also interact with winegrowers, because they are perceived to be the most thinking ahead (proactive) and try to develop international connections. In general, there is trust among members, and informal connections with global associations.

In conclusion, the actors and networks of the water, agriculture and environmental sectors, even though they share the same goals (water protection and less water consumption) but they are not all coherently connected and do not all reinforce each other. On the one hand, there are bilateral conflicts, between energy and water (fish path) and between agriculture and environment (water storage, determining what water-use is justified). On the other hand, some synergies between water and environment regarding forestry (laws are connected) and between water and agriculture (cooperation over water protection areas) do exist. Thanks to informal boards or sectoral associations (irrigation club, water alliance, etc.), some relationships are based on trust or cooperation. Viticulture and agriculture (vegetables) are connected to science and to other international partners with whom they share experience and new techniques and technologies. Finally, and more differentiated, politicians are not urging to speed processes and in fact limit collaborations because they want to keep the business as usual, good for their actual position

The majority of interactions between stakeholders and networks are existing even though not all institutionalised. Most relationships are based on trust and cooperation but some are also in competitions with no political support to decrease tensions. In addition, new decisions concerning adaptation are not always shared by all stakeholders. Thus, the context is neither supportive nor restrictive.

Levels and scales

The river basin management for the implementation of the water framework directive is carried out by different authorities in Bavaria. And, by the way, there is no dedicated authority or board for the single river basins. Within the Bavarian section of the Rhine river basin (i.e. the Bavarian Main river basin) there are several authorities and levels involved: The bavarian state ministry for the environment and consumer protection (StMUV), The bavarian authority for the environment (LfU), several local water authorities (WWA), and the district authorities, municipalities for some types of water bodies („Gewässer 3. Ordnung“). Thus, the number of involved administrative bodies is so high because of the different levels of state need to be involved and the boundaries of the river basins do not directly overlap with administrative boundaries. Moreover, challenges in cooperation and

communication exist across administrative levels, hindering effective implementation and decision-making at the local level. The separation of technical and legal aspects contribute to these challenges.

Regarding interactions and exchanges between levels, stakeholders at the local level know each other, but relations with different administrative levels are not meeting expectations. Authorities at municipal, district, regional and federal state levels seem to lack effective communication and information exchange about new legislation or requirements: “sometimes, some levels are not aware of some information”. Awareness seems limited among levels; however, there are occasional exchanges, e.g., neighbours inviting water organisations a few times a year for information sharing. Otherwise, there is cooperation between civil society organisations representing key sectors and Bavarian ministries in certain cases. For example, the Ministry of Agriculture and the Ministry for the Environment cooperate with different agricultural associations, associations representing the water sector and an association representing all municipalities. Together they have formed a pact to improve water quality to levels beyond what is required by the WFD and its sister directives. So cooperation exists but only in certain cases.

At the local level, municipalities face challenges and suffer a lack of autonomy. To face this, as an example, a network composed of 10 municipalities has been developed to exchange experiences and solve specific issues. Indeed, this voluntary organisation was created to overcome the difficulties encountered by municipalities in cooperating with the local water authority (WWA - multi-districts) due to a perceived lack of recognition of water scarcity. Moreover, authorities at the local level are not independent; all entities are part of the State. As a result, all the decisions require parliamentary involvement, limiting local autonomy.

As far as they are concerned, water authorities face challenges as technical issues are handled in one department, and legal issues are managed separately. For their part, forest authorities at the local and district levels combine both technical and legal aspects.

At higher levels, there is a general perceived lack of collaboration between water administration levels and stakeholders at the federal, regional or district level.

Water rights are delivered at the Bavarian level (federal), and the result can lead to tensions. The way the different levels cooperate is not declared as optimal to consider all the information available locally.

Regarding political relationships, the federal state, regional and district levels are facing several challenges, one of the main conflicts being between the Ministry for the Environment and the Ministry of Agriculture, for example regarding the question of peatland in Bavaria. Conflicts between these two government bodies can also be found at the local level, due to a lack of understanding of measures (e.g., storage in winter to be reused later in summer). Municipalities, for their part, attempt to connect irrigation (agriculture), water demand (drinking water) and environmental conservation (protected area for hamsters).

More generally, the quality of relationships varies based on topics and issues. One of the main disagreements between authorities and municipalities concerns land-use-related matters. But most of the time, dialogue and cooperation between stakeholders is challenging due to shared issues but differing goals.

In conclusion, within each domain (water, agriculture, environment), the federal level (Federal State of Bavaria), the regional level (Lower Franconia) and the local level (district administrations and municipalities) are acting coherently, and probably well connected with municipalities. However, at the federal state level, agriculture and environment have problems to act coherently and are even conflicting when it concerns water storing for irrigation or water supply protection areas, or protection of peatlands. But this summer, because of the drought, there is more discussion than ever.

The different levels and scales involved in water scarcity and drought management do not work together acknowledging interdependences and trust each other, which is neither supportive nor restrictive.

Problem perspectives and goal ambitions

The Franconian area faces challenges related to wastewater reuse, water protection areas, competition for water rights, conflicts between agriculture and environmental protection, authorities' lack of clarity on water extraction, the need for clear rules, and debates around energy transition. The ambitions include changing forest composition, addressing ecological issues, and finding solutions for sustainable land use.

First of all, there are local water conflicts and the authorities lack clarity on water extraction because of the need to develop the monitoring of water consumption. Farmers and municipalities express concerns about insufficient water, frequent drying of water bodies due to irrigation (35% of the total allowance), and potential conflicts over wells' overexploitation. Locally, the main conflicts concern water-protection areas, which are competing with cementations, mining, urban development, and preservation areas. At upper levels, authorities lack a clear picture of water extraction from the Main River and continue to pay the consequences of a minimal attention to groundwater extraction in the past. At the same time, drinking water quality requirements for irrigation are questioned it is being questioned whether water for irrigation needs to be drinking water quality and be sourced from the groundwater, and public awareness is increasing, pressuring authorities.

Competition for water resources was reported by interviewees as increasing, with some holding water rights as a privilege. For this reason, attempts are being made locally to switch from groundwater to surface water for storage during the winter and use during the summer (for example, the main concern of the farmers' club). But these initiatives often come up against resistance to the reuse of treated wastewater, particularly from farmers who are used to using groundwater free of charge. Similarly, proposals for farmers to invest in treatment plants for the free use of wastewater run up against problems of acceptance and conflict, particularly with the water users who already pay taxes for irrigation. Some research projects on the reuse of treated wastewater are underway. Municipal companies in charge of wastewater treatment and universities cooperate to treat wastewater until its quality is similar to that of drinking water. Then its application for irrigation is tested. While first results are promising some hurdles remain especially the cost of treatment and public acceptance.

Regarding water protection areas, according to interviewees, water suppliers and minorities, especially environmental organisations, disagree on protection areas and financial gains. Indeed, there is no compensation nor guidance for companies willing to comply with water protection areas. The requirements and recommendations are supposed to come from the Federal level, which doesn't seem to take responsibility for this.

To improve adaptation to climate change, the State now is open to supporting the irrigation of some forests as an exceptional measures during extreme conditions,: for instance, in one year a forest where more drought resilient trees had been planted was could have been watered with water from the Main, at a time when the transfer from the Danube was already critical and the water levels in the Main were consequently low. However, the organization in charge of the forest did not want the young drought-resilient trees to die off prematurely. But the primary mean and long-term ambition remains to change forest composition, introducing drought-adapted species to face climate change and reduce water needs, avoiding irrigation. However, due to the fast progression of climate change and drought it is becoming increasingly challenging to successfully plant new trees, even if they are drought-adapted species.

Among the main conflicts linked to agriculture and the environment, the ecological impacts of storing water for irrigation thus modifying the variability of river flows are the most difficult to resolve. In addition, the water authorities are lacking acknowledgment of water scarcity issues, leading to groundwater overuse without robust monitoring. Consequently, farmers declared to be asking for clear rules to prevent overexploitation, urging the State to act. Regarding land use challenges (mainly for farmers), conflicts have been pointed out between agriculture (wants to send lands to increase incomes, as with renewable energies), municipalities (want to maintain food production), and investors (want more lands to develop renewable energies). Finally, there is a need for crop rotations but municipalities and farmers lack specific financial support for the initiative to be successful.

Finally, energy and environmental interests are conflicting, as demonstrated by the energy sector's opposition to fish paths, due to the reduction of flows which impacts the energy production. Compensation measures for biodiversity protection are also discussed, including the 50% land compensation requirement for hamster preservation which impacts in fact all sectors who would need the land. Moreover, debates at all levels are underway on the goals and measures of the energy transition: for instance, economic interests related to substrate for biogas are not in line with water protection interests, while targeting the same goals, *"however, it is not really happening"* (interviewee, June 2023). Despite some successful renewable energy projects (photovoltaic - energy field) and citizen involvement, competition is emerging between farmers who want to maintain food protection and the need for space for solar panel installations.

In conclusion, as *"climate change goes quicker here than in other parts of Bavaria"* the 4 sectors (water, energy, agriculture and environment) share the same vision *"we will have more water during winter and less during summer, so that it needs to be stored"*. For example, sectors are collaborating to link water, energy and agriculture while complying with the WFD. However, no one comply with the urgent need to stop groundwater extraction for irrigation and to enlarge water supply protection areas. Some stakeholders are urgently calling for a switch to the use of surface water for irrigation in order to reserve groundwater, which is better suited to protecting drinking water, for domestic use.

The perspective of the problems and the ambitions of the objectives of cross-sectoral water management does not, in fact, always reinforce each other, which is neither restrictive nor supportive.

Strategies and instruments

WFD is mentioned as not sufficient to comply with all issues. *"WFD is not truly the right tool here, rather general and unspecific while more local measures with appropriate funding are necessary"*. Water protection areas seem to represent a key element but also a challenging one to protect water resources as it leads to potential conflicts. Percentages of protected areas vary across the federal State and has been declared as being around 20% of protected areas in Mittlberg, 7% in lower Franconia, and 5% in Bavaria. They are influenced by municipal concerns: protected areas can limit the economic development of municipalities.

Regarding irrigation, some strategies are locally initiated to improve the acceptance for wastewater uses. For instance, Nutzwasser project (initiated by a city drainage company) aims to change perceptions and a citizen-level investment (allowing co-financing for profits) is suggested for project acceptance. To be successful, these initiatives also need the financial system to be adapted, as surface and groundwater are currently "free" for farmers. A similar approach on surface bodies has recently started with practitioners, using the water from wastewater treatment process for irrigation, parts lower Franconia are involved in the project. In general, all these voluntary agreements are seen as more effective than the Water Framework Directive (WFD) for financial support. But there are some

remaining complaints about water strategy coordination and insurance systems. Indeed, viticulture, forestry, and agriculture are the sectors adjusting the most and emphasising the need for regional coordination. They are also suffering from limited insurance options regarding drought, especially the agricultural sector which is lacking solutions for irrigating vegetables.

Regarding water rights, as water reuse and data collection, each enterprise/farm has its water rights. But this is not in force anymore. Moreover, current regulations required do not permit the reuse of water from water treatment plants for the irrigation of crops: *"It's in the law [...] It's not allowed to reuse water for irrigation, even if Germany imports food and products grown with reused water!"* (Interviewee, June 2023). To effectively restrict water extraction from groundwater reserves, several of projects have been initiated: the first one, "data project", involves volunteer organic farmers and aims to improve knowledge of the volumes of water withdrawn (and to estimate actual needs), by collecting hourly data and measuring hourly pressure in the soil. The second one, "water storage project" is more cross-sectoral as it involves environmental NGOs and agroforestry, by exploring the positive impacts of agricultural practices such as hedges, mulch, et cetera. Moreover, the state is increasing its efforts to monitor water rights and digitize records in order to facilitate a knowledge-driven management of water rights.

Stakeholders interviewed described us some adaptation and mitigation efforts already made. *"The debate (about water) is everywhere in society, but adaptation is a long and slow process"* (Interviewee, June 2023). Yet, initiatives have already been launched, such as the "Sponge City" project in Würzburg, and a pilot project called "Smart Metres" funded by the Ministry of Environment to collect water withdrawal data. In addition, investments are being made in renewable energies. Among the observed mitigation efforts, some are facilitated by connections between sectors: this is the case, for example, in the forestry and water sectors, whose laws are connected, which facilitates discussions on incentivizing forest use for carbon absorption. Nevertheless, these projects are based on singular approaches, whereas a holistic approach would be more appropriate. Indeed, they are about gaining water, rather than changing common practices, which would be more efficient: *"Everyone needs to save water and change their behaviour"*. So, developing educational approaches to enhance behavioural changes is needed to achieve meaningful water conservation, *"because only taking water from the Main River isn't a solution"* (Interviewee, June 2023).

Finally, the national and federal levels need to get involved to solve incoherence. Indeed, three approaches have been suggested to solve incoherence at the Bavarian level: clear State regulation (but doesn't know how much water is extracted), incentives for change (the State has money, knowledge, and real experts), and rule-setting by the State (which can moderate, because it has the core instruments and human skills to do so). Most of the projects provide an opportunity for real intersectorality.

In conclusion, water protection areas, influenced by varying percentages and municipal concerns, lead to conflicts. Local strategies (the Nutzwasser project) address wastewater acceptance in irrigation, requiring financial system adaptation and a change of public attitudes towards water-reuse. Voluntary agreements are seen as more effective than the Water Framework Directive (WFD) for financial support. Complaints about water strategy coordination arise, especially from viticulture, forestry, and agriculture sectors, emphasising the need for regional coordination. Regarding water rights and reuse, businesses face restrictions. Initiatives like the "data project" involve organic farmers for improved water knowledge, and the "water storage project" explores cross-sectoral impacts. Adaptation and mitigation efforts include the "Sponge City" and "Smart Metres" projects. Investments in renewable energies are underway, but a holistic approach is deemed more efficient. Educational approaches are crucial for meaningful water conservation behaviour. National and federal involvement is needed to resolve regional incoherence, suggesting clear State regulations, incentives, and rule-setting.

The system allows for cross-sectoral synergies between strategies and instruments, but there are some uncertainties about how to integrate adaptation, which is neither restrictive nor supportive.

Responsibilities and resources

In the ecosystem sector, the forest department possesses expertise and resources for certain issues but lacks capabilities for addressing climate change-induced challenges, which are in the hands of the upper levels. For instance, the Bavarian authority for forestry is engaged in applied research, exploring scenarios under climate change (e.g., +1.5°C) and determining suitable species for mean to long-term forest renewal. To its concerns, the environmental NGOs have limited capacity at local level (district), as only two individuals are dedicated to implementing the Water Framework Directive (WFD), in the administrative district, specifically focusing on river renaturation.

Regarding political responsibility and communication, there is an urge for politicians to take responsibility, communicate transparently and emphasize the necessity for societal acceptance of changes. In fact, if most of the projects provide an opportunity for real cross-sectorality, this does not last over time and would require and make use of Bavarian regional funds. But the current political dynamic is not supportive to this, since those who gain votes “are the ones promising minimal change”: “Who tells the people “You don’t have to change”, gets the votes” (Interviewee, June 2023). Moreover, stakeholders are confronted with data secrecy and protection challenges. Local water authorities cite data protection and privacy concerns as reasons for not sharing information. Consequently, municipalities face challenges in obtaining the number of wells and the amount of water extraction data before 2019, attributed to data protection concerns. Current data study with the agriculture administration faces similar challenges.

Some water management offices (i.e., technical authorities responsible for advising multiple administrative districts, cf Figure 22) are facing long delays (e.g. up to five-years) addressing certain issues. In addition, this local authority is suffering from limited control mechanisms and staff, with only two controllers who cannot effectively monitor water extraction activities. Consequently, this sometimes leads to unusual instances of approval for excessive water extraction above commissioned rights: for example, an extraction of an additional 20,000 m³ of water has already been seen to be accepted a posteriori by an administrative districts water office

Members of Parliament from different parties expressed resource constraints that hinder the implementation of their proposals or initiatives. And yet, there's a general consensus around the capabilities of the State, which seems to possess knowledge, expertise, and financial resources, for effective water management.

At the local level, municipalities suffer limited responsibilities and resources. Indeed, on the one hand, Mayors are considered "parties of interest" without intervention powers, and on the other hand, municipalities have to finance water related projects, even if sometimes they can finance 50% of water-related projects.

In conclusion, the real issue relies on “political hesitation” for responsibilities and that the authorities don’t want to take responsibility (for example, local water authorities don't want to control water withdrawals and anyhow lack resources to do so, or lack the resources to do, the federal State of Bavaria doesn't want to define clear rules for farmers, or to handle new strategies). These limits are also linked to allocated resources to take on this new responsibility. The upper level is funding some studies but despite this, these authorities are still reluctant to take a stand and fear their voters’ reaction.

Responsibilities are not sufficiently backed by resources, particularly human resources. This is restrictive.

Conclusion

In the water management landscape, sectors such as energy, agriculture, environment, and water share common goals, yet face bilateral conflicts, particularly between energy and water and between agriculture and environment. Synergies exist, notably between water and environment in forestry and between water and agriculture in water protection areas. Informal boards and sectoral associations foster trust and cooperation, while viticulture and agriculture collaborate with science and international partners. However, politicians impede progress to secure re-elections, slowing down processes and limiting collaborations.

At the federal state, governmental district, and local levels, coherence exists within each domain, except for conflicts between agriculture and environment at the federal state level. Drought discussions prompt greater attention to climate change impacts, with a shared vision among sectors for seasonal water variations. Despite a kind of consensus from our interviewees on the need to increase water protection areas and focusing on groundwater resources, conflicts persist, particularly regarding water storage, protection of peatlands, and fish passes in rivers.

The real issue lies in political hesitation, avoiding responsibility and reluctance to define clear rules or handle new strategies. Funding studies, the upper level remains hesitant to take a stand, fearing voter reactions. The assignment of responsibilities does not directly impact sector relationships, but access to resources becomes problematic, leading to potential conflicts in the long run. Lack of communication and data sharing among authorities further hinders the implementation of initiatives and collective sector benefits.

While there is a degree of interaction in the institutional network, this does not always result in coordination. Further, the responsibilities of the various stakeholders or organisations which have to contribute to applying the WFD are not sufficiently stable or sufficiently backed by adequate resources. Thus, the degree to which the elements of the governance system are strengthening rather weakening each other is neither fully restrictive nor supportive.

● Flexibility

Actors and networks

The primary stakeholders in public infrastructure projects are the citizens who fund them. However, bureaucratic processes often hinder their acceptance, creating challenges in maintaining and renewing infrastructure. Implementing new projects takes a long time due to delays in obtaining authority approval, and there is a lack of willingness to explore innovative options, especially in the face of climate change and increased pressure during dry periods.

In local water communities, members can invite others, and it is feasible to involve various interest groups, including working groups with mayors and farmers. Cooperation between municipalities is proving beneficial, as they form coalitions with citizens to prevent monopolies, for example by opposing projects that give farmers access to water from the Main River for irrigation.

Who can join an irrigation club is regulated by its statutes and may vary from case to case. Municipalities could potentially join the irrigation club, but the administration may not be eligible for membership. At the governmental district level, a Member of Parliament is proactively organising boards, fostering cooperation between the governmental district, vineyards and farmers. This person

initiated a water technology event with Bavarian and Israeli companies, aiming to integrate major municipalities and industries like Coca Cola into this ad hoc Water Alliance. Citizens' involvement is indirect but facilitated through roundtable discussions with mayors, allowing them to contribute to the conversation.

In the different clubs or associations, it is easy to involve new actors or institutions (municipalities, authorities, water users, etc.). It is also possible to organise new coalitions to tackle specific issues.

Thus, many arrangements facilitate the inclusion of new actors, which is supportive.

Levels and scales

The way responsibilities are assigned has no direct consequence on the relationships between sectors or organisations. Instead, the access to information about water extraction and use ("Wasser clock" as mentioned by interviewees) is a problem that can create conflicts as far as the authorities don't communicate nor share relevant data or information (water needs, water withdrawals) to help the institutions / organisations implement their initiatives and make all sectors benefit from them.

The federal level oversees all aspects of regulation and decides what is to be implemented, with no flexibility envisaged, and the stakeholders interviewed all agree and trust their superiors' levels. For example: *"water rights are delivered by local authorities but actually they are given by the State"*. The municipalities are obliged to ensure the provision of basic public services including water supply, wastewater collection and treatment. They and the municipal supply companies created for the fulfilments of those tasks have to comply with the rules drafted by the federal state, the national and European level.

The municipalities are also connecting irrigation (agriculture) and water demand (drinking water) and environment and thus push for more cross-sectorality in projects. But this represent isolated actions, without any clear urge from one level or scale.

Thus, the governance system allow engaging different levels but only depending on the problem degree, which is neither supportive nor restrictive.

Problem perspectives and goal ambitions

According to one stakeholder, there is a need for an educational approach in the area as only taking water from the Main cannot be the solution. *"Everyone needs to save water and change its behavior"*.

The challenge is maintaining and renewing infrastructures, with the implementation of innovations and very long processes. In fact, during droughts, stakeholders interviewed mentioned that the pressure should be higher to implement innovative systems. There is no official board but occasionally there are ad hoc round tables between some actors.

But this is not always the case sometimes because *"if some share the same issues they do not share the same goals"*.

Regarding water scarcity and drought the water strategy of the Bavarian State Ministry for the Environment and Consumer Protection is not exclusively focused on water transfer and infrastructure solutions. However, it is often perceived as such as the interviews show. Little support seems to exist for cross-sectoral solutions. Water strategy from water authorities is perceived as a water transfer from the South to the North to any other adaptation solutions pushing for more cross-sectorality. On the contrary, Water pact between agriculture and water is focusing on local strategy but as a voluntary

agreement to do more than what the WFD is already demanding. This not push to reassess the goals and ambitions.

Also, it seems difficult to switch to an extension of the water protection areas, not only because of agricultural practices but also because of constraints stemming from regional planning. There is also a difficulty to prioritise between water supply protection, development of cities and irrigation of agriculture. During interviews, only agriculture and forestry sectors were proposing reassessed common adaptation practices representing a sort of flexibility. However, according to stakeholders, these are not clearly supported by higher levels such as the federal state of Bavaria at the moment.

The governance system does not yet seem to have the capacity to reassess objectives and ambitions, including at political level. As a result, there is no flexibility to encourage more cross-cutting ambitions regarding water resources, which is restrictive.

Strategies and instruments

Regarding water rights, it seems difficult to change from a system with old water rights and permits which rarely are monitored to system wherein water rights and permits are issued more restrictively and a full monitoring system is established. Additionally, the difficulties involved in the expansion of water protection areas demonstrate how inflexible established processes can be at times. However, those examples represent additional constraints more than flexibility. But progress is being made, although challenges persist. Only 42% of farmers declare their extraction, and encouraging compliance remains difficult. In the meantime, some farmers do not fully utilize their granted water rights, prompting the agriculture sector to propose a water storage project. To address the lack of a unified database, a project is underway at the local water authority levels to compile all relevant information. However, without any legal framework or obligation, some farmers have been cooperating for decades in water protection areas, with the establishment of compensation payments and measures.

For the irrigation of cultures, the current legislation does not allow the reuse of water for irrigation. Even though some farmers are urging for a change, *“Water is used as it has before”* (Interviewee, June 2023), without any possible flexibility due to the inertia of legislation changes.

In the context of industry and enterprises, the reporting of water usage has improved, offering a clearer picture. However, high water losses are observed due to ageing infrastructures, highlighting the need for modernization efforts. And, interviewees declared that when you want to implement new projects regarding infrastructures it can takes too long to wait for the authority’s approval/authorization. According to them, the system is too slow and complex and thus not flexible, while asking for too many bureaucracy.

Municipalities are actively maintaining their water infrastructures and adapting it to climate change where necessary, e.g. by creating connections with neighboring towns and villages to establish a multitude of possible water sources. At the district level, a proactive Member of Parliament has initiated a water-focused event where Bavarian and Israeli companies share practices and technologies. The wine-growing sector is particularly engaged in exploring new techniques and promotes it for the territory.

While many initiatives exist in the Main River basin, they are not integrated into a strategy that is neither restrictive nor supportive to greater cross-sectoral action to meet the challenges of climate change.

Responsibilities and resources

Reallocation of both responsibilities and resources seem difficult. For instance, the need to control water consumption, the "wasser clock", was mentioned by several interviewees. But this requires a water extraction charge, the "wasser cent" and stakeholders explained they lack the experts to set up such a charge. However, most stakeholders consider that the federal level has a large supply of competent, high-quality engineers who could be invited to work on those topics.

Some interviewees are also arguing on the need to provide more resources locally, in particular at municipal level, to monitor and control water extraction, even to distribute water rights as they are the closest to the field. However, by reallocating more responsibilities related to water rights and monitoring to a more local level it could lead to conflicts of interest as it could be difficult to "say no" for water rights when you are close to the water users. Also, it is questionable if a reallocation of responsibilities to a lower level would solve the problems when they are in part caused by a lack of resources at the higher level. When the federal state obligates municipalities to fulfil a task the federal state is responsible for ensuring that the municipalities have sufficient resources to fulfil it adequately. Thus, the resource problem would remain.

The way responsibilities are assigned has no direct consequence on the relationships between sectors or organisations. Instead, the access to some information is a problem that can create conflicts in the long run: the authorities don't communicate nor share relevant data or information (water needs, water withdrawals) to help the institutions / organisations implement their initiatives and make all sectors benefit from them. It is not because of a mistrust but because there is a common statement of the difficulty of water authority to neither monitor nor control groundwater consumption to disseminate a clear picture of water consumption by domain.

Also there is a lack of knowledge to drive decisions at the sectoral level. If there are some studies on climate change and drought on agriculture, it concerns only some crops (soy, quinoa, etc.) and not vegetables (market gardening), which is problematic, while there is no identified lever to fill this knowledge gap.

It is not possible to pool some of the assigned responsibilities and resources to other ones, which restrictive.

Conclusion

In clubs and associations, involving new actors or institutions is easy, fostering the formation of new coalitions to address specific issues. However, formal or legal committees have unclear processes and conditions. At the federal state level, regulations are overseen, and decisions are made on implementation, such as water rights delivered by local authorities but ultimately determined by the federal state. Municipalities as well as their supply companies must comply with these regulations.

Extending water protection areas faces challenges due to agricultural practices and land planning constraints, with difficulties in prioritising water supply protection, urban development, and agricultural irrigation. Agriculture and forestry propose flexible adaptation practices, but upper levels like the federal State of Bavaria do not urgently endorse them.

Individual initiatives, especially for irrigation, are multiple and locally implemented, featuring practices like water storage and wastewater reuse. Some argue for increased local responsibilities, particularly at the municipal level, to monitor and control water extraction and distribute water rights. This is not due to mistrust but a recognition of the water authority's difficulty in monitoring and controlling groundwater consumption, hindering a clear understanding of water consumption by domain.

While there is no particular issue in the way the responsibilities and resources is assigned, the polarization of power at regional level makes it difficult to assign responsibilities and resources to other ones, which is neither restrictive nor supportive.

- **Intensity of action**

Actors and networks

At local level, the water neighborhoods (volunteers), meet 2 or 3 times a year with their neighbours and invite the water organisations to talk to them. There are several positive examples such as the exchanges between regional government and local authorities (Unter- Oberfranken); or the visit of the installations related to the Nutzwasser project, etc.

Municipal companies express a desire for increased farmer engagement and activity to drive necessary changes. Cooperation with privately run biomass plants is more about individual profit than collective interest, revealing a predominant focus on financial gains, but this drives for more cross-sectoral projects. Where municipalities are involved in biomass plants they encourage the use of substrate that is less detrimental to soil and water quality than maize and corn.

Media impact primarily centres around concerns like microplastics and wastewater residues, overshadowing the efficient use of water resources due to a lack of acceptance and trust in water treatment reuse. And politicians, while theoretically in favour of new measures, are declared as in fact reluctant to implement change and contribute to maintain the status quo. Environmental NGOs advocate for environmental education and propose involving the media to foster dialogue with decision-makers. Water authorities, particularly on irrigation in agriculture, exhibit caution, lacking precise data on groundwater recovery. Efforts are underway, such as studies for assessing the local water balance and available water resources but assessing the situation remains challenging.

Some proactive members of Parliament are pushing for data collection and collaboration with various stakeholders to contribute to the slow top-down process of the ministry's Water strategy. While there is broad national support, overcoming barriers and effecting change through cooperation and pressure faces skepticism from some stakeholders. There is regional agreement with politicians, yet political inertia persists. And, despite the need for more cross-sectorality, the authority and government in Bavaria neither actively promote nor hinder the process. The Green Party advocates for more, but limited resources restrict their involvement, with only one Member of Parliament currently engaged in the city, down from three previously.

The forest is taken into account in all strategies, with the implementation of forestry laws and water laws as part of a clearly defined process. Forests, a culturally important landscape and land use in Bavaria, are likely to influence the attention paid to this sector, which is strengthening its ability to seek solutions to the threats posed by climate change to today's tree species.

On the other hand, there are individual initiatives to push for a change (farmers, NGOs, Members of Parliament from different parties). They are not sufficient to make the difference yet, but they push for it by providing some knowledge (environmental education) and raising awareness. However, adaptation to climate change can't be handled by the water sector alone.

All relevant sectors are not heavily involved to adapt to climate change in cross-sectoral interactions, which is restrictive.

Levels and scales

Higher levels of governance often lead to a loss of clarity, with concepts like sustainability resulting in vague goals and no defined measures. Implementing practical solutions takes a back seat to theoretical discussions. Political advice may not be the ideal solution for making sustainable decisions, as financial considerations take precedence over long-term societal benefits. The lack of in-depth knowledge among several boards representing water users further complicates decisions with a long-term impact.

There are established means for including citizens in a transition towards more sustainability e.g. in the energy sector that could be learned from. For examples wind parks and other renewable energy production became more publicly accepted when citizens were given the opportunity to become part of these projects and benefit financially from energy production in their region. Empowering citizens to benefit directly, as demonstrated by wind parks, proves the most effective method, fostering acceptance. Such models have not been copied for water-management, yet.

Protection of water, especially in designated areas, is crucial for municipal development. However, municipalities might not prioritise this issue unless it has a direct impact on their growth potential. The challenge lies in managing things locally due to complexity.

Municipalities, having direct problems for water supply as they have the responsibility to deliver suitable drinking water to their inhabitants, urge the region for more regulations and an extension of water protection areas. Farmers also created some clubs to exchange knowledge.

All levels are promoting actions to drive some changes at their level, which is supportive.

Problem perspectives and goal ambitions

The energy sector, particularly renewables, stands out as a driving force for change. The idea is to increase renewable energies, with municipalities and citizens playing roles as co-financers and co-beneficiaries, particularly in wind production.

However, there is a notable lack of action in both the Main River (First order) and the Tauber River (Second order), making the achievement of 2027 goals seem impossible. Insufficient skilled staff is a hindrance while the goals have already been extended, indicating a lack of willingness to meet them.

While there is a growing need for water, while it already exists, according to stakeholders there is no possibility to source water from external locations, such as the south of Germany or Bavaria. Also, despite the importance of water, for some interviewees there is no significant lobbying effort and according to some interviewees to treat the fundamental questions such as *“how much water can we take from the river?”* and which remains unanswered.

The wine growers' associations advocate for water-related issues. Vineyards, requiring water in specific periods, are aware of the need for change in practices if water is obtained, drawing inspiration from techniques in other countries. However, the challenge lies in building the necessary and expensive infrastructure, posing financial constraints, especially for smaller vineyards. At present the federal state is building mayor irrigation infrastructure as part of “pilot projects” in the region.

Currently, apart from experiments in all sectors, it's “business as usual” for local water management. There is ambition to change and to act (forestry, winegrowers, farmers, etc.), but rarely with a cross-sectoral and long-term vision. If so, it's mainly at the individual level (Member of Parliament, water alliance) or specific groups of interest (NGOs). There is a need to raise awareness on all the climate change impacts on the region.

While hydrometeorological extremes are already known threats in the region, actions to adapt to and mitigate them are still low-ambition without massive action, which is restrictive.

Strategies and instruments

Main categories of actors, networks and sectors are innovating and are experiencing solutions to save water or create new resources for irrigating. Some cities in the territory are already trying to reuse water. Lower Franconia is also involved in some reuse projects. Wine-growing associations are exploring new techniques with international collaborations. Farmers are storing water during winter to irrigate vegetables during summer, et cetera. Many initiatives are about securing water resources in order to keep using them as usual rather than systemic transformation. .

At the political level, an interviewee explained us there was a commitment for a holistic approach for part of the Franconian area, on groundwater extraction, industry, farmers, etc. including changing cultures, keeping water formerly drained in the fields. A kind of holistic law for water management. But these concepts are not yet here, after many years. Interviewees explained it died off due to conflicts between the environmental administration and the agricultural administration. It express the low level of flexibility in the development of cross-sectoral strategies. Some interviewees explain that during peak of water needs while drought occurs the entire legal requirements cannot be fully followed, but this does not mean there is no water on the tap. But in fact, there is now lots of stress during drought periods especially where the irrigation need is intense.

The industrial sector is engaged in water saving with incentives to use less water in order to save costs.

While strategies acknowledge forests effectively, the implementation of forest and water laws follows a clear process without the need for interlinkages between the two sectors. However, current instruments may prove inadequate in the face of ongoing or worsening climate change.

The Water Strategy 2050 background was mentioned by interviewee as interesting as it relates to the fact that if you take the water from somewhere else, you do not have as priority take care of the local water – The idea was mentioned by interviewees as *“if water is taken from elsewhere there is less of a need to protect local water reservoirs”* since they are not *“needed”*. Even if this was not added by stakeholders, this view disregards the importance of ecosystems and the services they provide.

In the contrary, some measures are implemented as in the agriculture sector which advocates for prioritizing climate mitigation, viewing water as a symptom rather than the root cause. Recognizing the complexity of the issue, farmers emphasize the need for multiple solutions rather than singular approaches found in projects. However, the existing projects often lack a holistic perspective (strategy or plan) and fail to address root causes, mainly aiming to acquire water without instigating changes in common practices. While these projects serve as adaptive measures, they may not ensure long-term resilience, making it increasingly challenging to adapt to future changes. The call is for a conceptual, holistic approach tailored to the region, emphasizing the inadequacy of relying solely on technology and techniques showcased in pilot projects.

There is a need for more expertise on local particularities and interviewees consider that more projects and tools could be supported by the federal state of Bavaria.

There are a lot of individual and sectoral projects based on water needs (smart metres, storage projects, etc.) and technology (new irrigation techniques, groundwater modelling, etc.) as part of the solutions. But to promote any relevant changes, there is a need for an overall and “holistic approach”

that implies changes in practices, within every sector, and common goals and ambitions. And so far, it seems too early to discuss this kind of strategy, as some also consider there is a strong need for environmental education first.

Instruments and initiatives do exist, but with no clear common cross-sectoral goals. Thus, the capacity of the strategies and instruments to urge for more adaptation to climate change is neither restrictive nor supportive.

Responsibilities and resources

The potential for the federal state level to drive necessary changes is hindered by various fears. Firstly, there is hesitation in instructing farmers on the cultural shifts required, fearing opposition. Secondly, exerting control by withholding further water rights could lead to resistance. Thirdly, engaging municipalities in altering land use and regional planning for drainage improvements is seen as necessary but fraught with opposition and potential anger, indicating a prevalent fear of conflicts. And political influence significantly impacts the extent to which climate change adaptation measures, like changing city planning to support water retention and resilience to torrential rain, are implemented. The allocation of financial resources and political decisions influence the commitment to such initiatives. And while some are willing to push for change, the financial investment required hinders progress. Moreover, local authorities, often lacking capacity or resources, may overlook the importance of certain issues. Insufficiently skilled staff is a hindrance, and the timespan for achieving the goals set out by the WFD have already been extended, because they could not be met in the past. A lack of willingness to meet them may be one reason why Bavaria has not complied with the goals.

However, the regional level is mentioned as having much knowledge and valuable experts which should be allocated to adaptation to accelerate the process at all levels and for all sectors.

The existing distribution of responsibilities and resources is deemed insufficient for effective cross-sectoral natural resource management. Lack of awareness and reluctance among relevant individuals to be part of the solution contribute to the challenge. At the management level, there is a reluctance to make tough decisions.

While there is heightened awareness of the reality and ongoing impact of climate change, the willingness to implement climate protection and mitigation measures lacks consistency. The authorities appear incapable of effectively addressing water needs and control, but increasing public awareness is exerting pressure on them.

Farmers also created some clubs to question responsible levels, such as municipalities and the federal State of Bavaria. The main issue is how to work with the representatives of the federal State if, at local level, they do not have neither power nor responsibilities *“there is no local influence”* as declared by one interviewee.

Besides, most of the projects provide an opportunity for real intersectorality, but this does not last over time. Indeed, they would require and make use of additional funds.

Even though resources are existing, the resources allocated, particularly human, are insufficient for implementing the local measures required to take on the responsibilities assigned, which is restrictive.

Conclusion

The overall assessment for intensity is neither supportive nor restrictive.

The capacity of the current governance system to urge for more cross-sectoral actions is existing but not supported to remain over times or to achieve ambitions targets due to a lack of awareness.

2.3 Concluding evaluations

The current governance system is neither restrictive nor supportive to urge for more cross-sectoral interactions in adaptation to climate change (Table 9).

The stakeholders who are pushing for cross-sectoral management of natural resources (water, land, soils, ecosystems) don't have enough human and financial resources or the power to implement their ideas. They would need some support from politicians. However, some don't want to drive changes and thus drives regardless of their real will business-as-usual.

Three reasons have been formulated to explain their position. However, for some, it is still not the case because the State fears:

- To ask farmers to change cultures as this would mean to tell them what to change asking for additional expertise,
- To control water consumption and to stop to give additional water rights because this would lead to opposition from all water users,
- To talk to municipalities what needs to be changed such as land use in their local and regional planning, i.e., concerning drainages), as this would cause opposition and political crises.

Authorities also show reluctance to change the status quo, expressing theoretical support for new measures but avoiding implementation due to uncertainty and the belief that the water sector alone cannot handle the situation. Individual initiatives by farmers, environmental NGOs, and Members of Parliament provide knowledge and awareness but lack the necessary impact. Municipalities, facing water supply challenges, advocate for improving water management at all levels and expanded water protection areas, but are faced with conflicting interests at the same time e.g. when it comes to balancing sustainable resource management and economic development. .

Farmers are forming clubs depending on the topic to tackle to exchange knowledge and question higher levels of responsibility like municipalities and the federal State of Bavaria.

And, despite ambitions for change and actions from various sectors, cross-sectoral collaboration remains limited, often occurring at the individual or specific interest group level.

Numerous individual and sectoral projects focus on water needs and technology, but a holistic approach that necessitates changes in practices within each sector is deemed premature. Environmental education is seen as a prerequisite for promoting meaningful changes. Stakeholders advocating for cross-sectoral resource management lack the necessary resources and political support, with reasons including a fear of conflicts, a general lack of awareness, and a reluctance to change for the sake of convenience.

Table 9: Matrix of the overall scoring in the Main River case study

	Quality of the governance regime : criteria			
Governance dimensions	Extent	Coherence	Flexibility	Intensity
Actors and networks				
Levels and scales				
Problem perspectives and goal ambitions				
Strategy and instruments				
Responsibilities and resources				
Overall assessment	Supportive	Neutral	Neutral	Neutral
Concluding evaluation	The governance system is neither restrictive nor supportive to urge for more cross-sectoral interactions in adaptation to climate change			

2.4 Identification of barriers and levers at the case study level

The main barriers and levers identified at the Main River case study level are as following:

Barriers

- The water management decisional process is not river base (Main River base), it is administratively base (county based),
- There is no Main River board to tackle cross-sectoral thematics to urge for water-energy-food-ecosystem nexus measures,
- There is a demand for a decrease in bureaucracy with unnecessary details asked to initiate new projects,
- (Local) water authorities do implement measures coming from the regional level,
- (Local) water authorities are reluctant to share information about water consumption,
- Drought is experienced since very recently with no water scarcity culture while the region is a hot spot of climate change with an acceleration of extremes,
- There is a general lack of awareness of local environmental challenges due to climate change,
- There is a lack of monitoring of water consumption from groundwater and other bodies of water in general,
- There is a political reluctance to urge for changes,
- The reduction of local water authorities' and staffs in the last 20 years are impacting the capacity to face new challenges and engage services in pilot projects,

Levers

- According to interviewees the federal state could drive changes. In fact, all stakeholders interviewed expressed their trust in the federal state level to have the capacity to act if it would wish to. Thus, the federal state level is really representing a lever with lots of potentiality. Especially because the federal state and governmental district level are declared as “full” of very valuable experts,
- Information is locally shared,
- The Bavarian Authority for Forestry is doing “applied research” on climate change and testing several scenarios that link water and forest sectors, which could lead cross-sectoral actions through catchments,
- High level of knowledge transfer through different networks, as the water neighbourhood (volunteering) – 70 neighbourhoods (quality thresholds, capacity building, relevant topics) with an existing office that tries to answer questions raised by the group,
- Pilot projects on water reuse are starting,
- Pilot projects on water Monitoring using modern methods / digitization will be launched soon,
- The State level has real experts that could be used for several topics,
- There are lots of isolated examples of cooperation between 2 or 3 sectors as exposed yearly at the water forum and which could, bring together, really lead to more impactful models of change through bottom-up initiatives.

3.0 Canary Islands case study

In their workshops, the stakeholders of the living lab of the case study 5 of Arsinoe have decided to tackle the following problem statement to create more resilience: *“To have a quantitative and qualitative, open, participatory and intersectional database that includes environmental, agronomic, economic and social aspects and takes advantage of the opportunities provided by digital tools. All of this is aimed at facilitating cross-cutting governance, for the transfer of knowledge and the adaptation of primary sector to climate change and for its ecological transformation and sustainability.”* (For more detailed information, see Deliverable 6.5, La Jeunesse et al., 2023).

Accordingly, the study of governance was focusing on the sustainability of agriculture production considering the need of sustainable water management and its links with the energy and drinking water sectors. The interview guide has been adapted to this topic (See Annex).

3.1 Context and case study description

The volcanic Canary Islands are heterogeneous in terms of landscape, orography and materials that have accumulated throughout their history since their formation some 20 million years ago. As a result, they are very heterogeneous in terms of the water resources available and the way in which they are managed and used. On the one hand, there is a group of western islands (El Hierro, La Palma, La Gomera and Tenerife, **Figure 27**) with higher rainfall, geologically younger, which means greater infiltration and consequently greater underground resources. On the other hand, there's the eastern group (Gran Canaria, Fuerteventura, Lanzarote and La Graciosa), with lower rainfall, older geological age, more eroded and less orographic, the islands closest to the Sahara. Gran Canaria is a model that combines the management methods of both groups. The island of La Graciosa is supplied by a water transfer pipeline from the neighbouring island of Lanzarote (Santamarta *et al.* 2022). The

heterogeneous distribution of rainfall is not only observed between the islands, but also within each island, where there may be areas with different levels of rainfall within each island. The north-east component of the trade winds and the island's orography create two distinct slopes: the normally wet "Barlovento" and the generally drier "Sotavento". At the same time, on the same slope, the altitude of the terrain influences the distribution of rainfall, which is less frequent and more irregular in the coastal areas and in the mountainous areas above 2,000 metres, where precipitation in the form of snow is possible. Various studies point to an irregular rainfall pattern and a general downward trend in precipitation, and also predict greater temperature increases at higher altitudes (Expósito *et al.* 2015; Carrillo *et al.*, 2023). The role of forests on the islands will be fundamental in this century, regulating water resources, promoting the infiltration of water into the island's aquifers and reducing erosion by conserving soil.

Surface water is scarce in the archipelago. The lack of rivers in the Canary Islands has meant that the inhabitants have had to rely on other sources, mainly underground. In addition, the steep slopes and permeability of the soil on some islands, such as El Hierro and Tenerife, make the construction of reservoirs extremely difficult. Nevertheless, surface water is of economic importance in certain agricultural areas, such as La Palma, where crops depend on rainwater run-off in the ravines. The Canary Islands therefore have three main types of water resources: surface water, groundwater and water for industrial production (desalination and wastewater treatment plants). In the last decade, the production of water resources through desalination has increased (ISTAC 2022), while natural water resources have decreased, since in some islands the extraction of aquifers has exceeded the recharge, especially for Gran Canarias and Tenerife (Vaswani Reboso, 2022 ; Santamarta *et al.* 2023)). The volcanic origin of the islands and their geological age also influence the permeability of the terrain, so that each island is different and faces different problems of access to water in terms of quality and quantity. Studies are needed, in order to be able to know certain values of natural recharge. This will be affected by climate change, as changes in the amount or frequency of precipitation will affect the amount of water infiltrating into the ground (Santamarta *et al.*, 2023).

In the Canary Islands, water management is different from that in mainland Spain: each island forms a separate hydrographic basin, separate from the others, unlike the situation on the mainland, where the "confederaciones hidrográficas" operate on a river and its tributaries, i.e. on a basin that generally extends over the entire length of the river. i.e. a basin that generally extends beyond the boundaries of an Autonomous Community (except in the case of Catalonia and Andalusia). The Spanish State directly manages inter-community basins through basin organisations (las confederaciones hidrográficas), while the Autonomous Communities only manage river basins that are entirely within their territory.

The Canary Islands have a subtropical climate that allows a number of fruit trees to be grown that are not cultivated in the rest of Spain (pineapples, banana, mangoes as e.g.) and which are the Islands' main export. The islands have maintained varieties that have given rise to numerous designations of origin in the field of vines, and the banana has also received a protected geographical distinction. All these crops are very sensitive to changes in temperature increases. This is why a context of climate change, in which a general increase in global temperatures is to be expected, could seriously affect these tropical crops.

In the Canary Islands, ARSINOE tackles the vulnerability of aquifers in two of the seven volcanic islands, El Hierro and La Palma, and considers the interdependence between water and agriculture. The agricultural sector is in fact the largest water user in the Canary Islands, where bananas are the most water-intensive crop and vineyards and the Canarian potato are the most important rainfed culture.

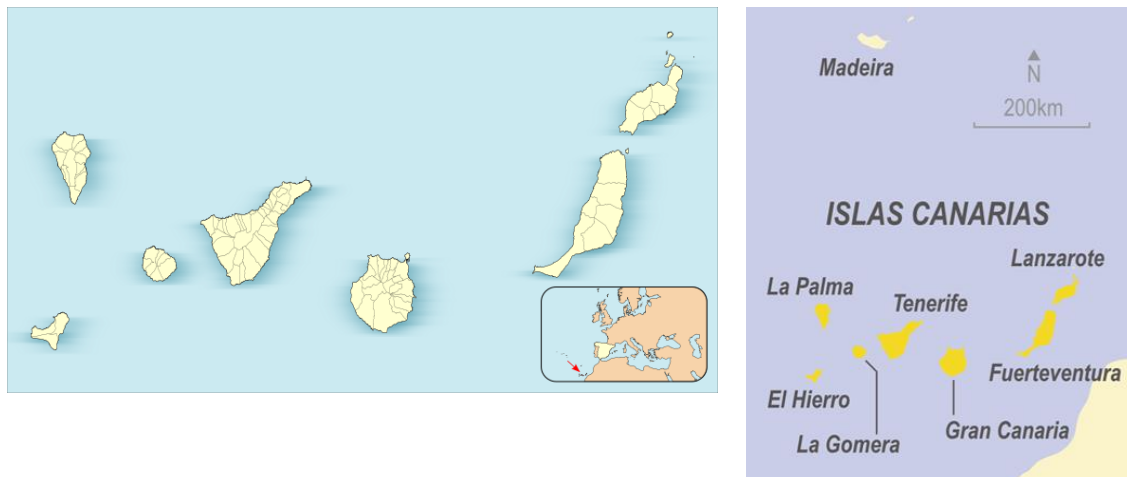


Figure 27: Localisation of the Canary Islands in the Atlantic Ocean (left) and Distances between Islands (right)²⁸²⁹

Both El Hierro and La Palma have agricultural sectors that play an important role in their economies. The fertile volcanic soils and favorable climate conditions support various agricultural activities. In El Hierro, agriculture includes the cultivation of crops such as cereals, vegetables, and fruits, as well as livestock rearing. In La Palma, banana plantations are a prominent agricultural activity, along with vineyards for wine production. Other crops grown on the islands may include citrus fruits, potatoes, and avocados.

The industrial sector on both El Hierro and La Palma is relatively modest compared to other economic activities. However, there are small-scale industries related to agriculture, such as food processing and packaging facilities.

The last volcanic eruptions started last September 2019 in the Cumbre Vieja ridge, on the island of La Palma, and is still ongoing (Figure 28, Figure 29). So far, lava has covered an area of 1000 ha, and volcanic ash is distributed throughout the island of La Palma, having even reached the neighboring islands of Tenerife and El Hierro. The eruption has severely affected the production of bananas for export, with losses so far estimated at 100 million euros (Rodríguez-Hernández, et al. 2022).

Access to drinking water is crucial for various sectors, including industry, tourism, and the local population. El Hierro and La Palma have implemented water management strategies to ensure a sustainable supply of drinking water. These strategies include desalination plants, reservoirs, and water treatment facilities to meet the demands of different sectors on the islands (Santamarta, Rubiales, et al. 2022).

Both El Hierro and La Palma have been focusing on renewable energy sources as part of their sustainable development initiatives. El Hierro has made significant progress in becoming a self-sufficient island in terms of energy by implementing a hybrid system that combines wind and hydroelectric power. La Palma also aims to increase its use of renewable energy, including wind and solar power, to reduce reliance on fossil fuels.

²⁸ <https://www.iberian-escapes.com/things-to-do-in-la-palma-fr.html>

²⁹ https://fr.wikipedia.org/wiki/Fichier:Map_of_the_Canary_Islands-fr.svg



Figure 28: The volcano eruption started in 2019 in La Palma is still smoking (La Jeunesse, July 2023)



Figure 29: Lava flows and volcanic ash from the volcano in La Palma (La Jeunesse, July 2023)

El Hierro

El Hierro is one of the Canary Islands, located in the Atlantic Ocean off the coast of Africa (Figure 30). It is the smallest and westernmost island in the archipelago. The island is of volcanic origin and has a diverse landscape, characterized by rugged cliffs, volcanic peaks, and lush valleys. The climate is influenced by the trade winds, with mild temperatures and relatively low rainfall.³⁰

The population of El Hierro is relatively small, and the island's economy is primarily based on agriculture, fishing, and tourism. The local population is engaged in traditional activities such as farming, livestock rearing, and fishing. In recent years, El Hierro has gained recognition for its commitment to sustainable development and renewable energy. The island aims to become energy self-sufficient through the use of renewable sources, such as wind and hydroelectric power.

³⁰ https://www.researchgate.net/publication/273130122_Patterns_and_Disturbance-Induced_Drivers_of_Plant_Diversity_and_Endemism_on_High_Elevation_Islands/figures?lo=1

El Hierro 100% Renewable Project, managed by Gorona del Viento: the island of El Hierro is part of an ambitious project to become the first island in the world to meet its needs solely with renewable energy. The wind-hydro system included building a hydroelectric power plant with 11.32 MW of installed power.³¹

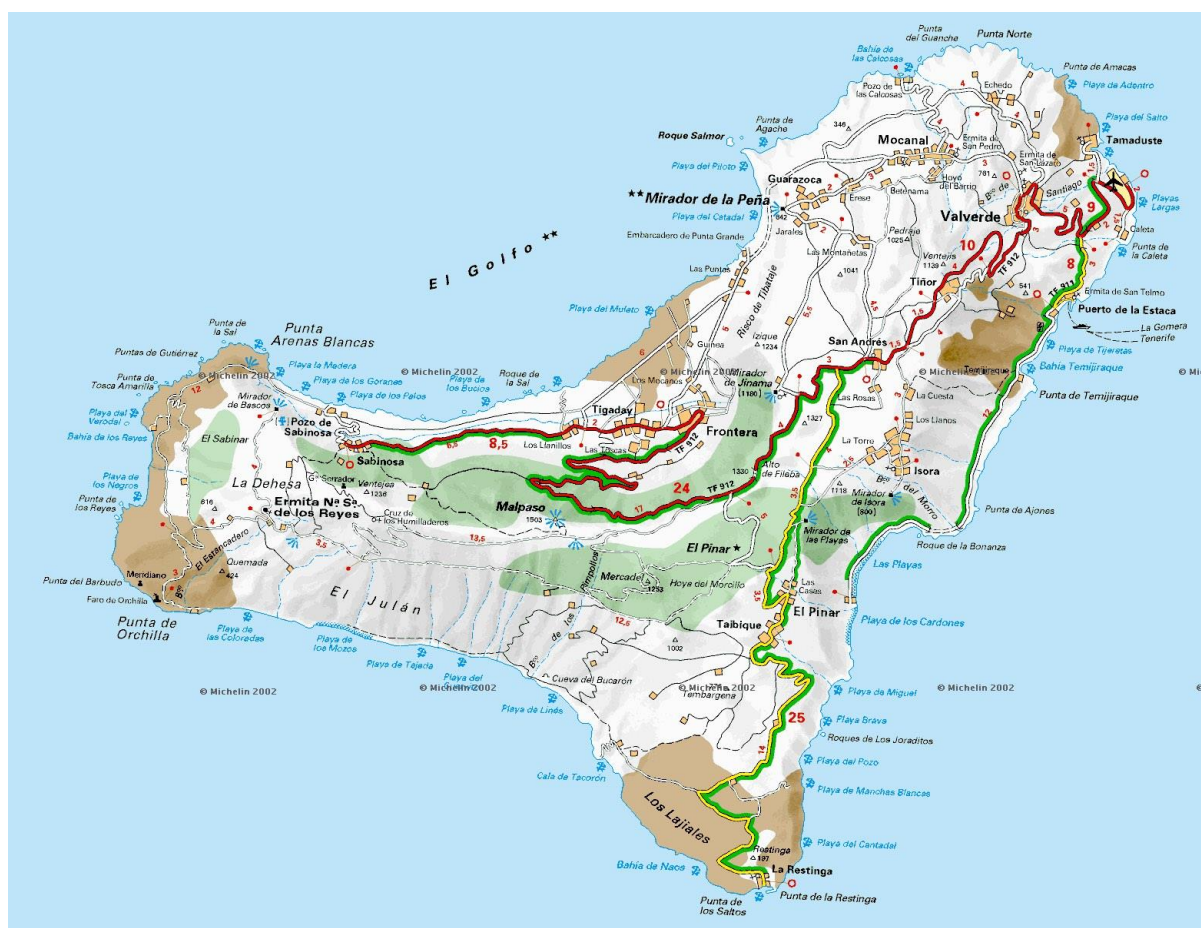


Figure 30: Main villages, rivers, natural parks, beaches and roads in El Hierro Island³²

La Palma

La Palma lies to the north-west of El Hierro. Like El Hierro, La Palma is of volcanic origin and has a varied topography, including volcanic craters, deep ravines and dense forests. The island has a mild subtropical climate, with cooler temperatures at higher altitudes and higher average rainfall than the other Canary Islands (Figure 31).

³¹ <https://www.investinspain.org/content/icex-invest/en/regions/canarias/industrias-destacadas.html>

³² <https://www.elhierrocanaries.fr/les-incontournables-del-hierro/>



Figure 31: Main villages, rivers, natural parks and roads in La Palma Island³³

La Palma has a particular typology of collection systems, most of which are galleries (see below), with the presence of some large-diameter wells and frequent underground galleries. There are also about one hundred and a half natural springs, distributed very irregularly and with very different flow rates, which are generally very dependent on rainfall. Apart from these, there are streams all over the surface of the island that come from the outcrop of small hanging aquifers of small extent and that provide modest flows that depend on rainfall (Plan Hidrológico de la Demarcación Hidrográfica de La Palma, 2018).

³³ https://viagallica.com/canaries/carte_ile_palma.htm

La Palma has a larger population than El Hierro and a more diversified economy. Tourism also contributes to the economy, with visitors attracted by La Palma's natural beauty and hiking trails. In 2002, the island was declared a UNESCO Biosphere Reserve due to its unique ecosystems and efforts to preserve its natural heritage (MASSOT MARTI 2011). Agriculture has always been the mainstay of La Palma's economy. It is an agriculture that has fulfilled multiple functions (landscape, ecological and economic) and that presents two different but complementary models. On the one hand, there is the agriculture of the "medianías" (between 600 and 1,000 m), which is mainly intended for self-consumption and the domestic market and is in decline. On the other hand, there is export agriculture on the coast, with an almost hegemonic crop, the banana, which survives thanks to national and European institutional subsidies (Martínez Fernández, 2021).

The last volcanic eruptions were in September 2021 in the ridge of Cumbre Vieja. The lava covered an area of 1000 hectares and the ash was spread all over the island of La Palma, even reaching the neighbouring islands of Tenerife and El Hierro. The eruption has severely affected the production of bananas for export, with losses so far estimated at 100 million euros (Rodríguez-Hernández, et al. 2022).

The main source of supply for the islands of La Palma and El Hierro is groundwater: in El Hierro it covers 60% of total demand, with the remaining 40% coming from the three desalination plants (Consejo Insular de Aguas, 2018), while in La Palma, nearly all of this demand is met by using available groundwater - more than 90 per cent (93,3%). Only 6.3% came from surface resources. The galleries provide 63.7% of the consumed resources, followed by wells and springs (Plan Hidrológico de la Demarcación Hidrográfica de La Palma, 2018).

In El Hierro, as far as consumption is concerned, it is essentially divided between the supply of drinking water (43.47%), tourism (2.4%) and irrigation (51.44%), while the industrial plant for the production of hydro-wind energy, the Gorona del Viento, represents 1.6% of annual consumption. In La Palma, the demand for water is determined by two main groups: irrigation (agricultural) and supply (urban and tourist). The largest demand is for agricultural irrigation, which accounts for 85.4% of the total. This is followed by urban water supply, which accounts for 11.0% of the district's total demand. The tourism sector is the third largest consumer of water (3.4% of total demand), after agriculture and domestic supply.

The water collection system on the two islands (which also exists elsewhere in the Canary Islands archipelago) shows the development of unique techniques for collecting and exploiting groundwater on these volcanic islands, where rivers are almost non-existent. Traditionally, there have been two systems for extracting water in the archipelago: galleries and wells. Hydrological plans show that there are almost 1,700 galleries in the archipelago (162 and 9 on the islands of La Palma and El Hierro respectively) and 3,000 wells (69 and 24 on the islands of La Palma and El Hierro respectively). Most of the galleries in the Canary Islands are privately owned. This private water management system is very old and very specific to the Canary Islands, and is run by water associations, called *Comunidades de Agua* or *Heredamientos*. They dug shafts and galleries, but also built infrastructure, networks of canals, tunnels and reservoirs. The limited intervention of public administrations until the 1930s left water management in the hands of private owners. This explains why, in the absence of public infrastructure, the private water access system (galleries and wells) was, and still is, used to meet drinking water needs. The water system is therefore the result of a combination of private and public infrastructure and different sources (Meza Delgado, 2019).

3.2 Results of the nexus governance assessment

The field visit took place in July 2023 with the interviews performed from the 7th to the 14th. It was completed by field visits in the parks of the Islands.

A total of 10 interviews were conducted in three islands: Tenerife, La Palma and El Hierro. Those 10 interviews permitted to engage discussions with a total of 19 stakeholders.

Table 10: Overview stakeholders involved in GAT interviews in the case study

CS#5 CANARY ISLANDS Governance analysis Field visit	Number of stakeholders interviewed	Number of Men	Number of Women	Men (%)	Women (%)
07/07 - 14/07 2023	19	11	8	58%	42%

The next paragraphs of this section are describing the assessment of each cell of the governance assessment tool matrix as described in the first point of the methodological section (Part A).

● Extent

Actors and networks

In the Canary Islands, the “Consejo Insular del Agua” – Island Water Council – is the entity that manages and plans the islands’ water policy, corresponding to the basin organisation on the peninsula territory. The *Consejo Insular de aguas* / Island Water Council is attached to the insular government, the Cabildo (Figure 32). The president of the Cabildo is the president of the Consejo Insular de Aguas. The body representing the various interests and uses of water is the “Junta General”, the general assembly. According to the water sector representatives interviewed, the most important stakeholders and networks are represented in this body, but in differing proportions: the public sector represents 50% of the elected representatives, the private sector (particularly businesses) 24% and representatives of collective interests (groups of irrigators or water owners) the remaining 26%. The Island Council's functions mainly concern groundwater, the main resource in the areas where there is almost no surface water. In La Palma, 80% of the water used comes from aquifers (Santamarta et al. 2022), in El Hierro 60% (Plan hidrológico de El Hierro).

There are various legal forms associated with water in the context of the Canary Islands, which play a key role in managing this resource along with the public authorities. They are groups of owners of water rights, some of which date back a long way and have very strong local roots. On the one hand, there are *comunidades de agua* / (water communities) and *heredamientos* (heritages), structures that date back to the colonial era, and on the other, the historically more recent structure of the “*Comunidades de regantes*” (irrigation communities). The latter can be formed without having any water shares and can access the resource by purchasing or leasing private or public water. The “*Comunidades de regantes*” are in charge of supplying water to farmers who pay a membership fee to be part of the association. This has allowed farmers, who were not shareholders in traditional water communities, to access the resource in the local water market. This has increased pressure on the resource. The legal form of these *comunidades de agua* or *heredamientos* corresponds to a commercial community of property. However, the “*accionistas*”, shareholders, specify that, on the one hand they pay to maintain the infrastructure and installations and, on the other, unlike corporate members, the owners of water rights “*have no income, do not make any profit, even if they can sell their water rights*”. They describe their participation in these communities as “an investment”, through purchasing shares in the companies that excavated the galleries or drilled the wells that give

them access to water rights in proportion to the money invested. These water rights may be leased or sold (Interviews, 10/07/2023)³⁴.



Figure 32: Cabildo insular de La Palma

The interests of the water communities, in their various forms, are represented by the Island Water Chambers “*Cámaras insulares de agua*”. Every island has its own. These chambers take part in water management and governance through their participation in the Consejo Insular del Agua.

In view of the traditional system of ownership, management and access to water characterised by the *comunidades de agua*, groundwater is mainly private. Still today, after the legislative changes that have taken place at national and regional level, the predominance of private water on the island territory is substantial. In the case of La Palma, for example, according to the people interviewed, 85% of water used on the island is private. For El Hierro, the research did not produce similar information, but the Hydrological Plan states that groundwater accounts for 60% of water used, and 51% of water on the island is used for agriculture. The *comunidades de agua* are at the centre of a very active water market, which operates on the sale, but above all on the annual rental of water shares. The same operation is found on the two islands of La Palma and El Hierro, although in El Hierro, according to data produced by the field survey, there appears to be a greater concentration of water and land, and restricted access to water in a water context that shareholders consider to be increasingly threatened. While the leasing of water rights allows producers without water shares to open up land to cultivation, the system for controlling the resource is concentrated and closed.

Other stakeholders with a role in water management are the private or mixed companies to which some municipal councils have entrusted water management. This is the case in La Palma, where the service has been delegated to a mixed company made up of a company from the Canary Islands (EMALSA), a French multinational (SAUR) and the municipal council of La Palma. This choice is criticised by the water communities, which see a lack of ability from the public authorities to take charge of water production, resulting in an increase in the price of drinking water. In addition, the choice made by the Cabildos on both islands to use desalinated water and to reuse wastewater as additional and alternative sources has opened water management up to the participation of

³⁴ A large amount of the money invested in hydraulic structures came from Canarians who emigrated to Latin America, particularly Venezuela and Cuba.

specialised companies, in particular TEDAGUA. These companies have technical innovation capacities and, according to some people interviewed, attempt to influence political decisions.

Environmental associations are strongly present in the public debate on water and in particular they criticise water uses that are not environmentally friendly, as well as the condition of the aquifers.

The Cabildos departments on both islands in charge of agriculture are perceived as being present and supporting farmers, a sector that is fundamental to the island's development, in particular banana production which accounts for around 35-38% of the bananas produced in the Canary Islands (ASPROCAN, 2023). Before the 2021 volcanic eruption in La Palma, 1,200 hectares were given over to banana plantations on the island, equating to production of approximately 140,000 tonnes (Figure 33, Figure 34). This makes the banana “the economic gold of La Palma”³⁵. Banana producer organisations in the Canary Islands also play a central role in commercial and political negotiations at every level, including the European Union. They are grouped into ASPROCAN – the Association of Canary Islands Banana Producers.

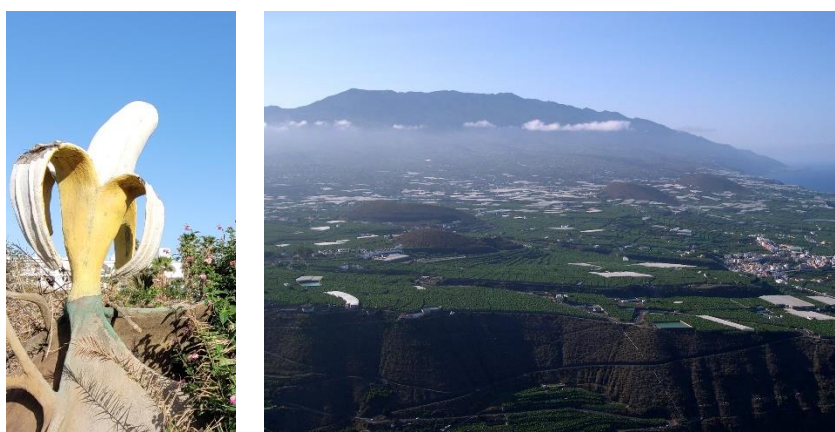


Figure 33: Banana plantations in La Palma



Figure 34: Plantations impacted by Lava and ashes from the volcano

³⁵ The other large producer that accounts for between 42-45% of production is the island of Tenerife, and in third place Gran Canaria, which covers 20% of production.

In the energy field, national stakeholders such as ENDESA, the national electricity company, and local stakeholders, Cabildos, public companies such as La Gorona del Viento in El Hierro or citizen associations such as La Palma Renovable in La Palma take part in the local energy policy.

The water-energy-food system involves all relevant stakeholders, which is supportive

Levels and scales

The Spanish state is organised territorially into municipalities, provinces and autonomous communities, with autonomous management and government. The basic local entities are the municipality, the province and the island (Canary Islands and Balearic Islands). In the archipelagos of the Canary Islands (and Balearic Islands), the islands have their own administration in the form of Cabildos or Councils respectively. The government of the autonomous community of the Canary Islands is one of 17 autonomous communities in Spain³⁶. It is divided into two provinces, Las Palmas and Santa Cruz de Tenerife, and is an outermost region of the European Union (OR) which, with the Azores and Madeira and the Cape Verde islands, make up Macaronesia. This geographical entity, which shares natural environments, a history and cultural traits is, at the same time, a European cross-border cooperation area between the Cape Verdean, Spanish and Portuguese governments.

In the Canary Islands, the hydrographic basin coincides with the island's political-administrative division and represents the fundamental territorial unit to which the water balance and management refers. The Island Water Council is an expression of decentralised administration. This body is, however, an exception in terms of the water management organisation on the peninsular territory as it depends on the island government (Cabildo) and not on the higher level of autonomous government (Comunidad Autónoma de Canarias) or central government. This is in fact the case for the other hydrographic bodies on the peninsular territory. In fact, in the peninsular territory, the basin body refers to central government or, where the basins coincide with the territorial boundaries of an autonomous community, to the autonomous government.

For the people interviewed, this process, referred to as the *insularisation* of water management (Sarmiento Acosta, 2004), i.e. management on the scale of each island, is the most coherent level for water management and planning. This water government system and structure, which are relatively recent (1987), are superimposed on an organisation of management and ownership of the resource that is very firmly rooted locally.

Several levels and scales are involved in the operation of the agricultural sector in the Canary Islands: supra-national levels, notably the EU (via the community programme to support agricultural production in the Canary Islands); the national level with the Ministry of Agriculture, Fisheries and Food, and producer networks in the archipelago; the regional level via the department of agriculture, livestock, fisheries and food sovereignty of the Autonomous Community, and public research bodies; and finally, the local level via the Cabildo's department for agriculture, livestock, fisheries and food sovereignty, local networks of producer organisations, irrigator and water communities and agro-industrial players.

For the energy sector, despite the condition of insularity which means that the islands are closed energy systems as they are completely disconnected from the continental system, the key player, ENDESA, is located at national level. Any local initiatives or projects that require energy to be injected into the network must be validated by this participant.

³⁶ Since 1982, the Canary Islands have been part of the autonomous communities of the Kingdom of Spain, the autonomous status of which was partially reformed in 1996, giving them a historic nationality. They have two capitals, Las Palmas de Gran Canaria and Santa Cruz de Tenerife.

The governance system involves all levels and scales relevant to the water-energy-food nexus, which is supportive.

Problem perspectives and goal ambitions

Most people interviewed see the availability of water resources and energy supply as critical issues because the most important economic activities developed in the Canary Islands – agriculture and tourism – are fully dependent on these two factors, which are also essential for all other activities and for the population in the archipelago. This results in tensions between agricultural use and urban and municipal use, with the requirements of the tourism industry in particular being included in this category.

These rivalries take place against a backdrop of scarcity resulting from the geological and hydrological characteristics of the archipelago, increasingly frequent and perceptible impacts of climate change, a highly specific water ownership system and "intensive" economic activities: on the one hand, an agricultural activity characterised by the banana monoculture (in La Palma) and, to a lesser extent, pineapples (in El Hierro), which requires large quantities of water; and, on the other hand, a tourism industry that receives on average ten million people each year in the Canary Islands. Although the islands of La Palma and El Hierro are not characterised by mass tourism, as is the case for Tenerife and Gran Canaria, but rather by a more rural form of tourism (Figure 35), changes are taking place, creating tensions around water and the conservation of protected natural environments.



Figure 35: A typical old house in El Hierro, still used for rural tourism. A reservoir for water collected on the roof during the rains was usually located in the courtyard of the house (photo right).



Pressure from tourism on water resources, can, as the case of La Palma shows, change the water market. According to information provided by shareholders from the communities of La Palma, in the space of a very few years the price of water shares has rocketed due to pressure on demand for drinking water on the island from new arrivals (sometimes foreigners who buy holiday homes) who are prepared to pay to have access to water to be able to live there. The members interviewed reported that the share price has risen from €15,000 to 120,000. This means that the agricultural activity is struggling to compete with other uses and farmers are struggling to pay such high prices to access water. However, according to those interviewed from the water communities in La Palma, 95% of water is still allocated to farming. This data could not be verified by other sources. Although the sale of water shares for other uses still seems to be a relatively limited phenomenon, the leasing of

water rights is very widespread. This highly active market is not protected from speculative movements.

According to these communities, a solution to reduce pressure on the agricultural resource would be for the island government to provide a public water supply system on the entire territory of La Palma, particularly in the island's mid-height places dedicated to agriculture, where municipal resources are not present and where private individuals take up residence and who need to be supplied in drinking water. In some cases, this can result in the sale of water shares and changes in use (Figure 36).



Figure 36: Location of water reservoirs next to banana growing areas

In El Hierro, the water shortage currently affects farming above all, which in the event of heat waves, such as in 2022, results in the use of larger volumes of water to ensure irrigation and soil moisture.

To meet the island's water demand, the authorities have incorporated new resources, in particular desalinated water³⁷. In La Palma, as a response by the Autonomous Government to the emergency caused by the 2021 eruption, which damaged the drinking water and irrigation water supply network, two portable facilities were installed to ensure water supply to farmers, in particular banana crops, and to the population (Figure 37). These facilities were removed once the networks damaged by the eruption had been repaired. There is currently debate on the interests of installing a desalination plant on the island. In El Hierro, following a water emergency situation declared by the Cabildo last year, three desalination plants have been installed (see Coherence/ problems perspectives and goal ambitions). They produce 68% of public water.

For farmers in El Hierro, a serious problem for two years now is the presence of a parasite, a cochineal, which attacks and destroys pineapple plants and is strongly affecting production. Several measures have been implemented with the support of regional government to deal with the disease and support farmers in the search for a solution (subsidies, research by the agricultural institute of the Canary

³⁷ In the Canary Islands there are 315 desalination plants.

Islands, experts from elsewhere, new plants and soil disinfection). Some farmers from the La Frontera cooperative in El Hierro believe that desalinated water could be the cause of the problem, although the technicians do not share this opinion: *“Farmers say that since 2018-2019, which I believe is when the desalination plant was installed, they started having all these problems concerning wilt. The desalination plant was installed and they started having all these problems related to wilt [pineapple disease, editor's note] etc. So they blame some of the problem on the water quality. As a technician, I can't say that, because I receive the analyses and I can see that the water is the same [as well water, editor's note] ... At the end of the day, the problems we are seeing here are due to the cochineal and there is no water that encourages the cochineal to develop. It doesn't make sense, ultimately...”* (Interview, El Hierro, 12/07/2023).

The cochineal problem has raised the issue of banning the use of plant protection products for produce destined for the European market, and there is a serious lack of molecules available to fight many diseases in a humid tropical and subtropical environment particularly conducive to their development. Farmers consider their land as disadvantaged compared with the rest of Europe due to their remoteness, but also in comparison with third countries, particularly African, due to the competition that their tropical products, which are not subject to the same health and environmental rules, impose on Canary Island production.

Environmental protection associations claim that the installation of a desalination plant is not a solution to the problem of insufficient water. The decision for desalination not only has an impact on the marine environment, but leads to a significant increase in energy use (for the desalination process and for water production) and an increase in the consumption of fossil fuels and CO2 emissions.

The water communities of La Palma also denounce a poorly maintained public infrastructure, with leaks affecting 30-40% of the water flowing through it. On the other hand, in their opinion, community infrastructures are in better condition, with losses of around 1 to 5%. The communities claim to have made improvements to the distribution system so as not to waste water, using pipes instead of open canals and sprinklers instead of gravity-fed irrigation, but the situation remains very uneven across the island depending on the community, between crops on the plains and crops on higher ground.



Figure 37: Banana plantations, covered with plastic for many to be protected from the wind, near to touristic places

This perception is not shared by other players interviewed, who consider that the water communities' irrigation networks and the public drinking water supply networks have significant losses that contribute to increasing farmers' expenditure on energy.

Competition with the tourism sector is also mentioned with regard to the use of land and territories in Natura 2000 zones or protected natural areas where tourist projects are planned (see Coherence/ Problem perspective and goal ambitions).

Stakeholders' perceptions of the problems vary widely, as do the objectives for solving these problems. Indeed, perceptions of water availability remain anchored in a sectoral vision where the critical climate context, rather than driving common solutions, increases tensions. This is restrictive.

Strategies and instruments

In terms of territorial planning, the Autonomous Community of the Canary Islands is unique in having a single document that integrates the protection of "natural" areas and land use planning for each island (Ley de ordenación del territorio/Territorial Planning Act). In contrast, the other Spanish Autonomous Communities have two separate administrations – one for urban planning and one for the environment planning – which are governed by two different sets of regulations.

As for water management, each island has its own planning instrument, the Hydrological Plan. Within the context of the Canary Islands' national and autonomous water regulation, each island is considered to be a watershed in its own right. The plan for the third planning cycle (2021-2027) has been approved for the island of El Hierro, but not yet for La Palma, which approved its second cycle plan three years late. Some participants, particularly scientists, consider that planning on the scale of the archipelago would make it possible to create a more consistent framework for a regional resource protection policy.

The Strategic Plan of the Common Agricultural Policy of the Canary Islands (Plan estratégico de la política agrícola común de Canarias - PEPAC) for the 2023-2027 period is the instrument that guides policy implemented at regional level in the archipelago, through the Canary Island government's Department of Agriculture, Livestock, Fisheries and Food Sovereignty³⁸. The programme is subsidised and co-funded by the European Agricultural Fund for Rural Development (EAFRD), the Spanish government's Ministry of Agriculture, Fisheries and Food and the Autonomous Community itself. The measures in the plan are rolled out locally via the departments of agriculture, livestock and fisheries of the Cabildos departments in charge and are supported by local technical support agencies. A second pillar of the agricultural policy for this outermost region is the community programme to support agricultural production in the Canary Islands "*Programa Comunitario de Apoyo a las Producciones Agrarias de Canarias - POSEI*". A simplification of procedures to access subsidies was also recently introduced for the sector.

The strategy adopted by the Canary Islands' government to meet the water challenges posed by climate change in recent years includes measures to develop and modernise irrigation and drinking water networks, desalination plants and the construction of new reservoirs and tanks (Consejería de Agricultura, Ganadería, Pesca y Soberanía Alimentaria, 2023). Among the instruments that farmers can use to save water is an application that allows them to manage an irrigation programme by calculating the water requirements and irrigation doses for 104 crops, using as a reference the evapotranspiration calculated from data supplied by the national network of SIAR stations (sistema de información agroclimática para el regadío/ agro-climatic system for irrigation). In El Hierro, measures have been introduced to save water in view of heat episodes which increase the evapotranspiration of water stored in reservoirs: for example, the La Frontera cooperative has put a cover on one of the reservoirs which supplies the cooperative with water. Mitigation: avoid pumping more water and produce water in treatment plants.

³⁸ This plan replaced the 2014-2022 Rural Development Programme (RDP)

In connection with SDG 12, Responsible consumption and production, the Cabildo of La Palma and the International Centre for Organic Farming (CIAB, a Canary Island foundation) organise training courses on organic farming, but this practice is not very well developed on the island. The context of mainly intensive conventional production of bananas and other subtropical fruits does not seem to encourage the farmers we met to adopt this practice. Despite production in the Canary Islands taking place within the framework of European Union plant health, environmental and food safety standards, monitoring the effects of conventional practices carried out nearby remains difficult and risky for organic producers.

In La Palma, an ecological banana plantation producer seems to be focusing his activity more on eco-tourism activities, where the plantation is becoming a place to receive school visits and travellers seeking rural tourism where environmental activities can be set up. In El Hierro, the La Frontera cooperative (specialised in pineapples, Figure 38) reports having a single farmer out of its roughly 200 members who practises organic farming. Although El Hierro is considered to be the island with the largest amount of certified organic land in the archipelago (approximately 3,500 hectares in 2023), most of this area is made up of pasture and fallow land. The island's organic crops include vegetables, herbaceous plants, millet and fruit trees, mainly fig, mango and apple trees³⁹.

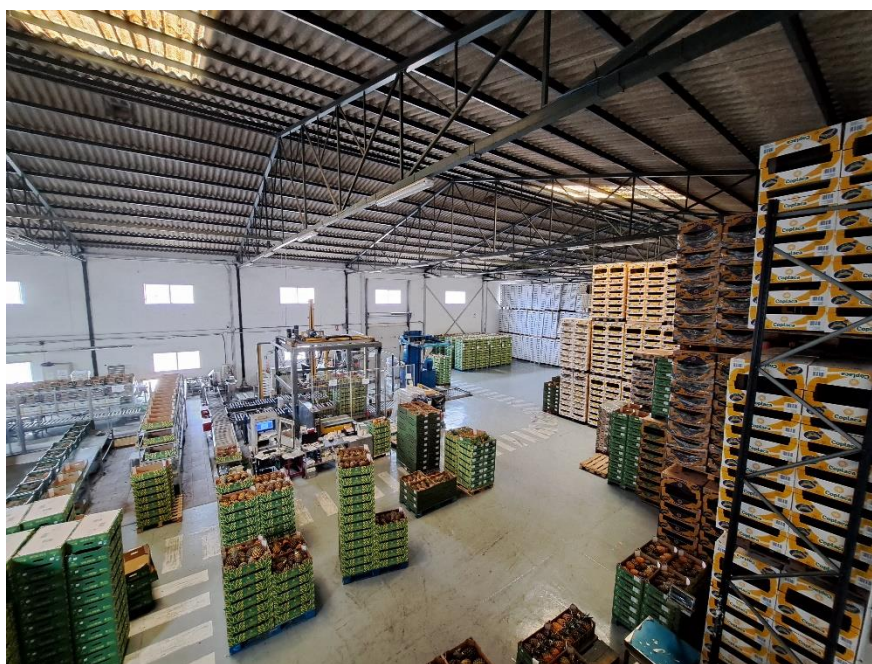


Figure 38: Pineapple cooperative in El Hierro (Cirelli, July 2023)

Experimental agro-ecological projects exist in the Islands: the Cabildo of Tenerife is currently funding the following experimental projects: renewable energy production projects that combine the processing of agricultural waste and energy production: goat or chicken droppings are used to produce biogas and fertiliser for crops (digesta). The aim is to help farmers reduce the energy costs of their farms. Funding has also been provided to support an ICIA project to treat contaminated agricultural waste (potatoes affected by a parasite) to be processed into cattle feed.

In the energy field, the Canary Islands are committed to renewable energies, concentrating on solar and wind power. On each island there are several separate electricity systems, but the majority of

³⁹ Consejería de Agricultura, Ganadería, Pesca y Soberanía Alimentaria
<https://www.gobiernodecanarias.org/agp/sgt/temas/estadistica/ecologica/index.html>. In La Palma, the area given over to organic farming is 700 hectares.

electricity is supplied by fossil fuels. In 2022, the Canary Islands government approved the law on climate change and energy transition, which aims to reduce emissions by 90% by 2024 compared to 1990. Concerning the implementation of renewable energies, the target set by the law and the Canary Islands Energy Transition Plan for 2030 is to achieve 37% of final energy consumption using green technologies, and 92% by 2040. Today, the share of renewable energy in the energy production mix is nearly 20% compared to 47.7% in continental Spain (2021 data). According to the Ministry of the Ecological Transition, renewable energy production in the Canary Islands comes mainly from wind power (15.8%) and solar power (3.7%). (Ministerio de la Transición ecológica, 2022).

El Hierro sees itself as an island at the forefront of environmental and climate issues. In 2014, a hydro-wind plant was inaugurated on the island, an innovative project capable of harnessing both wind and water power. The installation was designed to guarantee energy self-sufficiency for an isolated island system, with the aim of reducing dependence on fossil fuels, in particular diesel transported by boat. The project was designed in the 1980s by a local engineer, an executive of the Spanish electricity company UNELCO-ENDESA, who was subsequently Mayor of El Hierro several times and a member of parliament. Backed by international networks and bodies (Gioda, 2014), the project was mainly funded by public funds (Gorona del Viento is 66% owned by the Cabildo of El Hierro, 3% by the Canary Islands government, 8% by the Instituto Tecnológico de Canarias and 23% by ENDESA). It is a mixed company in which the island's interests are strongly represented. The project combines a wind farm, a hydraulic power plant and a conventional closed-circuit diesel power station. There is also an associated desalination plant to supply the system with fresh water. The combination of water and wind makes it possible to compensate for the intermittent nature of wind, even in the absence of the slightest breath of wind, and to produce electricity continuously by storing water in retention basins. The water used in the hydroelectric system is desalinated. However, the system also has a diesel-powered installation used only when the wind and water are not sufficient to produce the energy required to supply the network. This fossil energy is also used to operate the four desalination plants when the hydro-wind power is insufficient. Although the facility does not guarantee self-sufficiency in renewable energy for the whole of the territory, Gorona del Viento is able to cover up to 70% of the energy consumed on the island⁴⁰. Some of the energy produced is used to operate the facility's turbines.

In addition, the El Hierro local authorities are trying to implement other solutions to produce 100% green energy all year round. Projects for photovoltaic plants – solar farms – are recommended. The local authorities have also set themselves the target of replacing the island's vehicle fleet with electric vehicles. The idea is to build a solar farm to power electric vehicle charging stations. Currently, electric vehicles on the island are powered free of charge by a network of stations set up by the company Gorona del Viento (Figure 39, Figure 40). In addition, the Cabildo subsidises the purchase of zero-emission cars for the sum of between €7,000 to 10,000. Today, the local authorities' ambition is to power the island purely with renewable energy, particularly solar, and to achieve carbon neutrality by 2030 (at least within the island's perimeter). Added to this is the target to supply 100% organic food produced only on the island, as well as organic livestock farming and a sustainable fishing system. In the same way, the island's government has declared its ambition for a model of tourism that is not mass tourism like the one that exists on the islands of Tenerife or Gran Canaria.

⁴⁰ The production capacity of the wind turbine is 11.5 kW, the highest level of demand on the island is between 7-7.2, the average between 5 and 6 kW. In reality, the system operates as a mix of hydraulic and wind, with fossil (diesel) as a back-up to ensure continuous supply.



Figure 39: Map of the energy production project of the Gorona del Viento



Figure 40: View from the wind park of the Gorona del Viento project

In La Palma, the citizen organisation *Plataforma por un Nuevo Modelo Energético*, which stems from the *movimiento de los indignados* – M15, has developed a project in the form of a manifesto to raise islanders' awareness of the negative effects of the energy model based on fossil fuels and to promote an energy transition led by the citizens. The Cabildo of La Palma, 14 island municipalities and the regional government have signed up to the project and signed the manifesto. In 2018, the Cabildo of La Palma recognised the role of *Plataforma* in the island's energy transition and decided to finance the platform via the public company, Sodepal, to coordinate the island's transition under the label *La Palma Renewable* (Renewable La Palma). The *Agenda de Transición de Energía Limpia* is the strategic roadmap that *La Palma Renewable* has given itself for the energy transition process that it states it wants to promote.

The La Frontera cooperative, which has installed solar panels to power the pineapple packaging plant, is considering the adoption of renewable energy systems as a strategy for reducing production costs. However, this measure is not sufficient to cover all of their needs, which means that they still need to use electricity produced by fuel.

The tourism sector, through the work of its association, Ashotel, has developed a Sustainable Development Strategy and a Sustainable Development Observatory.

In 2022, the European Commission adopted a vast strategy for outermost regions aiming to reflect the specificities of these regions in all policies, focusing on "putting people first" by supporting living conditions.

The system has developed several instruments and strategies to support the environment, to ensure the sustainability of export agriculture, adaptation and mitigation to climate change and the energy transition at local and regional levels (Autonomous Community of the Canary Islands), which is a supportive context.

Responsibilities and resources

As part of the State's reorganisation through the creation of Autonomous Communities (1978), which had ensured a redistribution of powers over water between the State and the Autonomous Communities, this meant a substantial transformation in management of the resource. The 1985 water act (Ley de Aguas del Estado) established the principle according to which all inland surface water and groundwater – integrated into the hydrological cycle – constitutes a unitary resource, subject to the general interest, which forms part of the State's public domain as a public resource.

In the Canary Islands, this generated a major change in a system where, traditionally, private initiative has played a predominant role, leading to conflict. From 1987, the Canary Islands assumed exclusive powers in the field of water⁴¹, which are difficult to compare with those of the other autonomous communities on the mainland, thus acquiring a privileged position (Sarmiento Acosta 2004). Here, it is the Cabildo, the island government, which has jurisdiction over water, and not the Autonomous Community government, as in the rest of Spain. These powers are exercised on the island territory by the Island Water Councils. In the 1990s, the Autonomous Community of the Canary Islands transferred a number of powers to the island governments. The latter exercise, on each island, the functions and powers conferred on the basin organisations on the peninsular. In particular, their powers include the preparation and initial approval of planning instruments and the implementation of public action in water matters, the granting of concessions, permits and other acts relating to water, as well as the water policy. Despite the powers conferred on them by law, the Island Water Councils are relatively recent bodies (since 1987) compared with the Hydrographic Confederations in Spain, which are over a century old. In addition, they are established in water management contexts dominated by the presence of private owners. In this situation, the Island Water Councils often find it difficult to impose their action. Public funding capacity is limited to carry out necessary actions in terms of infrastructure, as well as to develop a water management action plan or research and development studies.

The Cabildos exercise a range of powers that make them public administrations with considerable importance in the administrative life of the Canary Islands. However, in 2017 a reform redrew the powers of the Cabildos and the communes, giving more power to the municipalities, which, according to some public sector employees interviewed, does not appear to be fully clear to the administrators when implementing projects.

⁴¹ Decreto 86/2002, de 2 de julio, por el que se aprueba el Reglamento de Dominio Público Hidráulico

The water communities (La Palma) complain about insufficient economic resources to modernise hydraulic infrastructures and expect the Cabildos to take care of this work.

Concerning resources, the Cabildos do not always have enough staff to carry out maintenance work or to provide technical assistance in the agricultural field (El Hierro). In other cases, there is also a lack of qualified staff with expertise, particularly in energy (La Palma) and land-use planning.

Several players highlighted the need for reliable studies and data regarding water resources. Farmers who are shareholders in the water communities in La Palma express the need for clear and updated data for an indisputable water balance. They think that the data used is too old and in particular that the studies conducted by the Cabildo are not carried out by experts with knowledge of the island's characteristics. Although the first cycle of the Hydrological Plan (2008-2014) showed a real effort to recompile data, for the communities interviewed the second cycle of the Plan, which was very late, was purely a “copy-paste” of the previous plan (Interview 10/07/2023).

Some local water experts share this belief that reliable and updated data is required. This subject is often mentioned in local media.

In the energy field, the new energy strategy for the Canary Islands calls for regional budgets to include a “climate perspective” and for 2% of the islands’ GDP to be allocated to measures in this field.

Finally, as an outermost region, the Canary Islands benefit from special envelopes under the European Regional Development Fund and the programme of options specific to remoteness in the field of agriculture.

For the players involved in this sector, it is more a question of expertise that needs to be developed at Cabildo level than a question of financial resources – renewable energy is a highly invested and financed sector of public policy. On the other hand, the agricultural sector has very specialised knowledge.

In general, responsibilities are clearly allocated and supported by funding. In some areas, such as territorial planning, recent reforms have created uncertainty in municipal and supra-municipal territorial management. There is also a lack of human resources and expertise. All this creates a context that is neither supportive nor restrictive.

Conclusion

The system has developed a variety of strategies and instruments to support the terrestrial and marine environment and biodiversity, as well as instruments to ensure the sustainability of export agriculture, the adaptation of the island to climate change and the energy transition at local and regional level (Autonomous Community of the Canary Islands), taking into account all actors and levels of governance and discussing the problems of different sectors. However, the overall elements of the system do not fully reflect what is relevant for a nexus-oriented water-energy-agriculture policy, which is neither supportive nor restrictive.

- **Coherence**

Actors and networks

The water communities have constant interactions with the Island Water Councils and the latter claim that they work in coordination with the municipalities and the water communities. Despite these

interactions, relationships do not seem to be based on trust. The water administration and management context is characterised by a transitional regime for access to groundwater that will change in 2040, bringing current private water rights back into the public domain. (see Coherence/Strategies and Instruments). This is a major change, barely mentioned at the moment by the players we met, but which seems to establish a feeling of mistrust that underpins relations and exchanges between these two categories of players. This is, in any case, what the field work revealed in the case of La Palma.

The water communities interact at several levels, even though they have different issues and may have differing views with regard to public projects on the island. The geographical location of cultivated land on the island, whether on the eastern or western slopes, on the plains or in the "medianía" (medium-altitude) areas, as well as the nature of their water sources – galleries, wells, reservoirs – can change their position with regard to projects affecting water resources or particular zones and environments on the island. In the discourse that the water communities construct about themselves, they seek to enhance the social structures rooted in a local history that have helped to write. They reject analyses and opinions that depict them as a system of *"aguatenientes"* (a restricted group of people who control and concentrate ownership of the water). While that may have been the case at a given time in their history, today the water rights system is very fragmented and the ownership of water shares is something that *"every family in La Palma has done at one time or another as an investment"*. However, they acknowledge that water *"es negocio"* ("it's business"). Members of the communities seek to promote the socio-community dimension rather than the economic dimension of the system: *"It is an almost perfect balance between the private sector, which functions as a company that has shares, and the social sector, which at the same time has all the communities working together to share"* (Interview, Water Communities 10/07/2023). For example, the case of lending water is put forward not only as a way of allocating water where it is needed, but also as a practice for intra-community aid that allows a community to have access to the resource when it is in difficulty (water shortage or high extraction costs, for example). This allows a community to use the resources of another one. This type of transaction also allows for the suspension of "water debts" (loaned water that must be returned) during a particularly dry season, allowing the debtor company to deal with its own irrigation season.

In El Hierro, the interviews reveal a situation where water is a commodity concentrated in the hands of a small number of players and the water rights system seems to be less fragmented than in La Palma. However, the fact that the public authorities have control over and management of significant water resources suggests that these water entrepreneurs exercise control over less abundant volumes.

In the agricultural sector, the cooperative of pineapple producers in El Hierro considers relations with the local administration (Cooperatives and Cabildo) and regional administration (Autonomous Community) to be cooperative and that the public authorities are responsive to problems in the sector, whether they concern agriculture, energy or water. For example, they have received subsidies – a plan to revive pineapple cultivation following the crisis endured by the sector, mainly due to cochineal disease. They have also received subsidies to deal with energy costs to extract water for irrigation.

In the energy field, the La Palma Renewable association and the Cabildo of La Palma have set up a cooperation that has not only led to the association taking charge of a programme to raise public awareness of renewable energy issues, but also taking the place of the public administration in carrying out functions and activities which it usually takes care of (survey of meters, solvent subscribers, insolvent subscribers) (see Extent/Strategies and instruments) due to a lack of expertise (see Extent/Responsibilities and resources).

Players interviewed in the tourism sector are willing to embark on sustainable approaches for their business. They have set up actions in several energy transition fields – mobility, energy, waste –, which has led them to relate to and interact with several sectors of public administration and civil society. In the Canary Islands, tourism is torn between, on the one hand, being a driving force for the local economy and a major source of employment⁴², and on the other, being identified as the source of major social and environmental impacts. The representative of the Ashotel Association, which brings together tourism entrepreneurs in the western Canary Islands (Tenerife, La Palma, El Hierro, La Gomera), expressed the sector's concern regarding a widespread feeling of rejection of the tourist industry which, according to him, can be partially explained by the development of holiday rentals – B&B and holiday homes – which is putting pressure on property and creating a local housing crisis. In fact, until now the seaside model characteristic of the islands guaranteed a fairly clear separation between tourists, concentrated in seaside tourist areas, and residents. He considers that the opinion and picture that certain players have of tourism entrepreneurs as “predators” of the region and its resources, particularly environmental protection associations, are not an accurate analysis of their activity. In fact, Ashotel stresses that *“only 4% of the territory is occupied by tourism infrastructures, while 60% is protected by various forms of protection and zoning (Biosphere Reserves, Nature Reserves, Natura 2000, etc.) and the remaining 40% is used by economic activities”*⁴³ (Interview with Ashotel, 14/07/2023). Ashotel specifies that all tourist activities are subject to very strict regulations, whereas land is occupied, particularly along the coast, by private individuals – generally Canary Islanders – who, on the other hand, do not comply with town planning regulations, particularly along the coast, and who are not controlled or sanctioned by the public authorities.

Finally, the islands’ local environmental, agricultural and water administrations do not seem to be coordinated and actions remain very sectoral.

The interaction between the different stakeholders offers opportunities for cooperation, especially within the same sector. Even if the sectors operate in silos at an administrative level, in the field technicians know each other and can move files forward, which is neither a support nor a constraint.

Levels and scales

Those interviewed believe that managing water on the scale of the island is the right way to deal with water-related issues. On the one hand, they are insular, and therefore closed systems; on the other hand, each island has its own geological and hydrological characteristics which, in their opinion, justifies planning on this scale. At the sub-local level, the degree of interaction is not always based on trust.

The fieldwork schedule did not allow us to gather the views of higher administrative levels, particularly the regional level, on this point.

For the energy sector, notwithstanding the condition of insularity which makes the islands closed systems in terms of energy production, the national level through the national electricity company is strongly present locally as well as in decision-making processes, which are centralised at State level. As the local public sector employee working in the hydro-wind power production company said

⁴² Companies in this sector employ 344,358 Canary Islanders, i.e. 39.7% of the total number of citizens registered for social security in the archipelago and 35.5% of GDP according to data provided by Impactur. <https://www.exceltur.org/impactur-2/>

⁴³ According to data provided by the Ministry for the Energy Transition, the numbers are precisely the opposite.

“ENDESA is in control” (Interview, 13/07/2023). Gorona del Viento, the public company⁴⁴ that manages the El Hierro hydro-wind power plant, has to sell the electricity it generates to ENDESA, and ENDESA, through its various companies, distributes and markets energy on the scale of the island via various sub-contracts. In El Hierro, like in La Palma, network access permits required to inject the renewable energy produced by the photovoltaic plants are also issued by ENDESA, which has control over the distribution network and is responsible for supply.

From an agricultural policy point of view, the different levels work together, their relations are based on trust and their interdependence is recognised.

Depending on the sector, the levels work together and recognize their interdependence. Relationships are not always based on trust, which is neither supportive nor restrictive

Problem perspectives and goal ambitions

The biggest problems felt and reported by the people interviewed were presented in § Extent/Problem perspectives and goal ambitions. Availability of the water resource and energy supply are considered by most players to be critical issues.

Although players may agree on the problems concerning water availability or energy costs, they do not always agree on the solutions and measures to deal with them.

In La Palma, the La Palma Renewable association involved in the island's energy transition considers that the context is not able to guarantee that the project will run smoothly. And this is despite the fact that the Cabildo backed and funded the association. The company set up to manage renewable energy projects is having problems getting off the ground, the national energy company is not giving potential energy communities access to the network, or is only providing very low levels of access in kilowatts, information on the condition and capacity of the network is not known and not available to the public, procedures are very slow, etc.

To reduce energy costs for the sector, the hoteliers' association wants to develop renewable energy projects to offset the CO₂ produced by tourism. In this respect, Ashotel recommends the installation of photovoltaic power plants on rural land (not occupied by agricultural activity), given that hotel roofs are often occupied by terraces used for leisure activities for guests – in other words valuable areas. The association is thus looking for land in tourist areas where it can install these power plants, or it is contacting farmers who would like to make their land available for agro-voltaic projects. Regulations stipulate that for photovoltaic plants on rural land, regardless of their power, an access point and connection to the electricity grid must be requested and a permit granted by the energy authority. However, under energy production regulations, safety in the operation of networks takes precedence over access rights, which has led the operator to reduce access on many occasions. In this context, network access points are becoming real hotspots, as the hoteliers' association points out.

The search for land on which to install photovoltaic farms or to be able to develop real estate projects shows the extent to which land is rare and disputed in the Canary Islands. In La Palma, agricultural activity dedicated to the production of bananas for export on the coast is one of the key factors that seems to have held back the development of coastal tourism thus far. The price of land, and in general, the profitability of the banana industry due to the subsidies that support it, are one of the factors that have prevented the construction of tourist areas, with the exception of a few places (Puerto de Naos, Los Canjacos). Until very recently, tourism on this island was described by the people interviewed as a secondary activity to agriculture. The island was known for developing rural tourism in the 1990s to

⁴⁴ 66% of the company belongs to the Cabildo of La Palma, 24% to ENDESA and the rest to the Instituto Tecnológico de Canarias, which took part in designing the project.

complement its farming activity, based on promoting its natural and cultural heritage, while remaining on the fringes of the mass tourism development seen in the western islands (Tenerife, Gran Canaria, Lanzarote and Fuerteventura). However, the economic recovery plan after the eruption of Tajogaite once again focused on the coast of the Aridane valley for tourism projects, which many describe as “urban and tourism speculation.”

To deal with rising energy costs to extract water, the La Palma water communities have considered installing solar panels. It would take 100,000 m² of panels to cover needs, but they cannot create photovoltaic plants on farmland, which is used for banana production and particularly limited after the 2021 eruption. They therefore attempted to set up a project with La Palma Renewable, in particular linked to geothermal energy, but so far without success. It is not possible to put the panels on greenhouse roofs due to plant development reasons. Innovations – transparent panels – have been suggested, but as they have not yet proved their worth, farmers prefer to find other solutions. In view of the fact that, since 2002, the whole island has been recognised as a biosphere reserve by UNESCO and part of the land is covered by Natura 2000 zoning, it is difficult to be able to install panels close to wells or galleries within this perimeter, as regulations on this matter are very strict. In this regard, they highlight what they consider to be a contradiction: *«Everything on La Palma is a protected natural area. There is the Natura 2000 network,... It is a contradiction, the protection of nature, which in reality becomes the protection of tourist interests and is presented as the reduction of CO2 emissions»* (Water Communities, Interview 10/07/2023).

The communities’ search for solutions therefore focused on hydraulic energy production projects using the water jumps that exist in the canal and gallery network. However, they came up against the rules of the national electricity producer, ENDESA, which considers these projects technically non-viable for reasons of connection and distance of production points from the electricity network. In fact, to be considered a self-consumption project, the law stipulates a maximum distance of 500 metres between the production facility and the user. If it is not a self-consumption project, the entire energy produced must pass through the network and be connected to it. The water communities think that the electricity company has too much decision-making power over local issues and they do not hold back in calling it the “electricity mafia”.

Players in the tourism sector are also experiencing difficulties in completing their projects to install photovoltaic plants due to the impossibility of connecting to ENDESA's electricity network in order to inject the electricity generated. According to the person interviewed, this is because the electricity network in place is already working at maximum capacity in a system that is insular and therefore closed. In this context, the Ashotel representative stressed the problem created by the fact that holders of connection rights linked to unfinished projects are now seeking to sell their rights in a speculative process. *“When Ashotel said, “we are interested” and we launched this type of photovoltaic project, we started receiving phone calls from people who said “if you want to be connected, talk to me, I’ve got connection rights (or rather access rights, editor’s note⁴⁵). And you pay me”. It’s the mafia...”* (Interview with Ashôtel, 14/07/2023). In response to this speculation of rights to access the electricity network, ENDESA has now included in its regulations a requirement for network access applications to make a deposit of €40,000 for each megawatt they want to produce.

The housing shortage resulting from the development of the tourist rental market particularly affects residents of the islands’ capitals, residents of tourist areas, and workers in the sector (approximately

⁴⁵ The law makes a clear distinction between, on the one hand, the right to be connected to a specific point on the network (right of connection) and, on the other hand, the right to access or use the network under the conditions defined by law (right of access). Right of access seems to be the cornerstone of a liberalised electricity sector, as the opening up of the market depends on the provision of electricity networks to different market players who will act in a unique network system. (Leiva Lopez, 2019)

38,000) are faced with the problem of price increases and a shortage of accommodation⁴⁶. To provide a solution to this problem, the Ashotel association of tourism entrepreneurs is proposing an initiative to build social housing (through associated builders) on land that municipalities would agree to provide.

Connection with the other islands and maritime transport is another issue reported by several players as a factor that affects their business. The El Hierro tourism association want the authorities to ramp up the island's boat services by increasing the number of trips and interconnections between the islands, which would make it easier to reach the island. It also wants to promote a diversification of the car rental market on the scale of the island, which is currently restricted to a single company. The issue of transport and the frequency of maritime connections is also reported by farmers interviewed from the La Frontera cooperative. Together with the traders and transport companies working on the island they form a front that is calling on the island's government and the Autonomous Community to address the matter.

Concerning water availability, there are various perspectives and solutions. On the one hand, there are those who, as a response to the operation of aquifers, recommend the creation of a desalination plant. This was the case of the Cabildo of El Hierro or the Ashotel association of tourism entrepreneurs, for example. On the other hand, there are those who consider it essential to repair existing infrastructure, in particular leaks, before committing to such projects. This second group includes environmentalist associations and some water communities in La Palma. The first consider that the problem could be partly resolved by dealing with the numerous leaks in the public drinking water and agricultural network instead of continuing to subsidise the energy costs of inefficient irrigation or water services with public money. The water communities do not all share the same view regarding introducing desalinated water into the local water system. Some fear an effect on the water market, with water competing with private groundwater; on the other hand, some producers see it as an additional resource to meet growing needs, particularly in certain areas of the island particularly affected by heat phenomena or faced with dwindling or even drying up water resources. For the tourism sector, seawater desalination would be a solution to meet the high demand for water resulting from this activity: a tourist's consumption is four times that of a resident. The project to install small desalination plants in each tourist area is not an option that public authorities encourage: too many regulatory constraints and impacts in the sea or in the networks to discharge residue from desalination operations. However, according to the person interviewed, resistance from the authorities is essentially summed up by a commercial argument *"the island's government is more interested in you using the water they produce"* (Interview, 14/07/2023). Some structures reuse "grey" water to water parks and gardens.

In El Hierro, the view of a technician who works with farmers from the cooperative (who irrigate from the La Frontera reservoir) is that the community does not limit its members' water consumption. In other words, as long as they pay, they can consume as much as they want. He believes that some farmers, particularly the older generations, are not really aware of the water and climate issues. Also, the renewal of the generations in farming is another problem raised by the sector.

The various uses of water and land are the cause of an unsustainable use of resources. The perception of the problems and the solutions proposed are sometimes conflicting, which is restrictive.

⁴⁶ In July 2023, general elections were held and the new president of the Autonomous Community of the Canary Islands promised in his campaign that he would regulate the use of accommodation by tourists in the Canary Islands. According to data from the National Statistics Institute for 2023, the holiday home phenomenon accounted for 33% of accommodation on the islands, with over 42,000 accommodation units and 179,000 beds.

Strategies and instruments

It was not until the 1960s that the law formalised public administration intervention in the regulation of water withdrawals in order to transfer administration of part of the groundwater resources – which had largely been privatised – and the control of the resource to the public domain. At the time, the law recognised this private right to water management, but regulatory changes in the 1990s⁴⁷ amended it by creating a transitional period, which will end in 2040. During that year, management and use of groundwater will be transferred from private to public management. In this way, the public sector attempted to regulate access to underground resources and control their operation.

As the members of the water communities interviewed described, the market linked to private ownership of water is provided by the *Comunidades de agua* or the *Heredamientos*, which sell the water not used by their members. Buyers may be the municipalities, industries, in particular tourism and farmers who do not have access to water rights. In this system, the intermediary also plays an important role as they are the party that buys, distributes and sells water. Intermediaries may include players such as local authorities, which own or have rights of way over the pipes and channels that enable water to circulate, and therefore the market in the true sense of the term. This transmission network works like an electricity network in which water of different qualities is discharged from different owners of different networks. The existence and longevity of this market, as shown on other islands in the archipelago⁴⁸, therefore resides in the fact that supply is guaranteed by the numerous catchments spread across the island and the exchange of flows means that a drop in flow from one catchment can be compensated for by the production of others, and finally an adequate transmission network to move the water around.

Another strategy by the public authorities to intervene in the water market, which results from private management with the aim of balancing the supply of water and containing prices is based on options: desalination of seawater and wastewater processing, which is currently particularly supported by the new European regulation on the reuse of wastewater, which came into force in June 2023. Projects to reuse regenerated water in agriculture will be implemented in the next few years thanks to the Recovery, Transformation and Resilience Plan, Phase II, financed by the EU's Next Generation fund, in particular on the island of Tenerife.

Although the entry of desalinated water on the market has enabled access to additional resources, it has also increased water prices because the cost to produce this water is expensive and is reflected in the price of water. In addition, according to some farmers interviewed, not only does it have an impact on the environment, but its quality is inferior compared to groundwater.

In the case of El Hierro, the construction of a desalination plant is taking shape within the context of a state of water emergency (June 2022). The Cabildo authorities justified this on the grounds that there was a serious water shortage on the island, due in part to a delay in the redevelopment of a major storage infrastructure (the Frontera reservoir), but also to the low rainfall in recent years, which has prevented the aquifers from being refilled. The strategy used by the authorities, which was to declare a legal state of water emergency has, according to other players – scientists and environmental protection associations which have expressed themselves extensively in local media – , allowed them to derogate from the ordinary rules of management and to justify the implementation of seawater desalination projects very quickly⁴⁹, without any bureaucratic obstacles, and to “favour the industrial desalination sector” perceived as particularly powerful.

⁴⁷Canary water law 10/1987; Canary water law,12/1990, Last amendment: December 27, 2021.

⁴⁸ “*El mercado del agua en Canarias*”, José Luis Guerra Marrero, undated document.

⁴⁹ In summer 2022, a seawater desalination plant with capacity of 1,200 m³/day was installed in record time, as reported in the press.

Measures adopted in 2023 by the Regional Ministry of Agriculture, Livestock and Fisheries of the Canary Islands government, which approved the granting of subsidies to reduce the extra cost for extracting water from wells and galleries, as well as desalination and the production of recycled water, show the extent to which the strategies put in place by the various sectors are not the subject of joint action.

Environmental groups, whose views we analysed through studying the local press, denounce regulations that do not sufficiently protect aquifers – which are in fact over-exploited – and a certain permissiveness towards water communities. They also recall the role of island councils to impose sanctions.

In 2022, the Canary Islands government enacted a law on climate change and the energy transition through which it set itself the target of decarbonising the islands' economy by 2040, 10 years ahead of the timetable set by Europe. Within this framework, various aids are allocated to promote the development of renewable energy (Next Generation Fund). This takes the form of an incentive programme linked to self-consumption and storage, and an aid line specifically focused on promoting energy communities on the islands.

The project of the Palma Renewable association is part of this effort to promote an energy transition policy. The association, which started out as a citizens' initiative, is greatly supported by the Cabildo, which is working closely with it to raise awareness among the island's population of an energy model based on renewable energies, so that eventually the island of La Palma will be powered exclusively by 100% renewable energy. To do this, the association intends to rely on the energy communities it helps to create and support. In addition, this allowed the island's government to develop skills and a service on the subject.

It should be noted that, at the same time as the Parliament approved the law to reduce emissions, it was also working on the strategic tourism plan for the Canary Islands, which after the pandemic sought to increase tourist accommodation capacity. Environmental protection associations and some political groups fighting against the current model of mass tourism are advocating for a more controlled form of tourism that respects the protected environments and the quality of life of the islands' residents. To do this, the associations propose a limit on the number of visitors to the archipelago, particularly by introducing a tourist tax, or more specifically an ecotax, which would represent an economic contribution paid by tourists and donated to environmental protection activities. The political party PODEMOS also defended this suggestion to control the number of tourists in the Canary Island and the suggestion to ban non-residents from purchasing property.

Very recently (in 2023 and 2024), the Cabildo of La Palma declared the general interest of two tourism projects that target a wealthy clientèle seeking contact with nature and an “ecological” tourism offer. If the environmental assessment is favourable, both projects plan for the construction of a 1400-bed golf camp and various sports and leisure facilities on an island that is a biosphere reserve and a protected natural area. Local and regional environmental groups and resident associations have rallied against the project, arguing not only the impact on the already contested water resources and on certain protected species, but also the need for accommodation for the island's residents after the recent volcanic eruption. The tourism sector therefore seems to be taking on new importance on the island, subordinating the other sectors to its development, as some farmers fear. The Palma Renewable association makes the same observation on an economic model that has reached its limits on the island “we export bananas and import tourism” (Interview, La Palma Renewable, 10/07/2021).

Planned and existing policy instruments create overlapping and conflicting incentives, which is restrictive

Responsibilities and resources

The creation of Island Water Councils in the 1980s represented a transcendental change in the management of this resource, in particular in a situation of transition from a clearly private regime, such as that which prevailed in the Canary Islands for many decades, to a public domain regime, as set down by the law in force. The legal intention is to fundamentally increase the capacity for intervention and public control over all forms of water management, in particular through two instruments: hydrological planning and the decentralisation of management through the allocation of powers based on the Island Water Councils.

From a point of view of resources, players emphasise a lack of up-to-date data and a water balance to be able to make choices. For water players (Island Water Councils, farmers, environmental groups), it is necessary to learn more about the aquifer refill system, particularly in terms of useful refill and natural discharges.

There are forms of competition between the different responsibilities: in particular between the territorial planning sector and the energy sector, or the tourism sector, or between the latter and the environmental protection sector. One of the administrative sectors that reports having the most difficulty in coordinating with the other administration departments is territorial planning.

For both the energy and agricultural sectors, European funds provide solid economic support.

The responsibilities assigned do not seem to facilitate forms of cooperation between the different sectors of the Water-Energy-Food Nexus, despite the resources allocated, which is restrictive.

Conclusion

Interactions between stakeholders in the water, agriculture and energy sectors are not always cooperative, robust or based on trust. Different levels of government work together, but their interdependencies are not always taken into account. Perceptions of the problems vary and there is no common basis for agreement. Different policies on land use planning, water management, energy, agricultural development or tourism create conflicting requirements. The system also lacks a medium- and long-term vision for water and land resources in the context of climate change, which does not seem to be a major concern for the actors interviewed. In addition, the responsibilities that must contribute to policy implementation are sometimes contested (particularly in the water sector), and there is a lack of human resources at certain levels of government.

Thus, the elements of the governance system weaken each other, which is restrictive.

- **Flexibility**

Actors and networks

The administrative system is, according to some people interviewed, highly bureaucratic, very slow and therefore not very flexible.

The water communities consider their way of working to be more flexible and faster than that of the public water administration when it comes to intervening on the network *“Often the public administration does not have the resources or the agility that we communities can have when it comes to solving things. For example, if you want to repair something or hire something, the administration*

has to put it out to tender... The water communities ask for four estimations and in two weeks the problem is solved. It can also be very expensive to go through the public sector because the public costs are much higher” (Interview, Water Communities 10/07/2023).

Although the private ownership of water and the resulting market has produced a system capable of producing water and moving it where needed, in some contexts the players behind these transactions represent a closed group (El Hierro). In other contexts, where the rights are more fragmented (La Palma), the system has enabled new shareholders via the sale of shares.

However, on the islands of El Hierro and La Palma, new water management players have emerged in relation with seawater desalination. In both cases, the inclusion is related to crisis situations: eruption on La Palma in 2021 and water emergency declared in El Hierro in 2022.

In the energy sector, the semi-public company Gomera del Viento and the citizen association La Palma Renovable have developed innovative approaches in the renewable energy production field.

The system seems to allow for the inclusion of new actors, but it also has a certain rigidity that is neither supportive nor restrictive.

Levels and scales

The governance system is characterised by a decentralisation of decision-making and power. The Cabildos exercise a range of powers that make them very important public administrations in the administrative life of the Canary Islands. The allocation and transfer of power to these entities is considered to be one of the most emblematic manifestations of the decentralisation process that began in Spain in the 1980s.

In terms of water management, as stated earlier, almost all ordinary management and planning activities are the responsibility of the Island Water Councils. However, the law states that powers can be transferred from the Island Councils to the Canary Islands government, therefore upwards, if the lower body, the Island Council, is unable to exercise its functions. This may derive from an agreement between the two levels of government, or in cases of poor administration and non-compliance with obligations and where the autonomous government decides on a temporary subrogation of all or part of the powers of the Island Councils.

Depending on the issue (particularly in agriculture), the system makes it possible to change levels of responsibility (cf. the problem of parasites for tropical pineapples/pineapples in El Hierro) and mobilise higher levels, particularly in a sector that is heavily subsidised by the national government and the European Community.

The status of outermost region characterised by insularity, remoteness, vulnerability to climate change and economic dependence on a small number of sectors, is compensated by specific funding mechanisms at European Union level.

The governance system allows engaging different levels and scales, which is supportive.

Problem perspectives and goal ambitions

The players interviewed share the perception of the problems encountered by the different sectors of the archipelago, although the solutions to deal with them differ. Thus, there is little scope for reassessing objectives across sectors.

The natural disasters and exceptional events that the Canary Islands have suffered in recent years (eruptions, fires) and the intrinsic vulnerability due to their location, puts the territory and their population, as well as public administrations, in a situation of uncertainty, but at the same time of acceptance for emerging options. For example, after the eruption of the volcano Cumbre Vieja in 2021, a desalination plant was installed and allowed producers to save many banana crops from the effects of the natural disaster. This introduced the debate on desalination on an island that, until this point, had never used this kind of resource.

Objectives can be reassessed, but not always for shared projects and issues, which is neither restrictive nor supportive.

Strategies and instruments

The “island interest project” is a planning instrument in the Canary Islands that orders and designs, for immediate implementation, structuring installations and facilities or industrial, energy, tourism, cultural, sporting, health or similar activities of a strategic nature, in response to pressing needs or urgent action.

The projects authorised through this instrument must be of island interest and serve a strategic interest, which must be accredited during the procedure. They may be put forward by public or private initiatives, with the exception of those that affect rural land within the context of environmental and agricultural protection, which can only be public initiatives. This instrument can therefore be used to access procedures that depart from ordinary rule. The Cabildo of El Hierro used this instrument to declare two eco-resort tourism projects as “island interest projects”, which the territorial planning in force did not allow. The system’s flexibility therefore lies in the departure from ordinary rule.

In the same way, the Autonomous Community government enacted the green islands law,⁵⁰ which defines territorial planning of tourist activity on the islands of El Hierro, La Gomera and La Palma while respecting “natural, agricultural and landscape” values. The law allows the island governments of these three islands to build tourist accommodation on land classified as “rural land” (under the rural land protection law), scattered across rural land traditionally used for farming and livestock.

In addition, the numerous nature protection tools rolled out in the archipelago must not be forgotten.

In terms of energy policy, the Canary Island government developed the energy storage strategy “Estrategia de almacenamiento energético de Canarias”, the aim of which is to move towards using energy storing systems at user level as a means of achieving higher demand coverage through self-consumption. The electricity systems on the Canary Islands are characterised by the existence of six fully independent sub-systems that are not interconnected with the continental electricity systems. As presented earlier (see Coherence/Strategies and Instruments), this hinders the widespread integration of renewable energy sources, namely wind power and photovoltaic power, which are variable by nature. In this context, energy storage is an important element to provide greater flexibility to the electricity system and separate electricity production from demand in certain time slots. However, for those interviewed, it is as if the electricity market operator is holding back the integration of new energies into the system. This presents barriers to entry, in their opinion.

The institutional set-up allows for the combination and use of different instruments and allows actors to make pragmatic choices, even if these instruments allow for the implementation of

⁵⁰ Law 6/2002 on the territorial planning of tourist activity on the islands of El Hierro, La Gomera and La Palma, recently reformed in 2019 (Law 14/2019).

projects defined as "in the general interest", which do not enjoy unanimous support. This context is restrictive.

Responsibilities and resources

The use of extraordinary instruments such as the "island interest project", which allows a disregard for ordinary procedures and responsibilities (for example the development of generally controversial tourism projects) may be a threat for inclusion, transparency and, consequently, accountability.

During the crisis situations experienced by both islands following the volcanic eruption, fires and droughts, the governance systems activated safety nets that have enabled the economic sectors, particularly agriculture, to partially bounce back.

Finally, the municipalities and island authorities, on the basis of local priorities, can escalate projects to the Autonomous Community to receive European funding.

Although there is no particular problem with the way responsibilities and resources are allocated, the use of extraordinary procedures can undermine trust and threatened transparency between stakeholders, which is neither supportive nor restrictive.

Conclusion

The governance system allows for multiple ways of achieving objectives, depending on the opportunities and threats presented by the context. Although it is sometimes possible to reassess objectives, this is often to the detriment of cross-functional management. From an energy perspective, it does not yet seem possible to guarantee the transition to green energy. The water market facilitates the reallocation of resources between different users and provides an element of support for farmers who have difficulty accessing the resource, by guaranteeing them a flexible allocation of the resource. Nevertheless, the market places those with greater economic and social capital in a dominant position. In the context of tensions over land and water, this situation encourages overexploitation of water resources, which makes it neither supportive nor restrictive.

● Intensity of action

Actors and networks

Although some sectors want to implement more cross-sector management, for example the administration in charge of territorial planning in Tenerife, the La Palma Renewable association and the agro-ecological farm in La Palma, the company La Gomera del Viento in El Hierro, or the pilot projects promoted by the Cabildo of Tenerife, in practice, in most cases, the different stakeholders find it difficult to implement a more sector-based approach to resource management.

The environmental protection associations are against an economic development model that has reached its limits, questioning a tourism model that they describe as "damaging" and denouncing the inability of the public authorities to opt for a more sustainable tourism model, or even the unwillingness to try to remedy the situation. They are also campaigning for more ecological farming while recognising agriculture as a traditional activity of the islands which characterises rural landscapes. They are also encouraging a diversified, non-polluting energy model that uses the renewable energy sources available in the Canary Islands.

In the vast majority of cases, the adoption of water-saving practices by farmers is linked more to the desire to make savings on the energy-related costs of their activity: the water communities of La Palma for extraction, the La Frontera cooperative in El Hierro – which buys and distributes products and provides technical advice to farmers – for production processes.

Private players in the tourism sector are applying pressure above all to maintain the income that is currently generated by approximately 15 million tourists per year, of whom 5 million visit the western islands only, including El Hierro and La Palma. Although these two islands are characterised by rural, discovery-based tourism, with activities in nature, such as hiking and scuba diving, which is more sustainable than the purely seaside tourism that characterises islands such as Tenerife or Gran Canaria, the people interviewed have expectations of major tourism development on the island and the associated facilities and services. However, players in the tourism sector put forward ideas and are highly involved in “ecological transition” projects (mobility pilot project), renewable solar energy projects (by installing solar panels) and “circular economy” projects (recycling of organic waste from hotels and reuse of compost in hotel green spaces).

Finally, territorial planning players, who due to their field would be in the best position to apply a cross-sectoral vision, observe with bitterness that there is a generalised perception among citizens, but also elected representatives and public sector employees who do not belong to this sector of public administration, that planning is an obstacle, a tool *“without any purpose, which is there to annoy, to neutralise projects”* (Interview, Tenerife Territorial Planning Department, 14/07/2023). The sector is also affected by a great deal of bureaucracy in procedures, which paralyses public action and completely diminishes planning as an instrument of regulation. Some projects are carried out, however, despite the negative opinion of the planning services. The use of the declaration of “general interest” makes it possible to overrule negative opinions or even to carry out impact studies.

There is very limited pressure for behaviour change or management reform from any actor or coalition across the water-energy-food nexus, which is restrictive.

Levels and scales

The scale of the basin, and therefore the island scale for the Canary Islands, is the administrative level for water management and planning. Given that the hydrographic basin coincides with the island's boundaries, it is the autonomous community that exercises power over the public water domain. However, the latter transferred its powers to the Island Councils and the Island Councils transferred their powers to the Island Water Councils. Supra-regional exchanges are therefore limited. The history of water management in the Canary Islands and of the special private water regime has led to water systems with strong local roots, which have given rise to island configurations of power. For now, in this context, changes in behaviour regarding water use do not seem to be encouraged at this scale.

For the agricultural sector, the regional, national and European levels intervene locally in different forms, but not all levels and scales bring about change.

On the national level, the energy sector is part of the Ministry for the Energy Transition and Demographic Challenges, which is organised into three secretariats: environment, energy and demographic challenges. On the scale of the archipelago, the national electricity company is present and has supported innovative local products, such as the Gomera del Viento project. The experience of La Palma Renovable is another example of bottom-up change, via the constitution of energy communities.

There is pressure from certain levels and/or scales for behavioural change or management reform to a limited extent, which is neither supportive nor restrictive.

Problem perspectives and goal ambitions

It is clear that the promotion of a governance system that is more focused on water-energy-food-ecosystem links depends largely on a few players, such as environmental protection associations, scientists and a few institutions, but it is not yet an established perspective or ambition. The housing crisis resulting from the development of holiday rentals, the pressure on protected environments due to the high number of visitors, the pressure on land to build new hotels are the arguments around which debates are organised and expressed.

The perception of problems and the ambitions of objectives in the fields of water, energy and food are very little oriented towards a cross-sectoral vision, which is restrictive.

Strategies and instruments

At national, regional and local level, strategies and instruments exist for a more Nexus-oriented management, but in practice they are not applied.

The Canary Islands government has set up and rolled out Oficinas Verdes, or Green Offices – a network of counters to raise awareness and support the green transition and the fight against climate change. This network stems from the Regional Ministry for the Ecological and Energy Transition, the main objective of which is to develop, collect and disseminate useful information and services for companies and citizens who undertake projects linked to the ecological transition. The aim is to move towards a sustainable system based on the circular economy, efficiency and renewable energies. These are information points on grants and subsidies available from the European Regional Development Fund (ERDF), the LIFE and Interreg programmes or other subsidies for "green" projects.

The predominance of economic thinking in the management of the energy and agricultural sectors does not yet sufficiently encourage changes in behaviour and management reforms.

The relevant policies and instruments provide only a very limited incentive to reform current behaviour or management, which is restrictive.

Responsibilities and resources

There are a few examples of responsibilities assigned (Cabildos territorial planning unit, the public-private company SODEPAL in La Palma or La Gorona del Viento in El Hierro) and resources allocated (EU funds, Outermost Region - OR subsidy) that encourage a more cross-sectoral approach. However, if we examine the actual impact, particularly in relation to the large number of responsibilities and compartmentalised resources, the intensity of action remains low.

The responsibilities and resources of the various sectors allow limited cross-sectoral action, which is neither favourable nor restrictive.

Conclusion

Tourism stakeholders and networks, the actors with the most economic and social capital, show a willingness to include their activities in sustainable initiatives aimed at changing the image of the sector. Environmental associations and some sectors of the public administration have a cross-sectoral vision, but their actions are difficult to implement. Although the system has developed a number of tools and strategies and has the resources to do so, it is difficult to change the status quo. Which is restrictive

3.3 Concluding evaluations

The system of governance of the WEFE nexus in Canary Islands (El Hierro and La Palma) is neither supportive nor restrictive.

The analysis has revealed a system of governance in the Canary Islands that is paradoxical in a number of points.

The Canary Islands are characterized by their insularity and remoteness from the rest of Spain, but the possibility of access to the European Union market places them in close proximity to the Spanish mainland. In addition, in order to overcome the constraints arising from their geographical remoteness, these regions are also recognized as the ultra-peripheral regions of the European Union.

Considered a reservoir of biodiversity due to the diversity and uniqueness of their natural environments, most of the islands have active volcanoes, which expose them to recurrent terrestrial and submarine eruptions, collapsing volcanic slopes and earthquakes, making them highly vulnerable ecosystems.

Several protection regimes - national parks, biosphere reserves, terrestrial and marine nature reserves, rural parks - have been established to safeguard environmental diversity, but these appear to be under increasing threat. These threats are linked to the effects of global warming - a decrease in average annual precipitation and an increase in average annual temperatures, which studies suggest will have the greatest impact on high-altitude species - as well as human settlement, infrastructure development, overexploitation of natural resources and pollution.

The tourism industry is the mainstay of the archipelago's economy, characterized by a mass tourism model organized mainly by international tour operators, with socio-environmental impacts that are not fully calculated. In fact, there is no official estimate of tourism water consumption on an annual and homogeneous basis, and tourism waste is hidden behind residential waste flows, as the two types of waste are managed together. This means an increase in demand for resources, infrastructure and public services, as well as an increase in overall energy consumption. In particular, the development of holiday rentals such as *Air B&B* has a significant impact on the housing market. While public opinion polls carried out by the Canary Islands Tourism Observatory show that more than 80% of the local population are in favour of continuing to promote tourism, the media report a kind of "tourism phobia" linked to the difficulties of the local population in living in an economy based on the needs of tourists. On the islands of La Palma and El Hierro, mass beach tourism is less pronounced, but the fieldwork revealed pressure from certain categories of local stakeholders (elected representatives and tourism entrepreneurs) to increase the conditions of the tourist offer on the island (number of beds and intensification of maritime transport).

Agriculture remains an important basis for local development, with banana plantations being the main economic driver for the island of La Palma (as well as Tenerife and Gran Canaria). In general, bananas, grown mainly on the coast, are a hegemonic export crop that survives thanks to national and European subsidies. This product is complemented by a small number of other fruits, such as pineapples, the most important product of the island of El Hierro. As a consequence, the Canary Islands are highly dependent (more than 90%) on imports of basic food for the daily needs of the archipelago's population.

The archipelago's dependence on all trade flows, both sea and air, is widespread, and this type of transport is dependent on fossil fuels. Fossil fuels are also the main source of energy, since the Canary Islands are not connected to the mainland grid. This means that they have a high level of greenhouse gas emissions (transport and thermal power plants are the two sectors that generate the most emissions in the Islands). At the same time, the Canary Islands are at the forefront of renewable energy innovation: the island of El Hierro, with its La Gomera del Viento hydro-wind power plant, is an

internationally renowned example. The autonomous government of the Canary Islands has set ambitious targets for renewable energy (37% of final energy consumption by 2030 thanks to green technologies) and highly innovative experiments in public partnerships and civil society (La Palma Renovable platform).

Water appears to be a hotly contested resource between intensive economic activities - tourism and agriculture - against a backdrop of highly variable availability from one island to another, with overexploited aquifers dependent on rainfall in a climate change scenario. According to experts, rainfall will decrease as temperatures rise and winds become more variable.

In addition, part of the water resource, particularly groundwater, is subject to a private water ownership regime in which water rights can be leased or sold, giving rise to a very active market that is not immune to speculative activity.

Historically, water management has created a socio-technical system that is specific to the physical and institutional characteristics of this island territory: little or no surface water and limited public intervention, leaving water management in the hands of private owners. In the absence of public infrastructure, the private system of access to water (in particular by digging galleries and wells) and its distribution networks has been and still is used to meet drinking water needs. The water network is therefore the result of a combination of private and public (more recent) infrastructures and different sources. Against this background, the distribution networks - both for drinking and agricultural use - have very high leakage rates (40-50%), a problem that is far from being solved. Considering that drinking water is also produced through energy-intensive desalination plants, this makes water resources very expensive.

In this context, field research highlights a tension for communities with private water rights between the free market allocation of the resource (water as a business) and the water needs of agricultural production (water as an input in the production cycle). If the ownership of water shares allows water to be sold as a source of investment and profit, it is also necessary for the water community to be able to control the availability of the resource for agricultural needs, since a significant proportion of the owners are involved in agriculture production. What remains to be seen is to what extent water communities, as a system of social cooperation - and not just a community of commercial interests - will be able to resist the new pressures on the resource.

In light of this:

- The governance system lacks a cross-sectoral and nexus-oriented vision, as well as a medium- and long-term vision for the management of resources, especially land and water.
- Interactions between stakeholders in the water, agriculture and energy sectors are not always cooperative, robust or based on trust.
- From a public policy perspective, there is a variety of strategies and instruments to support the natural and marine environment and biodiversity, as well as instruments to ensure the sustainability of export agriculture, the adaptation of the island to climate change and the energy transition at local and regional level, but because they are defined without taking into account the interdependencies between the WEFE sectors, the objectives are often contradictory or create conflicting requirements.
- The conditions of access to the network of the national public company present on the island through the license (for the supply of energy) are subject to technical issues that make the implementation of local renewable energy systems, especially solar, rather complicated. This discourages actors who want to stick to this type of energy choice.

- The water market facilitates the reallocation of resources between different users by guaranteeing them a flexible allocation of the resource. Nevertheless, the market places those with greater economic and social capital in a dominant position. In the context of tensions over land and water, this situation encourages overexploitation of water resources.
- The current transitional regional legal regime for water seems to encourage water communities to withdraw from the maintenance of water supply networks.
- Environmental awareness of water is very uneven between the different categories of actors and within each category itself.
- Environmental associations and certain sectors of the public administration (territorial and environmental planning) have a cross-sectoral vision, but the implementation of their actions comes up against the rigidity of sectoral visions and interests. They have little influence or power.

Table 11: Matrix of the overall scoring in the Canary Island Case study

	Quality of the governance regime : criteria			
Governance dimensions	Extent	Coherence	Flexibility	Intensity
Actors and networks				
Levels and scales				
Problem perspectives and goal ambitions				
Strategy and instruments				
Responsibilities and resources				
Overall assessment	Neutral	Restrictive	Neutral	Restrictive
Concluding evaluation	The governance system is neither supportive nor restrictive			

3.4 Identification of barriers and levers at the case study level

The main barriers and levers identified at the Main River case study level are as following:

Barriers

- At institutional level, lack of coordination between the various departments and institutions
- Bureaucratic administration management that slows down any initiative or project (felt by all stakeholders)

- Perceptions of the availability of water resources that remain rooted in a purely sectoral and localized vision
- A general low level of awareness of the problems associated with water and its availability in society as a whole
- Lack of up-to-date hydrological data enabling reliable hydraulic balances to be drawn up for decision-making purposes (for policy makers and farmers alike)
- Lack of energy expertise in cabildos and municipalities (La Palma) and human resources (La Palma and El Hierro)
- Traditional forms of control over access to water, which have led and continue to lead to a concentration of rights over the resource
- Lack of generational change among farmers

Levers

- The governance system has developed a multitude of strategies and tools to support and protect biodiversity and the natural environment, as well as tools to adapt and mitigate the island to climate change at local and regional levels.
- At the level of the Autonomous Community, there is a planning strategy that brings together spatial planning and the protection of natural areas in a single document (*Plan insular de ordenamiento de Tenerife*), promoting a cross-sectoral vision. This framework could serve as a basis and example for the effective implementation of governance based on the consideration of interdependencies between the different sectors of water, energy, agriculture and environmental protection.
- 46% of the island's territory is protected (7 biosphere reserves, 4 national parks, 1 RAMSAR site, 174 NATURA 2000 sites).
- Public research institutions (University of La Laguna) and agricultural development institutions (ICIA - Instituto Canario de Investigaciones Agrarias) have a recognized level of expertise that can be used to produce data that can be used to make an up-to-date and shared appraisal of the water situation.
- A tradition of innovation in the field of energy technology, which has produced original solutions that can be replicated in other island contexts.
- An active environmental movement, well represented in the public media and in public space

4.0 Sardinia case study

In their workshops, the stakeholders of the living lab of the case study 9 of Arsinoe have decided to tackle the following problem statement to create more resilience: *“How to enhance and stabilize sustainable and resilient food production under conditions of climate change and limited production inputs, such as land, water, energy?”* (For more detailed information, see Deliverable 6.5, La Jeunesse et al., 2023).

Accordingly, the study of governance was focusing on crop production and in particular onto the emblematic Sardinian durum wheat production and its local chains. The interview guide has been adapted to this topic (See Annex).

4.1 Context and case study description

Durum wheat in Italy and Sardinia

Italy has over 12.6 million hectares of Utilised Agricultural Area (UAA), of which around 1,700,000 hectares are currently used for growing wheat. After Canada, Italy is the second largest producer of durum wheat. In order, the durum wheat-producing regions in Italy for 2021-22 (ISTAT, 2023 ; Table 12 ; Table 13):

Table 12: Production of wheat in Italy by regions

Region	UAA (ha)
Puglia	360,000
Sicily	264,000
Emilia-Romagna	193,000
Basilicata	122,000
Marche	114,000
Tuscany	83,000
Piedmont	62,000
Lombardy	60,000
Sardinia	30,000

In Sardinia, an autonomous Region of Italy and also an island (Figure 41), for these same years, 21,156 hectares were given over to durum wheat, broken down by province as follows:

Table 13: Production of wheat in Italy by provinces

Province	UAA (ha)
Sassari	1,652
Nuoro	157
Cagliari	177
Oristano	2,654
South Sardinia	15,265

The organic sector is inherently sustainable. It brings together organic producers in the form of POs (Producer Organisations) within the COPAGRI union.

As for soft wheat, only 1,000 hectares were cultivated between the province of Oristano (Figure 42) and the south of Sardinia in 2021-22 (ISTAT, 2023). And, in 20 years, the all region has considerably reduced the area used for growing wheat by 20%: in 2004, it accounted for 97,000 ha.

Durum wheat is used in Italy to make semolina for pasta. Pasta is an extremely important product, both for domestic consumption (consumption per capital in Italy: 28 kg per year) and for exports, which absorbs around 50% of production. Requirements are estimated at approximately 1,700,000 quintals. In 2021-22, this volume was 529,000, i.e. a deficit of 1,100,000. National production of corn and wheat decreased due to producers' low pay, which led to a drastic reduction in the land allocated to these crops. The past two years seem to have shown signs of recovery.



Figure 41: Localisation of the case study⁵¹

The supply chain is made up of various participants and steps.

The five steps are:

- step 1: seed variety selection and production
- step 2: cultivation with selected seeds (certified or not, even if the supply chain offers quality selected seeds)
- step 3: storage/sale of cereals
- step 4: grinding in mills
- step 5: processing (bread and pasta)

The stakeholders in the supply chain are:

- seed and multiplication companies
- agricultural production companies
- cooperative and private storage companies
- semolina mills
- pasta/bread factories.

⁵¹ https://www.researchgate.net/figure/Location-map-of-the-Island-of-Sardinia-Italy_fig1_281774167

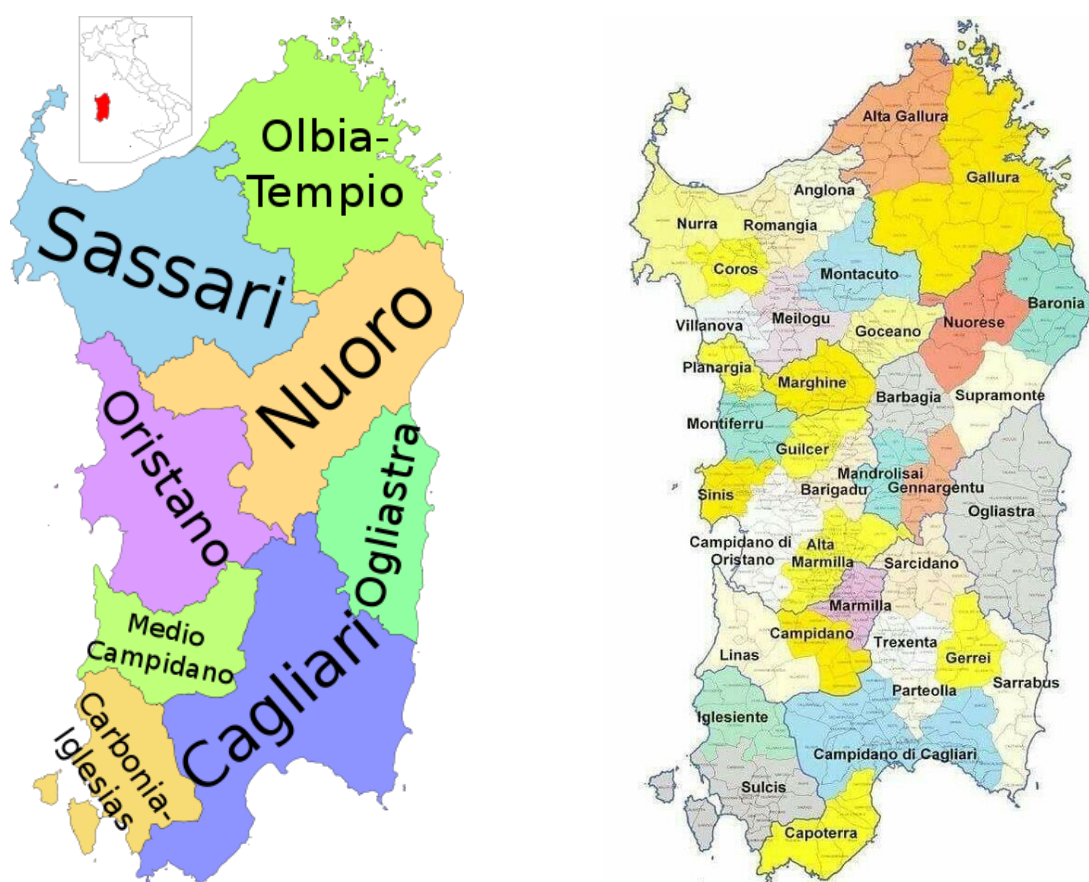


Figure 42: Main administrative limits of the autonomous region of Sardinia⁵² (Provinces on the left)⁵³

Upstream of the supply chain are companies that supply the inputs for agricultural production, namely seed companies and suppliers of technical resources (fertilisers, fuel, pesticides). Seeds are mostly of national origin: the seed growers produce and market seeds, which are then reproduced by specialised agricultural companies (seed multiplication companies). The linchpin of the chain is the farm, which produces the raw materials to be processed. In general, the farmer sells their crop to private traders (seed storage companies). In Sardinia there are a few cooperatives that may own mills. Some traders may have their own storage facilities or act as intermediaries between the farmer and the industry. The storage company is therefore a key and powerful stakeholder in the supply chain. They may have a mill and processing capacity at the same time, or market the product to the pasta and bread processing industry at a later date.

Upstream of the wheat production process, regional agencies such as LAORE (agency for the implementation of regional agricultural and rural development programmes) and AGRIS in Sardinia are dedicated to technical support and research. In this field, AGRIS is involved, in particular, in improving varieties to adapt them to climate change. The balance between supply and demand shows that the milling and pasta industry depends on imports. Annual demand in Italy is just over 5 million tonnes, of which over 2 million tonnes (35%) have to be imported from abroad, mainly from countries in the dollar zone - Canada and USA - but also from Turkey and Greece.

The level of quality, in technical terms, which is above all expressed in the percentage of proteins, is particularly high in the varieties from these countries. But over time, there have also been quality

⁵² <https://www.pinterest.fr/pin/41095415343262101/>

⁵³ https://fr.m.wikipedia.org/wiki/Fichier:Map_of_region_of_Sardinia,_Italy,_with_provinces-it.svg

problems linked to the use of crop protection products. In addition, production quantity has also decreased in recent years due to the CAP reform, although, over the past two campaigns, surface areas have shown signs of recovery.

The national strategic plan in connection with the CAP (NSP-CAP) and in particular the cereals sector (chap. 3.5.11 with the exception of rice) points out that durum wheat production in the South and in the hillside areas of Central Sardinia represents around 44% of the total cereal area and is strategic for supplying the national pasta industry (Ministero dell'Agricoltura, 2023). The primary and secondary processing industries in the durum wheat sector generate income of around 7% of the total agri-food sector. In addition to its importance in domestic consumption, the role of pasta exports is significant in terms of positive contribution to the agri-food trade balance.

The adaptation of water management to drought in Sardinia

After nearly two decades of drought episodes (Piras et al., 2016 ; Bird et al., 2016) with serious consequences on the supply of drinking, agricultural and industrial water, in 2006 the Region of Sardinia introduced a centralised water management system for the region (Cirelli and La Jeunesse, 2020). The regional multi-sector water system – SIMR⁵⁴ is made up of all the water supply and distribution structures designed to supply, directly or indirectly, a number of areas. By creating this, the regional authorities wanted to bring water management under regional administration in order to harmonise water quantities distributed to the various sectors (drinking, irrigation, industrial) and consumption prices, which are now the same for each sector throughout the region. The regional basin authority, which is in charge of the water policy (coordination, data production, planning, programming and implementation) is made up of the Institutional Committee - which is the political body - and the Regional Hydrographic Agency (ADIS) - the technical body in charge of planning. The entire region has been defined as a single hydrographic basin which falls under the jurisdiction of the region and constitutes the hydrographic district of Sardinia. Water is no longer directly governed by the traditional regional organisations, such as the Land Reclamation Consortia⁵⁵ (Figure 43), but by the Region via a single regional supply agency, ENAS. This organisation, under the control of the Region and the Basin Authority, guarantees the management and control of resources and ordinary and extraordinary maintenance of infrastructures and sells water in bulk to macro-users: industrial consortia; the company Abbanoa, single operator of the "in house providing" drinking water service on a regional scale; and finally, for the agricultural sector, the Land Reclamation Consortia, which then distribute water throughout the territory of the consortia to member producers. The structures and infrastructure of the SIMR have become regional assets *ex lege* and the Region has become the sole owner of all public water concessions.

Thus, water governance in Sardinia is based on the regional multi-sector water system - SIMR, established by regional law 19/2006.

⁵⁴ SIMR = Sistema Idrico Multisetoriale Regionale, created by regional law 19, in 2006.

⁵⁵ Land Reclamation Consortia (in Italian Consorzi di Bonifica) are bodies governed by public law in charge of operating and maintaining drainage equipment to guarantee water security for the region, as well as the supply, regulation and quantitative and qualitative protection of water for irrigation, agricultural production, livestock and forestry. There are seven Land Reclamation Consortia in Sardinia: Nurra, Gallura, North Sardinia, Central Sardinia, South Sardinia, Oristano.

The Region retains ownership of all public water concessions or derived titles, whatever their name, which use infrastructure that is part of the regional multi-sector water system. The system consists of structures in the various sectors: civil for drinking, irrigation, industry and the environment, and infrastructures for collecting, regulating and transporting raw water for multi-sector uses (Mereu et al., 2016):

- dams;
- crossings;
- aqueducts;
- canals;
- lifting stations;
- hydroelectric power stations.



Figure 43: Roles of the water allocation of the Consorzi di Bonifica

Hydroelectricity production is part of the regional institutional framework as an instrumental mode of operation (to supply all water pumped from one system to another) and subject to cost reductions for other uses of drinking, agricultural and industrial water. ENAS pays energy to all the irrigation consortia to compensate for the loss of the dams. Hydroelectricity production is mainly controlled by ENAS, although some dams used for hydroelectric production are controlled by ENEL, but as the concessions expire in 2028, the region plans to recover them.

The regional water governance system, and in particular allocation of the resource to the different categories of use, has been designed as a top-down non-negotiated process, in response to the high level of fragmentation at local level of the system of institutional stakeholders in the water sector and the prior low level of efficiency in their management.

4.2 Results of the nexus governance assessment

The field visit took place in Sardinia between 28 March and 6 April 2023.

Two members of the Governance Assessment Team (University of Tours, France), with one member of AGRIS as case study leader, conducted a total of 15 interviews with different stakeholders (public administrations, local authorities, businesses or civil society organisations), involving a total of 18 people (3 women and 15 men).

Table 14: Overview stakeholders involved in GAT interviews in the case study

CS#9 SARDINIA Governance analysis Field visit	Number of stakeholders interviewed	Number of Men	Number of Women	Men (%)	Women (%)
28/03 - 06/04 2023	19	16	3	84%	16%

The next paragraphs of this section are describing the assessment of each cell of the governance assessment tool matrix as described in the first point of the methodological section (Part A).

● Extent

Actors and networks

As for the system of stakeholders in the durum wheat sector, the sector is highly structured, with the presence of the main stakeholders in the various steps that characterise it. Development and research, first, with Agris, which is a key stakeholder in the sector through its scientific work on the selection of seeds genetically adapted to the situation of Sardinia and to the production of quality products. Then, seed companies, pasta and bread producers, the companies that buy and store cereals, and the mills in which they are ground before being processed. In addition to these stakeholders in the economic chain, there are public institutions that carry out research on wheat varieties and the conditions for their adaptation to climate change, as well as those that provide technical support to farmers. According to some of the people interviewed, consumers should also be present in the sector, in particular with the role of pressure groups to demand a quality product. The regional consumer association that we met has not yet moved into the field of food due to a lack of human resources.

The durum wheat governance system involves all relevant stakeholders, which is supportive.

Levels and scales

Due to the demand for irrigation of certain equipped areas, including durum wheat, the scale of water management comes into play in durum wheat governance. However, although characterised by a water management system that is highly centralised in the hands of the Region, the Basin Authority (which coincides with the Region in Sardinia) works in cooperation with the local authorities and the other public bodies that operate in the watershed. Thus, the Land Reclamation Consortia, which intervene locally both in the agricultural sector and in securing the land within their boundaries, represent an intermediate level of intervention between the region and the municipalities. Civil Protection calls on their collaboration if necessary because they have in-depth knowledge of the area and a vision that goes beyond the municipal level. Water sharing therefore includes the agricultural component, including for durum wheat requirements.

In connection with agricultural activities, the bio-districts (bio-distretti)⁵⁶ form another intermediate level, between the municipalities and the region, for the development of quality agri-food activities related to sustainable land management. They are regional bodies in charge of planning, developing, and in the case of durum wheat governance, strengthening the organic farming sector. Their creation and implementation are supported by the region's technical bodies.

The wheat sector operates at different levels and scales: from supra-national stakeholders, in particular the EU (via the CAP and the Green Deal) to local stakeholders (producers), including national stakeholders (ministries of agriculture and the environment), regional stakeholders (public research bodies, regional agencies, industrial stakeholders) and sub-regional stakeholders (owners of mill and irrigation consortia).

The durum wheat governance system involves all relevant levels and scales, which is supportive.

Problem perspectives and goal ambitions

Paradoxically, in a regional context of increasing drought (Figure 44), the sector's perceived problems are mainly linked to economic factors: price fluctuations (until the war in Ukraine, there had been a downwards trend for over eight years), market instability, and the unequal weight of the various stakeholders in the sector. Producers consider themselves to be in a weak bargaining position with regard to the sector's downstream, i.e. cereal storage companies, flour mills and processors, manufacturers and sellers of wheat by-products (pasta, cakes, semolina). This is particularly true in a regional context where there is just one processing industry and a limited number of mills.



Figure 44: Irrigated wheat plots

In 20 years, the agricultural area for durum wheat crops in Sardinia has decreased: the region has lost 70% of land allocated to durum wheat, down from 96,710 hectares in 2004 to just 29,894 in 2023. This collapse is accompanied by the loss of over 50% of cereal farmers, from over 12,000 in 2000 to less than 600 today (ISTAT 2023).

Due to high temperatures, harvests dropped after the very dry summer of 2022. Against this backdrop, the gap between industrial supply and demand is widening, leading to supply difficulties for the milling and pasta industries, worsened by recent market disruption resulting from exogenous factors such as

⁵⁶ Created by a regional law in 2014.

the global durum wheat supply trend, increasingly influenced by climate change and the war in Ukraine.

Another problem affecting the sector, mentioned by the people interviewed, is the fragmentation and lack of organisation of producers. According to a stakeholder from the organic sector, the oldest cooperative on the island (Satra Sardinia), this sector is also affected by the difficulty producers have in grouping together when, according to him, there is a need to concentrate production on the market in order to shorten the supply chain and reduce production costs.

For the regional agricultural department, there is also a problem related to the lack of awareness (sometimes among producers themselves) of the sector's potential, particularly in connection with local and high-quality production. Some stakeholders in the sector are aware of the favourable context for the development of typical local products (*pane carasau*, traditional pasta made from an ancient, local, organic wheat variety, etc.) and their potential on the market. Some small producers or cooperatives have set up a closed artisanal sector - from growing the wheat to processing, production and selling the product. In general, most producers choose the type of variety and seeds based on public aid from the national and European agricultural policy.

Another problem that affects more generally the agricultural sector, brought up by the Regional Department for Agriculture, is the installation on farmland of solar and wind energy production facilities, which is leading to a decline in available farmland. In fact, farmers can rent out part of their land to energy-producing companies. To date, several solar panel plants have been created and companies have been formed with private partners. However, the economic profitability of energy production has not outweighed that of the profitability of farming for some farms, leading to these projects being abandoned. The result of these unsuccessful experiments is that the companies have moved on, leaving wastelands of non-dismantled energy plants, described by the interviewees as “*elephant graveyards*” (Interview 20/03/2023). According to the public service employee interviewed, 1,000 hectares are concerned by this and “*there should be a law to prevent this*”.

The various stakeholders in the sector interviewed share the view that, against a backdrop of global warming, wheat will depend increasingly on irrigation. However, this perception is not necessarily associated with the issue of water availability. Some stakeholders (water, agriculture, environment) consider that centralising water management under a single administration was a winning choice, as the system has proved its worth and could even be used as an example for other regions. In fact, despite extreme heat episodes and the scarcity of rainfall in the country over the past two years, the SIMR's management has enabled large volumes of water to be stored (80% of the reservoirs' capacity according to the Basin Authority) and sufficient volumes of water to be guaranteed for different uses. During the very dry summer of 2022, Sardinia did not suffer from water shortages like other regions of Italy, in particular thanks to the volume collected during autumn 2021. The regional water authorities claim that the system can guarantee enough water to cover the requirements of the various uses for up to three consecutive years of drought (La Jeunesse et al., 2016). This is only possible, however, if a water savings policy is implemented in every sector.

The lack of water was not mentioned as a major problem during interviews, nor during Living Lab workshops at the Arsinoe site in Sardinia. It would seem that, for most stakeholders (with the exception of the water authorities), the perception of water availability is based more on a short-term vision, based on the current storage capacity of the regional reservoirs, than on a longer-term vision based on climate projections.

Despite the aspects that make the system efficient for transferring water from one side of the island to the other, at the local level the sector-based supply systems still have a major leakage problem. Institutional stakeholders consider that more than 50% of the total amount of water entering the

drinking water network is lost⁵⁷, the regional distribution network is in poor condition and requires substantial investments. Water losses in the main towns are higher than the regional average, reaching nearly 63% in the municipality of Sassari (INSTAT, 2023). For agricultural irrigation, meters connected to control and remote detection systems have been installed in recent years, but in the areas of the Land Reclamation Consortia, not all measurement systems are efficient.

In this context of increased use of irrigation, the reuse of wastewater is starting to take shape and to be considered as a possible solution and alternative. Experiences are conducted on the island with the irrigation of parks and gardens in tourist and residential areas (e.g. Palau, Villasimius). The Land Reclamation Consortium of Nurra (Figure 42) reuses “untreated water” for around 10% of its irrigation needs and a project was recently funded to use wastewater from the Arzachena water treatment plant to irrigate the Land Reclamation Consortium of Gallura (Figure 42). Despite these experiences and the publication of regulations and measures to encourage the reuse of treated wastewater for agricultural, industrial or even civilian purposes,⁵⁸ wastewater does not yet seem to represent a real alternative resource for all farmers. According to the administrators of the Consortia (in particular in the south of the island), some farmers are still resisting the use of this treated water.

One of the subjects raised by the work of the Living Lab was food security, in particular the effects of climate change on durum wheat yields - in connection with soil quality and water availability - and the threat it may pose to meeting the durum wheat needs of the island and more generally the country. However, in the interviews, the subject of food security did not emerge as a concern for the stakeholders and often food security (in the sense of food sovereignty) is confused with food health safety. Only one producer of rice and rice seed (and to a lesser extent, wheat) at the head of a large regional agricultural company said to be very concerned about food security. The person interviewed considers the increasingly dominant role of multinational chemical companies to be a threat for the independence of farmers on the choice of varieties to use and to conserve⁵⁹. The concentration of the seed market in the hands of a few multinationals would also have an impact on the entire sector and is therefore perceived as a real problem for the cereal sector, but also more generally for national and international agriculture. These chemical companies now control the entire production process: from the research and development phase through to the production and distribution of seeds, to the creation of molecules for weed control (patented). This is seen all the more as a problem because, at the time of the on-site visit, the EU was preparing to deregulate new genetically modified organisms by exempting new biotechnologies from labelling, traceability and risk assessment.

Perceptions of problems differ between stakeholders, associated with different perspectives, which is restrictive.

Strategies and instruments

There are many instruments available to the durum wheat sector in Sardinia, as well as genuine strategies for developing the durum wheat short supply chain, at various levels.

The rural development programme (PSR) is the main government instrument for developing the agri-food system and rural areas in Sardinia, co-funded by the European Agricultural Fund for Rural Development (EAFRD).

⁵⁷ The national average is 42%, characterised by very marked differences between the regions (INSTAT 2023).

⁵⁸ Water protection plan (2006), Discharge discipline (2008) and Regional directive on reuse (2019)

⁵⁹ In the case of one seed grower-producer, the multinational BASF, with which he worked, put an end to their collaboration and no longer grows the seed varieties produced by the Sardinian company in question for the producers to whom it sells its crop protection products. Just to provide an idea of what is at stake, the seeds produced by this Sardinian entrepreneur are used on one third of Italy's rice-growing area.

Concerning policies specific to durum wheat, at regional level, i.e., the autonomous region of Sardinia, durum wheat is part of the wider cereals sector. However, there are actions specific to durum wheat which are funded, such as sector-wide agreements. The Sardinia Region was the first Italian region to introduce the durum wheat sector-wide agreement instrument, which aims to create short, quality supply chains. Agreements can be signed between individual or associated durum wheat producers, as well as with other stakeholders that operate in the sector in the seed production, wheat processing, by-product manufacturing and marketing phases. They can be set up between a farmer and a milling industry; between a farmer and a pasta production industry; between a farmer and a milling or pasta industry and also between a storage centre and a milling and pasta industry. They guarantee a minimum price as well as the use of certified seeds. Additionally, the land concerned by the agreement has fixed production volumes per variety of wheat. Conceived within the regional institutions (AGRIS, LAORE and the Regional Department for Agriculture and Livestock), this “sector-wide agreement” instrument was taken over and applied at national level by the Ministry of Agricultural, Food and Forestry Policies and is still the main measure supporting the durum wheat sector in Italy.

The use of certified seeds, which is the fundamental principle of the sector-wide agreement, is in itself one of the strategies encouraged by the regional authorities to pursue quality production. This guarantees seed quality (purity, germination capacity) and, thanks to the traceability to which it is subject, ensures that production is maintained within quality chains.

In the same spirit of regional support for the sector, the farmers’ union Coldiretti⁶⁰ has promoted a project “solo sardo” (only Sardinian) since 2019 that aims to promote local production and support the island's producers. It is an agreement between the Coldiretti union and the Adiconsum Sardegna consumer association, named “*Patto del made in Sardinia*”, which promotes the production and marketing of pasta made purely with products from Sardinia.

The creation of a food origin label, a project supported by Coldiretti with other trade union and citizens’ organisations in the EU, finally led to the promulgation of a regulation making it compulsory to indicate the country of origin or place of provenance of the primary ingredient of a food. This is a very effective support instrument for the short supply chain⁶¹.

Additionally, the Meteorological-Climate Department of the Regional Environmental Protection Agency has developed an irrigation support tool which, using daily data, gives the farmer an indication of the right time to irrigate depending on the crop sown. This helps farmers to target their actions and to save water.

This same Meteorological-Climate Department, which has a permanent drought monitoring activity, has developed a regional “indicator of the percentage of soil subject to drought conditions”. This indicator, which the structure also proposes to develop nationwide (see CReIAMO, 2018), is useful for characterising the available resource scenarios with regard to the demands of the various uses in the short and medium term throughout the region. The Meteorological-Climate Department also produces a drought monitoring report every month and every 10 days (three per month) which describes the month's situation using meteorological indicators.

Some farmers use precision technologies. For example, as with the “Agriculture 4.0” tool, the aim is to produce with fewer and fewer resources, particularly water and chemical inputs, while maintaining high quality standards.

The farmers interviewed are highly critical of the European Common Agricultural Policy. According to them, the new agricultural strategy “The Farm to Fork”, at the heart of the European Green Deal, is a

⁶⁰<https://www.coldiretti.it/>

⁶¹EU Regulation 775/2018 with effect from 1 April 2020.

threat to agriculture in European countries. They see it as a policy that makes the direct payment of European subsidies conditional on the application of environmental criteria, such as: obligation to set land aside, buffer zones, crop rotation, grassland, fight against soil erosion, etc., which are now essential for agricultural production. This would distort competition between producers in the European Union and those in countries outside Europe. These increasingly demanding rules for European farmers, including the time it takes to understand and manage the declaration of their activities, would become untenable while at the same time Europe authorises the import of agricultural and agri-food products obtained using breeding or cultivation methods that are prohibited for European farmers. The cereals sector would be particularly affected, especially by the import of Canadian and Ukrainian wheat, or the import of rice varieties from Asian countries.

On the other hand, farmers in the organic sector welcome the new obligations of CAP 2023-2027 in terms of environmental protection measures applied to the sector and the opportunities represented by the CAP's eco-regimes and which propose alternative paths to environmental certification.

From the point of view of water governance, the SIMR remains the tool on which resource management is based. The representatives of the Land Reclamation Consortia interviewed believe that the strategy to centralise water management through the implementation of the SIMR works. In addition, water-saving systems are installed in practically all Land Reclamation Consortia and the region of Sardinia systematically finances the installation of control systems to improve water management and reduce waste.

For the people interviewed, the effects of these measures are clear: water savings enable an extension of irrigated areas or water programming over two years. This is the case of the Land Reclamation Consortium for Oristano which, thanks to these water savings (28% saved between 2021 and 2022), has been able to plan crops over a two-year period. This strategy allows farmers to sell their harvest in advance and reduce uncertainties linked to weather conditions.

Finally, on a broader scale, the Region of Sardinia has adopted a tool - the Regional Sustainable Development Strategy - which is both an agricultural planning instrument and an institutional governance tool. The Regional Sustainable Development Strategy is intended to be integrated into the regional development programme and the regional climate change adaptation strategy. For this, the Region has delegated the development phase of the Sustainable Development Strategy to the Department of Environmental Protection. This is not only a planning document that is intended to cut across the various economic, environmental and social policies, but also and above all a new approach to designing and implementing public action at regional and local level. The final document, approved in 2021, is the result of work carried out within the administration, which involved the creation of cross-functional working groups⁶² and civil society through the organisation of a forum (Regione Autonoma Sardegna, 2021).

The durum wheat governance system has developed a diversity of tools to support local, regional and national durum wheat chains, which is supportive.

Responsibilities and resources

In the durum wheat sector, responsibilities are clearly allocated. In fact, the stakeholders from the cereals sector interviewed, both for durum wheat and rice, clearly know who to contact for technical

⁶² Two bodies have been created to ensure collaboration between the various regional administration departments: the institutional steering committee and a discussion table on which all regional services sit (tavolo interassessoriale/ inter-agency table)

assistance, funding and expertise. In addition, the distribution of responsibilities in the sector's governance was not contested during the interviews.

The interviews conducted at ARSINOE also showed that, in general, the administrations have the resources required for their activity (Department of Agriculture, Department of the Environment, Regional Hydrographic Agency, Land Reclamation and Irrigation Consortia), with the exception of the Meteorological-Climate department of the Regional Environmental Protection Agency, where the lack of staff and funds for training, upgrading or even taking part in international scientific events is a major constraint for carrying out the work and meeting the growing responsibilities of the structure.

Also, the public agencies concerned by the sector's governance seem to have a sufficient, and even advanced, level of expertise to deal with climate change-related issues, in particular with regard to the new generation of personnel recruited. AGRIS - the regional agency of Sardinia for scientific research, experimentation and technological innovation in the agricultural, agro-industrial and forestry sectors – has been conducting research for years on the development and selection of durum wheat varieties to adapt and respond to extreme climate change phenomena, which is now recognised throughout the quality chain (Figure 45, Figure 46).



Figure 45: Entrance of the experimental farm of Agris



Figure 46: Experimental plots of durum wheat at the San Michele Agris station (Cirelli, March 2023)

As for financial resources, they were not declared as limiting. Administrators complain more about bureaucratic delays and complications in accessing funding than about a lack of funds offered. In this context, European funding represents major opportunities. For example, the national recovery and resilience plan can fund a significant amount of the interconnection work for the multi-sector water system required for agricultural development.

The responsibilities assigned are clear, and almost always supported by adequate resources, which is supportive.

Conclusion

The governance system shows a degree of comprehensiveness in terms of actors, scales, perceptions of problems, existence of instruments and provision of resources for the durum wheat, which is supportive.

● Coherence

Actors and networks

Although the durum wheat sector is presented as an integrated system, the stakeholders that make up the system do not have the same economic or decision-making power. Upstream of the sector, farmers in Sardinia are highly fragmented and not very collectively organised. They thus have far less bargaining power. However, within the sector, stakeholders downstream of the production chain, i.e., those who store the wheat and then process it, have considerable power in transactions. In Sardinia, this imbalance of power within the sector is particularly marked as there is one very large industrial stakeholder that buys, stores, processes and sells durum wheat. There are other, smaller and more artisanal chains of activity that also own mills, but there are very few of these to represent a counterweight. Some stakeholders interviewed describe a form of “real monopoly” of a single industry that covers every process in the sector, from selecting the seed to putting the finished product on the shelf. Despite this, with the strength of an area where the stakeholders are in contact, the stakeholders explain that the network is more a means of mediation than conflict.

Also, synergies are set up between stakeholders within the sector with the aim of promoting improved local varieties in collaboration with local scientists, including Agris. For example, the local bread, “Coccoi”, involves around 20 artisan bakers who have joined forces to set up a committee to defend this traditional bread and obtain a protected designation of origin (PDO) (Figure 47). Similar initiatives exist for the creation of short supply chains for the production of artisanal pasta based on the use of “native” wheat varieties, grown and processed in Sardinia⁶³. The Regional Department of Agriculture regrets that these experiments are not being replicated more quickly in view of the market potential and the immense local cultural heritage that this knowledge and these artisanal skills uphold, such as the magnificent Easter bread made by families all over the island. The relationships that exist between the various operators in the chain are multiple and characterised by a dynamic that responds to a logic of commercial synergies. After the institutionalisation of the SIMR, for a long time the relationships between the Land Reclamation Consortia and the Basin authority were marked by a lack of trust following what was experienced by the consortia as a kind of “expropriation”. The representatives of the agricultural sector of the Land Reclamation Consortia met now acknowledge that, although centralised management has deprived the Consortia of a certain degree of autonomy in terms of resources and bargaining power vis-à-vis the regional administration, the fact that they no longer manage and maintain the water systems is an undeniable gain. Today, synergies and collaborations exist with most of these structures, even if discontent is periodically reported by the press. The only dissenting voices are those of the representatives of the Land Reclamation Consortia located in the northern part of the island. Their opposition to the system is explained, in particular, by the fact that

⁶³ The example of the Coopérative Isola Sarda, which is part of the project, accompanied by the Coldiretti union “solo sardo” (only Sardinian).

the SIMR is not yet fully operational in this part of the region and, in addition, by the fact that centralising water management has led to the loss of control of a highly strategic resource in an area characterised by luxury tourism, particularly in the Gallura area. There are rumours according to which some interest groups want to pass a law to restore control of the Land Reclamation Consortia over the dams that have come under regional management. However, regional public sector employees consider this to be very far from reality. Against a backdrop of global warming, in which drought and water shortages are more and more frequent, the centralisation of water management within a single body in the form of a multi-sector system is a guarantee of secure access to water for all users. Further, as mentioned by one of the public sector employees interviewed, the regional law of 2006 that established the SIMR was unanimously approved by the regional council of the time. Seventeen years after its creation, although it still receives some criticism, the people interviewed reported that the main stakeholders consider that the integrated multi-sector system works in areas where the interconnection system has been completed. In fact, thanks to interconnection work between the various dams (currently 31) in the region, the system makes it possible (particularly for the central-southern part of the island, which is the most agricultural) to move and allocate water from where it is to where and when it is needed.



Figure 47: Easter bread production by Coccoi

Interactions between stakeholders are conducive to the coordination of actions in the durum wheat sector, which is supportive.

Levels and scales

Several levels of administration are involved in managing the durum wheat sector. First at European level via the Common Agricultural Policy. But also at the Italian national level, then the regional level, particularly due to Sardinia's autonomy in this area. Stakeholders in the sector are well aware of the mutual dependencies between these levels and the constraints this may represent in their practices.

Finally, there are also levels that can be qualified as intermediate on the scale of the island of Sardinia, such as the bio-district (cf. § Extent-Levels and scales) for agriculture or the Land Reclamation Consortia for agricultural irrigation since they represent sub-parts of the island.

These levels seem to work in confidence within the sector. However, the people interviewed told us about tensions and even inconsistencies between the quality standards desired locally and competition from non-European cereals.

A certain amount of distrust persists between the water management sector and the agricultural sector, rather than within the durum wheat sector itself.

Concerning water management, some Land Reclamation Consortia continue to express local resistance to the Region and the Basin Authority, demonstrating a desire to reduce control over the sharing of local water resources solely to the intermediate level of these entities.

The different levels and scales involved in durum wheat chain management work together, acknowledging interdependences and trust each other, with the exception of the European level, which is neither restrictive nor supportive.

Problem perspectives and goal ambitions

The industrial phase for processed products is currently benefiting from wide promotion on both domestic and foreign markets. The agricultural phase is characterised by low profitability across the chain of value, with the exception of very short chains where the varieties of wheat grown and their place in the region, products “made in Sardinia”, are a guarantee of quality and a marketing argument.

In Italy, durum wheat remains characterised by a regional and national offer that is structurally fragmented in terms of quality because Italy, like Sardinia, imports durum wheat to meet production needs, in particular the more industrialised production of pasta and semolina. Further, even when raw material prices increase, farmers or consumers are not the first to benefit. The advantages will be felt more by stakeholders in the sector who have the capacity to store wheat until the moment is right to put the product on the market.

However, the perception of the challenges concerning water resources, the need for irrigation and the relationship to the sharing of resources with other sectors is subject to differing views. The main issues are related to field productivity and low rainfall (440 mm). Irrigation is becoming crucial, both for the farmer and for experimental facilities.

While the traditional organisation of water uses was highly fragmented at island level, with a specific focus on the Consortia's perimeter, the new flexible and dynamic regional vision is struggling to establish itself as the solution for dealing with the effects of global warming. Other solutions, such as building new water reservoirs to store rainwater, have been put forward by local interest groups (in particular ANBI).

At European level, the Green Deal injunction is seen as a threat to agriculture in European countries because the standards are too demanding for farmers. Behind the Green Deal lies the phenomenon of environmental dumping of agricultural products because the market allows the import of products from countries that do not and are not obliged to respect the same environmental sustainability standards in agricultural production as European producers. If we want a real Green Deal, we need to put a stake in products from countries that do not use the same farming and production methods (respect for rules, safety at work, respect for workers).

An example of the inconsistency of objectives in the face of current problems is the plan to increase the area dedicated to wheat. "Ricoltiviamo la Sardegna" (Replant Sardinia), supported by the Coldiretti union and the regional association of the Land Reclamation Consortia (ANBI Sardinia), aims to increase

the region's agricultural area from 37,000 hectares to 100,000 hectares of irrigated land to cover the new cereal needs generated by the effects of the war in Ukraine. Critics of the project argue that there is a problem of water availability to irrigate the new areas. They also consider that this strategy to increase the agricultural area is accompanied by a desire to dismantle the SIMR in order to return dam management to the consortia.

More generally, farmers and public sector employees in the regional agencies in charge of agricultural policy point to an inconsistency between the requirements of national and European environmental and health legislation and the import of less controlled non-European products. One example mentioned concerns the maximum limits of certain contaminants in food products⁶⁴.

The perspective of the problems of the durum wheat chain and the goal ambitions do in fact not systematically reinforce each other, which is neither restrictive nor supportive.

Strategies and instruments

Durum wheat sector-wide agreements provide a response to the sector's various issues: price fluctuations, payment times, funding, and maintaining quality production. Farmers can thus access a guaranteed minimum price and shorter payment times while guaranteeing quality production thanks to the use of certified seeds. While the aim of the sector-wide agreement, which is precisely a tool to control price fluctuations, is to make the objectives of the stakeholders who commit to it complementary, the dichotomy specific to the industry, particularly between the agricultural phase and the industrial phase, remains. This is why, despite these schemes, the farmers interviewed consider that the incentive measures introduced to encourage more farmers to join can sometimes be restrictive. The timetable for submitting the application and the rules for receiving government funding are also obstacles to this form of contractualization. But above all, the strongest criticism concerns the unequal relationship between the various stakeholders in the sector. Every EU member state must have a national strategic plan for the CAP (NSP) instead of regional rural development plans. Programming includes measures under the two pillars of the CAP: direct payments and rural development, financed by the European Agricultural Guidance and Guarantee Fund (EAGGF) and the European Agricultural Fund for Rural Development (EAFRD). Each decentralised region of the member states therefore decides on its own strategy depending on its needs and priorities, meaning that Sardinia can define its own roadmap. However, the end of the "monoculture" system introduced by the new CAP is affecting farms that have to fulfil contracts with suppliers. This crop rotation obligation envisaged in the name of environmental protection and sustainability to combat soil depletion makes it impossible to guarantee cereal quantities in the sector-wide agreement. For farmers, this would mean reducing production by half in two years or giving up on the EU incentives that have existed for nearly 30 years. For cereal producers, the three most important points are:

Bcaa 3: ban on burning wheat stubble. This is related to the introduction of restrictions on the use of crop protection products and the obligation to bury stubble (not straw, which can be removed).

Bcaa 7: compulsory rotation.

Bcaa 8: obligation to leave 4% of the useful agricultural area in fallow.

⁶⁴ For example, the accepted level of heavy metals in rice is 0.15 microgrammes per kilo; however, rice imported from Asian countries, such as Cambodia and China, is accepted, containing up to 0.40 micrograms.

The CAP also supports the conversion to organic farming with an objective of 25%. This is currently 17% in Italy (Rete rurale Nazionale, 2021).

The people interviewed pointed out inconsistencies between the agricultural sector and the production of renewable energy supported by the Department of Industry. The projects in question envisage the installation of wind farms on very productive farmland, such as in Campidano (Figure 42). Many mayors want to attract this type of infrastructure into their area to provide additional income for the commune. To deal with the issues caused by these installations, which are sometimes abandoned without being dismantled (see Extent/Problems perspectives and goals ambitions), the Regional Department of Agriculture has adopted a policy that allows the installation of energy facilities on farmland only with the aim of producing energy for the farm and not to supply the network. However, this does not solve the inconsistency of these strategies for developing durum wheat cultivation on the one hand and making farmland available for energy production on the other. Also, at national level, there appear to be genuine attempts to coordinate activities between the national strategic plan (CAP 2021-2027 regulation) and the water management plans (directive 2000/60/CE) with a view to integrating the main policies for the qualitative and quantitative protection of water resources.

The water resource centralisation strategy has also led to conflict with energy production. First with ENEL, the national electricity company, which is now a multinational with State participation and holds several concessions for the production of hydroelectric power. The Region has integrated the dams that supply ENEL's power stations into the SIMR and intends to do the same with the power stations for which the concessions are due to expire soon (2028). Two disputes were taken to court and the Regional Water Tribunal pronounced two decisions in favour of the Region⁶⁵. There is also a conflict concerning energy production with the Land Reclamation Consortia which, in losing control of the dams, are no longer able to produce energy to operate the consortium's pumping and irrigation system. This is why, as a public sector employee from the region explained during interviews, *"it was seen as a deprivation of power"* (Interview 29/03/2023) which involved compensation. Thus, ENAS is refunding the Consortia for energy costs associated with pumping water.

The governance system of the durum wheat does not systematically allow for synergies between policy instruments, which is neither supportive nor restrictive.

Responsibilities and resources

The stakeholders and structures in charge of the durum wheat policy say that they understand each other's responsibilities and know how to coordinate themselves. The regional research and production support structures also seem to be very close to producers, providing support and different ways to communicate with them. The representative of the Regional Agricultural Department considers that it has the resources - both human and financial - to operate. The problem therefore seems to be a lack

⁶⁵ In 2016, the regional water tribunal pronounced two decisions in favour of the Region. For the judges, the decisive factor was the fact that the dams were built on government land and are therefore public property. Consequently, as the power plants cannot be dismantled, they must also be transferred to the region. This result was not accepted by ENEL, which appealed to the court of second instance, but the State attorney's office recommended that the matter be settled out of court. The transfer of two hydroelectric power stations on Tirso river, now regional property, resulted in significant savings because neither the Region nor the Land Reclamation Consortium of Oristano will have to pay ENEL to guarantee the electricity required to produce water. The Region entrusted ENAS with management of the region's hydroelectric production, which is used for the energy-intensive water transfers in the SIMR on the one hand, and is sold to TERNA (Rete Elettrica Nazionale S.p.A.), the Italian energy transmission company, on the other.

of awareness and knowledge of the potential of the durum wheat sector which should be developed further.

In the field of water management, responsibilities have been redistributed following the creation of the SIMR. The decision was taken by regional government and applied to the Consortia, which experienced it as an enforced decision (top-down). Hence the resistance described earlier by certain consortia and the desire of the ANBI - Associazione Nazionale Consorzi di Bonifica Italiani (the national association that brings together the regional Consortia) - to push the initiative for a law aimed at changing the distribution of responsibilities.

In 2006, an ad hoc organisation was created, the Ente Acque Sardegna - ENAS -, by reforming a former body in charge of water resource management (Ente Autonomo Flumendosa), consolidating it through providing the experience and skills of staff from another redundant regional body, the *Ente Sardo Acquedotti e Fognature* (Sardinian Body for Drinking Water Supply and Sanitary Water Collection Network) and the Land Reclamation Consortia. As the body in charge of distributing water to the various sectors, ENAS is at the heart of this reconfiguration of the water management system. However, this structure has been managed for many years by an extraordinary committee appointed by central government⁶⁶. This situation largely weakens the body and above all demonstrates the difficulty it has in asserting its full legitimacy. Some stakeholders see this as the current regional government's desire to weaken rather than strengthen this structure. Another sign of this would be a lack of personnel at ENAS, which has been understaffed for a long time and has not been able to hold onto highly skilled and experienced executives. A change in personnel would be necessary. However, the Land Reclamation Consortia that we met (South Sardinia and Oristano) also report having insufficient financial resources to modernise the water distribution networks. On the other hand, regional administrators consider the resources for extending the interconnections of the SIMR or for processing wastewater to be sufficient. Bureaucratic red tape was mentioned as a real obstacle to developing the activity. As for human resources, the problem lies in excessive staff turnover in the regional administration, on the one hand, and a lack of skilled labour on the other, particularly for carrying out work and interventions on the networks.

Responsibilities are clearly assigned but with some distrust and sometimes a lack of resources, which is neither supportive nor restrictive.

Conclusion

While there is a degree of interaction in the institutional network, synergies for the same objectives are not always produced. Further, the responsibilities that should contribute to applying the policy are sometimes contested and not always supported with adequate resources. Thus, the degree to which the elements of the governance system are strengthening rather weakening each other is neither fully restrictive nor supportive.

⁶⁶ The "commissariamento" is the act by which a body or institution is subject to a commissioner, i.e., a person to whom a higher authority, in this case central government, has entrusted a task to complete or an order to carry out. The notion of commissioner refers to the idea of a strong, external, superior power, present in a context with the aim of exercising lasting control and dealing with an extraordinary, crisis or emergency situation. To achieve the assigned objective, the commissioner simplifies and speeds up the usual processes and replaces or takes over, temporarily or permanently, the management and control of ordinary institutions.

- **Flexibility**

Actors and networks

The durum wheat sector in Sardinia is perceived by most stakeholders as being subject to a monopoly. Durum wheat processing and the marketing of its by-products are largely controlled by a few large operators (mills, storage companies), which seems to make it difficult for new stakeholders to be involved. However, in case of difficulty, the sector can contact experts, including scientists from the island or the country. Further, the production of renewable energy by some farmers shows an ability to involve new stakeholders, such as energy production companies, in connection with the agricultural world, although these are individual and not collective decisions.

Concerning irrigation requirements, the SIMR is very flexible from a technical point of view because it can reallocate water resources where they are needed, which shows the exchange between different water users, including the durum wheat industry. Although the decision-making process is concentrated in the hands of the Region (via the Basin Authority) and the implementation process is in the hands of ENAS, the Land Reclamation Consortia stakeholders join the negotiation process when water stress is high.

Further, the creation of bio-districts for organic farming has its place in the sector with the development of new synergies and also the development of sector-wide agreements. This demonstrates the sector's flexibility to include new stakeholders, represented here by the COPAGRI of Sardinia and more specifically by Agenzia LAORE Sardegna for south Sardinia. Bio-district products are also closely linked to the tourism and artisanal sectors, which defend and promote Sardinian heritage.

Local arrangements facilitate the inclusion of new actors, but not the ones from the public sectors to new initiatives, which is neither restrictive nor supportive.

Levels and scales

CAP policies are implemented by the regional administration and rolled out in local areas. The regional level is where farmers, via the Land Reclamation Consortia, express their water needs. Thus, at the Land Reclamation Consortia level, local management is ensured and the issues raised at this local level are passed on by the consortia to the regional bodies, i.e., ADIS and the Agriculture Department. Further, supply chain agreements conceived at the regional level of Sardinia, thanks to the work of the AGRIS and LAORE agencies, have been taken up by the national ministry for agriculture and then applied in the other Italian regions.

The consortia are thus autonomously introducing water management actions in the area, namely distribution, drainage of farmland, maintenance of supply networks, installation of water meters and water-saving measures. Recently, the consortia have also been sharing civil protection powers by monitoring the area to prevent hydro-geological risks, including floods and landslides.

Sustainable development and its European and international objectives are reflected at every level, with agricultural issues being addressed at island level. European guidelines are translated locally by the introduction, by the Department of Environmental Protection, of a regional sustainable development strategy (see §Extent/ Strategies and instruments). This is a transposition at regional and local level of the 17 Sustainable Development Goals (SDGs) of the United Nations Agenda 2030 and is one of the few examples of efforts of this type in Italy. The Ministry of the Environment has recognised it as a national example of good practice to be replicated.

The governance system concerning agriculture and durum wheat allows engaging different levels and scales, which is supportive.

Problem perspectives and goal ambitions

The various problems faced by the durum wheat sector in Sardinia are largely shared by the people interviewed. However, the regional context of a virtual monopoly by a major manufacturer (fourth largest producer in the world), which represents a potential imbalance of power between upstream stakeholders (producers) and downstream stakeholders (mills, storage companies and industrial processors), may make it difficult to reassess the objectives. Although dialogue exists today, the ability of farmers to impose new objectives, if they want to, seems difficult.

Processing across the region is in the hands of four or five processors. These are local companies which have the capacity to store, grind large quantities of wheat, produce and then sell the flour on the international market, which allows them to control prices.

At the regional agricultural policy level, the durum wheat short supply chain is considered strategic, with great potential for its links with Sardinia's gastronomic traditions, which are recognised on the national and international markets. This promotion of local know-how has also become a sales opportunity and a guarantee of quality for the region's largest producer⁶⁷.

Representations of the issues associated with water management differ on the need for, and even the technical and political advantages of, centralising decision-making at regional level, despite the fact that the system has already proved its worth over the last few decades. For the regional powers, the regional multi-sector system is the response to the risks of an increasingly extreme and uncertain climate situation. The system has the capacity to integrate and respond, in a single system, to the needs of different sector uses throughout most of the region. One of the stakeholders met described this system as *“a model of solidarity, which guarantees access to water for all, wherever it is needed”* (Interview 01/04/2023, Sardinia). However, implementation throughout the region is not yet complete and requires a lot of time, particularly as it is sometimes delayed for bureaucratic, financial or technical reasons. This fosters controversy and maintains a climate of mistrust.

The governance system appears to have the capacity for new evaluation of goals and ambitions, which is supportive.

Strategies and instruments

It appears possible to mobilise several types of strategies and resources for the sector. The durum wheat sector-wide agreements are an initiative and project developed at regional level by AGRIS in the first decade of the 2000s. Their interest for the sector has been recognised by the Ministry for Agriculture, which transposed the sector-wide agreements into national regulation as the main measure for supporting the durum wheat sector in Italy. Also, faced with the crisis in Ukraine and soaring prices of agricultural raw materials, the European Commission has set up a European anti-crisis plan for the cereals sector, which plans for extraordinary interventions to grow additional hectares of cereals (corn, durum wheat) to reduce dependency on foreign imports.

Additionally, following discussions between the regions within the EU and Italy, a specific measure for durum wheat, known as “coupled payment” (in the sense of funding linked to durum wheat), has been proposed to support farms in the centre and south of the country, which includes Sardinia.

At regional level, the Land Reclamation Consortium of Oristano received an additional allocation of 30 million cubic metres of water from ENAS to increase national fodder production.

⁶⁷ The company has just created and launched a production line for pasta declared to be made exclusively with local varieties of wheat.

The institutional arrangement provides the opportunity to combine and uses different instruments and actors can make choices in a pragmatic manner, which is supportive.

Responsibilities and resources

The responsibilities are clearly assigned, but according to the stakeholders interviewed, the resources allocated do not seem to be insufficient, while the durum wheat sector is considered to be a strategic sector because it is not only a quality sector, but it also has significant commercial potential. Thus, against the backdrop of the war in Ukraine and its repercussions on the wheat market, the European Commission has set up an anti-crisis plan which allows cereal growers to grow more hectares. Further, while the sustainability of the durum wheat sector depends on structural factors, such as dynamics specific to the Sardinian farming sector, the choices made by the EU in terms of cereals policy, but also economic factors (volatility of market prices and production factor prices) make it highly dependent on exogenous factors. In the regional context, the people interviewed deplore the polarisation of decision-making power towards mills (storage companies) and processors. However, this is independent of the distribution of responsibilities and resources in the durum wheat sector, which they do not criticise.

While there is no particular issue in the way the responsibilities and resources is assigned, the polarization of power makes it difficult to assign responsibilities and resources to other ones, which is neither restrictive nor supportive.

Conclusion

The overall assessment for flexibility is supportive.

- **Intensity of action**

Actors and networks

The stakeholders who defend a local and sustainable durum wheat sector are mainly the public sector employees from the regional agencies in charge of agronomic issues (LAORE and AGRIS). AGRIS – the regional agency for agronomic research – plays a key role in applied research for the development of durum wheat selection and varietal improvement programmes. The aim is to obtain varieties that are increasingly effective in terms of production, quality and resistance to drought. Although they play an important role in researching solutions to adapt crops and soil to climate and economic challenges, they have a relative weight in the balance of power within the sector.

However, the Regional Department for Agriculture has supported the sector with the implementation of the “Sector-wide agreement” tool, which was finally extended nationwide. It has also supported seed certification to guarantee quality and traceability. It has also encouraged the creation of cooperatives of producers and small millers, with the aim of strengthening the weak link in the sector, even if few initiatives have been launched to date. Farmers do not seem able to organise themselves or to seize the sector's potential. According to one regional public sector employee: *“in recent years, there is an element of the system that realises the opportunity that exists, in other words, the possibility of stable growth in certain markets and even in certain markets linked to typical local production: we can make “pane Carasau”, we can make products that are very successful. But this is just a small percentage of cereal growers in Sardinia. The others are completely dependent on the Common Agricultural Policy, they go wherever there are subsidies”* (Interview 29/03/2023).

As for larger stakeholders in the sector, such as manufacturers that process, make and market durum wheat by-products, in particular pasta, the short supply chain is becoming a guarantee of quality that

can be used to build sales arguments for specific products. Although they use wheat from local producers, from local and certified varieties, they do not seem prepared to question the asymmetrical relationships at play in the sector.

Concerning access to irrigation, the regional stakeholders (the Basin Authority, the Hydrographic District Agency and ENAS) support and work to maintain and improve the model of an interconnected and multi-sector system. In term, the project is for the entire island to be connected and equipped by the SIMR. On a sub-regional scale, support for the SIMR depends on the consortia. In the southern and western parts of the island, they seem to have come to terms with joining the SIMR, the benefits of which they recognise, while pointing out the existing weaknesses. In particular, they mention that the management of dam safety tests take too long and delays their commissioning or complete filling. Others, especially in the north of the island, seem to be working more for the system to be dismantled in order to return to more local management of water supply and demand. These structures are less connected to the system and their consortium regions are close to high-standard tourist areas. For these consortia, providing water to the tourism sector would be the most profitable solution. Even the regional ANBI, whose president is also the president of the Land Reclamation Consortium in Nurra (north of the island), is calling for a regional law to restore local control of reservoirs, in other words in the hands of the consortia. Finally, scientific research in agronomy, through national structures such as AGRIS, which have presence in the region, is stepping up research and development to support the development of quality sectors.

Thus, overall, the stakeholders and networks that are relevant to the governance of the durum wheat system are heavily involved in developing the durum wheat sector, which is supportive.

Levels and scales

The regional level seems to be the most supportive of the creation and development of a short supply chain. Every year, the Department of Agriculture and Agro-pastoral Reform carries out searches for money to finance the supply chain agreement. This is seen as an important supply chain in the regional context. It is strategic and, above all, it is linked to the gastronomic traditions of Sardinia.

The creation of a regional steering committee to move the regional sustainable development plan forward, in which all regional departments are represented, is important because the development strategy of the SDGs makes it possible to intensify the development of local durum wheat sectors that meet these requirements.

The sub-regional bodies, in particular the Land reclamation consortia, support farmers in their durum wheat irrigation requirements, although this practice is still limited.

The recognition of sector contracts initiated in the regions and deployed nationally also demonstrates the intensity of actions concerning the sector at different levels. However, efforts to develop short, sustainable and quality supply chains seem to be essentially the responsibility of the Sardinian region, still vulnerable to external markets, which are not always offset by initiatives at other levels.

If the regional level pushes the development of the local durum wheat chains, other levels do not support this intensively, which is neither supportive nor restrictive.

Problem perspectives and goal ambitions

The future of the durum wheat market does not seem to be a topic that is generating a great deal of debate within the institutions, or even among all categories of stakeholders. The commercial element of products derived from durum wheat processing concerns a local market, which does not have the ambition to expand to other dimensions. Also, environmental or consumer associations are not particularly involved in these subjects because the food issue associated with durum wheat is not

currently one of their main concerns. Therefore, consideration of the issues and objectives of the wheat industry remains very much confined to actions that are specific to the fields of action of stakeholders in the sector.

The challenges facing the durum wheat industry are not well known outside the industry itself, which is neither supportive nor restrictive.

Strategies and instruments

The instruments made available to the durum wheat sector are used by the sector and are mobilised as the industry develops. In this context, the possibility of obtaining the “Agricoltura 4.0” tax credit ⁶⁸ is interesting. With this measure, farmers can count on the tax credit to invest in new equipment. It is government funding to help step up development of the sector.

Strategies and instruments do exist to develop sustainable durum wheat chain, but without an intensive shared strategy, which is neither restrictive nor supportive.

Responsibilities and resources

Responsibilities in the durum wheat sector are clearly identified. Dedicated resources are available. However, they do not protect the sector from the volatility of input prices or market prices.

In the water sector, the responsibilities redistributed after the 2006 law that created the SIMR are contested by some of the representatives of the Land Reclamation Consortia, which is weakening the legitimacy of the system and making it less effective in some areas.

Responsibilities and resources make it possible to support a sustainable durum wheat chain to a limited extent, which is neither supportive nor restrictive.

Conclusion

The overall assessment for intensity is neither supportive nor restrictive. The system has stakeholders who encourage and support the creation of a local sustainable quality durum wheat sector by putting in place ad hoc instruments, measures and resources. However, the unequal balance of power within the sector, the low capacity of farmers to organise themselves collectively, and the fact that the island has a virtual monopoly on the industrial processing of raw materials all undermine the governance system, which remains highly vulnerable to external factors.

4.3 Concluding evaluations

The governance system of the durum wheat in Sardinia is quite supportive for the development of local chains (

⁶⁸ Agricoltura 4.0 is the evolution of the “precision agriculture” concept, which is used to define targeted and effective action in the agricultural sector using data such as the physical and biochemical characteristics of the soil. It is a set of tools and strategies which allow the farm to use advanced technologies in a synergistic and interconnected way with the aim of making production more efficient and sustainable.

Table 15).

Durum wheat is a traditional product that forms the basis of the diet of the local and national population, and a high added-value product for tourism and exports. Climate projections have shown that in the future, the region will be characterised by an overall increase in temperatures (average and extreme), an overall reduction in annual rainfall and a high intensity and frequency of extreme weather events such as heat waves along with drought and heavy rainfall (Regione Autonoma Sardegna, 2019 ; Piras et al., 2016 ; Bird et al., 2016). While durum wheat is a crop that is generally able to resist unfavourable weather conditions, in the coming climate context, irrigation will be essential to avoid any impact on the quality and yield of crops. And the durum wheat sector is currently developing short quality supply chains.

Although the durum wheat sector is supported by regional stakeholders and partially by national stakeholders, thanks to the implementation of ad hoc instruments and measures, the sector is still very vulnerable to the price fluctuations of international markets, the increase of production costs caused by the conflict in Ukraine, and competition from non-European markets. Regional research bodies (AGRIS) and technical support bodies (LAORE) are the driving elements in improving the sector.

The war in Ukraine has led to renewed interest in increasing the area used for growing wheat, both common and durum, with support from several levels. This context is encouraging multi-scale trade in this cereal.

Against the backdrop of climate change and the use of irrigation, including for wheat, the centralised water management system allows the regional authorities to take the resource from where it is to where it is needed. However, there are still demands for a return to the previous situation, where power over water resources was more local. These demands are weakening the current system.

From an institutional point of view, there has been repeated recourse to the “commissariamento”, i.e. the sub-control of certain central structures of the water-food governance system (such as the Land Reclamation Consortia or ENAS). The “commissariamento” makes it possible to set up an extraordinary management system that does not base its action on the usual procedures and can depart from the ordinary rules. This creates a context of institutional uncertainty which weakens these institutions and legitimises the demands.

To finish with, the governance system lacks a cross-sectoral and WEF Nexus-Oriented vision: in a context where water resources and the uses to which they are put will be increasingly linked, in an area where the profitability of crops is extremely heterogeneous depending on the site and variable over time, due to both increasingly extreme and difficult climate conditions, some farms will only manage to achieve positive profitability thanks to specific aid for crops, such as irrigation.

Table 15: Matrix of the overall scoring in the Sardinian Case study

	Quality of the governance regime : criteria			
Governance dimensions	Extent	Coherence	Flexibility	Intensity
Actors and networks				
Levels and scales				
Problem perspectives and goal ambitions				
Strategy and instruments				
Responsibilities and resources				
Overall assessment	Supportive	Neutral	Supportive	Neutral
Concluding evaluation	The governance system is quite supportive			

4.4 Identification of barriers and levers at the case study level

Barriers

- Weak structuring and collective organisation of durum wheat producers,
- Unbalanced power forces within the sector between producer farmers and mills and processors,
- Lack of cross-sectoral vision (soil, agriculture and food, water and energy),
- Poor representation of farmers in the uncertainties regarding the availability of resources in the context of climate change, with a vision focused on the storage capacity of the many dams on the island, the development of which has been suggested by some stakeholders,
- The increased intensity and frequency of droughts is both an obstacle and a lever for taking climate change into account in the development of the sector.

Levers

- Public research and development institutions in the agricultural (AGRIS, LAORE) and hydrological (University of Cagliari in particular, CRS4) sectors offer advanced expertise in support of innovation for the local development of the sector,
- A well-developed network of stakeholders,
- Strong capacity for innovation from some local companies,

- An artisanal sector for durum-wheat-based products with high added-value, which would be a solid basis for a market to be developed.

5.0 Lessons learned from barriers and levers to urge for more local resilience in the case studies

While considering the four European case studies, some similarities and differences are highlighted. The bureaucratic administration management or requirement that slows down any initiatives or projects are mentioned by a large amount of stakeholders. Also, the lack of monitoring data to give a clear pictures of water withdrawals, in particular during drought, is declared by both water users and water managers. Hydrological balances are sometimes used to evaluate uses.

As a major risk, drought is always mentioned, but with different level of perceptions. Most of the time, the real impact of climate change on drought in the near future and its effects on water resources is underestimated, even if it is mentioned as possibly restricting development of some socio-economic activities.

In all the case studies, environmental perspectives lack the human resources to be properly taken into account at local level. Thus, even if climate change strategies are existing with associated tools and instruments, implementation of measures is not really in an acceleration phase.

The question of the reuse of water is central in many places to face drought hydrometeorological extreme events previously cited as a main issue. Most of the time, the development of these techniques require legislation updates at national and European level and call for new infrastructures.

Finally, the cross-sectorality approach is not very well developed, even though the urge for renewable energies has accelerated projects relating to the link between water, food and energy.

Many pilot projects and initiatives bringing innovation on territories are launched at local level. They are supported by connections between actors and, above all, increasingly developed and collaborative networks of stakeholders in all sectors, both private and public, and sometimes with synergies between the two. What is regrettable is that the capitalisation of all these experiments, whether successful or not, is not planned yet.

In conclusion, the case studies explored need to be made more aware of the issue of climate changes in order to increase the pressure to implement adaptation measures or at least to list the necessary resources.

6.0 Next steps of ARSINOE

The ARSINOE project is at the halfway point at the time this report was written and offers the opportunity to pursue discussion with stakeholders to provide recommendations and activate levers. During a next stakeholders workshop organized by ARSINOE partners, recommendations derived from the governance analysis are planned to be presented and discussed with stakeholders. In order to prepare this, a work will be performed between the governance assessment team and case study leaders to organize the presentation of the main blocages and levers identified with the governance analysis to get further to the creation of resilience. Those levers, associated to the work performed on innovation pathways and the current development of one selected innovation to be implemented in case studies, will be useful to push for adaptation in case studies.

7.0 References

- ASPROCAN (2023) Estadísticas 2022 de production et comercializacion de Plátano de Canarias IGP.
- ATT, BDEW, DBVW, DVGW, DWA & VKU (2020). Profile of the German Water Sector 2020. Access via: https://www.vku.de/fileadmin/user_upload/Verbandsseite/Publikationen/2020/FINAL_brachenbild_ENGL_wasserwirtschaft_2020_DIN_A4_15032021_1_.pdf.
- Bavarian Environment Agency (2016). Öffentliche Trinkwasserversorgung - Wasserversorgungsunternehmen. Access via: https://www.lfu.bayern.de/wasser/trinkwasserversorgung_oeffentlich/wasserversorgungsunternehmen/struktur/index.htm
- Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (ed.) (2000). Wasser für Franken. Access via: https://www.wwa-ban.bayern.de/ueberleitung/system/doc/broschuere_wasser_fuer_franken.pdf
- Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (2024). Wasserwirtschaft in Bayern – Organisation. Access via: https://www.stmuv.bayern.de/themen/wasserwirtschaft/wasserwirtschaft_in_bayern/organisation.htm.
- Bird D.N., Benabdallah B., N Gouda, F Hummel, J Koeberl, La Jeunesse I., S Meyer, F Pretenthaler, A Soddu, S Woess-Gallasch. Modelling climate change impacts on and adaptation strategies for agriculture in Sardinia and Tunisia using AquaCrop and value-at-risk (2016). *Science of the Total Environment* 543: 1019-1027. <http://dx.doi.org/10.1016/j.scitotenv.2015.07.035> 0048-9697
- BMU/UBA (eds.) (2018). Water Resource Management in Germany. Fundamentals, pressures, measures. Dessau-Roßlau. Access via: www.uba.de/en/water-resource-management.
- Bressers H., N. Bressers, C. Larrue Eds. (2016). *Governance for drought resilience. Land and Water Drought Management in Europe*, Springer Open Science, <http://link.springer.com/book/10.1007%2F978-3-319-29671-5>
- Bressers H., N. Bressers, A. Browne, C. Furusho, I. La Jeunesse, C. Larrue, G. Özerol, M.-H. Ramos, U. Stein, J. Tröltzsch, R. Vidaurre (2015). Governance assessment guide. Adapt to drought and water scarcity. <https://hal.inrae.fr/hal-02602379>
- Bressers H. (2009). From public administration to policy networks. Contextual interaction analysis. In: *Rediscovering Public Law and Public Administration in Comparative Policy Analysis. A Tribute to Peter Knoepfel* (ed. N. Stephane and F. Varone), 123–142. Lausanne: Presses Polytechniques.
- Britannica. (2023). Encyclopædia Britannica. Récupéré sur Encyclopædia Britannica: <https://www.britannica.com>
- Bundesanstalt für Gewässerkunde (2002). Water Resource Management – Country Profile Germany. Online access via: https://www.bafg.de/GRDC/EN/02_srvcs/24_rprtrs/report_27.pdf?_blob=publicationFile
- Carrillo, J., Hernández-Barrera, S., Expósito, F. J., Díaz, J. P., González, A., & Pérez, J. C. (2023) “The uneven impact of climate change on drought with elevation in the Canary Islands”, *npj Climate and Atmospheric Science*, 6(1). <https://doi.org/10.1038/S41612-023-00358-7>
- Cirelli C., I. La Jeunesse (2020). Adaptation of water management to face drought and water scarcity : lessons learned from two italian case studies. In *Facing hydrometeorological extreme events : a governance issue*. Ed. by I. La Jeunesse and C. Larrue, Wiley, pp245-258, 508 p.

Atmospheric Science, 6(1). <https://doi.org/10.1038/S41612-023-00358-7>

Consejería de Agricultura, Ganadería, Pesca y Soberanía Alimentaria (2023) *Diagnóstico de la eficiencia de las infraestructuras de riego, así como los requerimientos de obras de regadío en Canarias*. Gobierno de la Comunidad Autónoma de las Islas Canarias .

Consejo Insular de Aguas de El Hierro (2018) *Plan hidrológico de El Hierro Ciclo de Planificación Hidrológica 2015-2021, Documento Ambiental Estratégico*.

Consejo Insular de Aguas de El Hierro (2018) *Plan hidrológico de El Hierro Ciclo de Planificación Hidrológica 2015-2021, Documento de participación pública y consulta*.

Destatis. (2022). Statistisches Bundesamt (Destatis). https://www.destatis.de/EN/Home/_node.html
deutschland.de. (2023). [deutschland.de. Récupéré sur deutschland.de:
\[https://www.deutschland.de/en/topic/business/germanys-industry-the-most-important-facts-and-figures#:~:text=What%20are%20the%20largest%20sectors,%2C%20and%20Siemens%20\\(electric\]\(https://www.deutschland.de/en/topic/business/germanys-industry-the-most-important-facts-and-figures#:~:text=What%20are%20the%20largest%20sectors,%2C%20and%20Siemens%20\(electric\)
al\).](https://www.deutschland.de/en/topic/business/germanys-industry-the-most-important-facts-and-figures#:~:text=What%20are%20the%20largest%20sectors,%2C%20and%20Siemens%20(electric)

Diakakis, M. e. (2016). Factors controlling the spatial distribution of flash flooding in the complex environment of a metropolitan urban area. The case of Athens 2013 flash flood event. *International Journal of Disaster Risk Reduction* 18, 171–180. doi:10.1016/j.ijdr.2016.06.010

ELSTAT, 2023. www.statistics.gr. Retrieved 2023-07-10

ESA (2017). The European Space Agency platform : https://www.esa.int/ESA_Multimedia/Images/2017/08/Mapping_Germany_s_agricultural_landscapes

Expósito, F. J., A. González, J. C. Pérez, J. P. Díaz, and D. Taima (2015) “High-Resolution Future Projections of Temperature and Precipitation in the Canary Islands”. *J. Climate*, 28, 7846–7856, <https://doi.org/10.1175/JCLI-D-15-0030.1>.

Founda, D.E. (2015). Interdecadal variations and trends of the Urban Heat Island in Athens. *Atmospheric Research* 161–162 , 1–13.

Galderisi et al. 2020. Strengths and weaknesses of the 100 Resilient Cities Initiative in Southern Europe: Rome and Athens’ experiences. In *City Territory and Architecture* (2020) 7:16.

Giannaros C, Agathangelidis I, Papavasileiou G, Galanaki E, Kotroni V, Lagouvardos K, Giannaros TM, Cartalis C, Matzarakis A. The extreme heat wave of July-August 2021 in the Athens urban area (Greece): Atmospheric and human-biometeorological analysis exploiting ultra-high resolution numerical modeling and the local climate zone framework. *Sci Total Environ*. 2023 Jan 20;857(Pt 1):159300. doi: 10.1016/j.scitotenv.2022.159300. Epub 2022 Oct 8. PMID: 36216066.

Gioda A. (2014) « El Hierro (Canaries) : une île et le choix des transitions énergétique et écologique », *VertigO* - la revue électronique en sciences de l'environnement [En ligne], Volume 14 Numéro 3 | Décembre 2014, mis en ligne le 28 décembre 2014, consulté le 05 juillet 2023. URL: <http://journals.openedition.org/vertigo/15595> ; DOI : <https://doi.org/10.4000/vertigo.15595>.

Glick, T. F. [1970]. (1988). *Regadío y sociedad en la Valencia medieval*. Valencia, Del Cenia al Segura.

Hellenic Republic, 2019. National Energy and Climate Plan. Ministry of Environment and Energy.

Hellenic Republic, 2022. 8th national communication and 5th Biennial Report under the united nations framework convention on climate change. Ministry of Environment and Energy.

- Hellenic National Meteorological Service (HNMS), 2023, Annual Bulletins on the Climate in Greece, years 2014-2021. http://www.hnms.gr/emy/el/climatology/climatology_extreme
- HNMS. (2022). *Hellenic National Meteorological Service*. Récupéré sur [http://emy.gr/emy/en/Instituto Tecnológico de Canarias \(2020\) Estrategia de almacenamiento energético de Canarias](http://emy.gr/emy/en/Instituto_Tecnológico_de_Canarias_(2020)_Estrategia_de_almacenamiento_energético_de_Canarias), Dirección General de Energía del Gobierno de Canarias.
- Ioannidis P. 2016, "Successive local government institutional reforms in Greece: From regionalization to regionalism?" *Journal of Economics and Business*. Vol. XIX - 2016, No 1.
- Koutsoyiannis, D. M. (2017). The Water Supply of Athens through the Centuries. 31-42. https://www.researchgate.net/publication/322775403_The_water_supply_of_Athens_through_the_centuries
- La Jeunesse I. ed. & C. Larrue co. Ed. (2020). Facing hydrometeorological extreme events: a governance issue. Collective book, 4th volume of a serie on Hydrometeorological extreme events Science Policy Interface Edited by Ph. Quevauviller, Wiley, 508 p.
- La Palma Renewable (2019) *Agenda para la transición a la energía limpia*. Clean Energy for EU Islands, 33 p.
- Leiva López, A.D. (2019) "Los conflictos de acceso de instalaciones de generación renovable a las redes de electricidad en el actual escenario regulatorio". *Revista General de Derecho Administrativo*, lustel, mayo 2019, n°51.
- López-Pérez, M., Martín-Luis C., Catalán A., Salazar-Carballo P.A. (2022) «Estimation of radiation doses due to groundwater intake at a volcanic island: Tenerife (Canary Islands, Spain)», *Food Control*, 135. doi:10.1016/J.FOODCONT.2022.108830.
- Mc Donnell, K., Molnár, L., Harty, M., & Murphy, F. (2020). Feasibility Study of Carbon Dioxide Plume Geothermal Systems in Germany–Utilising Carbon Dioxide for Energy. *Energies*. ; <https://doi.org/10.3390/en13102416>
- Mereu, S., Susnik, J., Trabucco, A., Daccache, A., Vamvakieridou-Lyroudia, L., Renoldi, S., Virdis, A., Savic, D., Assimacopoulos, D., 2016. Operational resilience of reservoirs to climate change, agricultural demand, and tourism: a case study from Sardinia. *Sci Total Environ*. 543, 1028–1038.
- Ministerio para la Transición Ecológica, Gobierno de la Comunidad Autónoma de Canarias (2022) *Estrategia de Energía Sostenible en las Islas Canarias*.
- OECD. (2017). Land-use Planning Systems in the OECD: Country Fact Sheets, OECD Regional Development Studies. Paris: OECD Publishing. doi:<https://doi.org/10.1787/9789264268579-en>
- Pérez Marrero L.M. (1990) "El proceso de privatización de las aguas en Canarias", *Anuarios de Estudios Atlánticos*, n° 36, p. 429-461.
- Piras, M., Mascaro, G., Deidda, R., Vivoni, E.R., 2016. Impacts of climate change on precipitation and discharge extremes through the use of statistical downscaling approaches in a Mediterranean basin. *Sci Total Environ*. 543, 952–964.
- Plan Hidrológico de la Demarcación Hidrográfica de La Palma. Ciclo de planificación hidrológica 2015–2021. (Decreto 169/2018, de 26 de noviembre).
- Plan Hidrológico de la Demarcación Hidrográfica de El Hierro. Ciclo de planificación hidrológica 2015–2021. (Decreto 184/2018, de 26 de diciembre).
- Fundación Caja Canarias.

- Santamarta, J.C., Rubiales, I.C., Rodriguez Martin, J. and Cruz Pérez, N. (2022) "Water status in the Canary Islands related to energy requirements", *Energy Efficiency* (2022) 15: 13.
- Santamarta, Juan C., et al. (2023). "El impacto del proyecto europeo ARSINOE en la gestión del acuífero de la isla de El Hierro (Canarias)". En: Melgarejo Moreno, Joaquín; López Ortiz, M^a Inmaculada; Fernández Aracil, Patricia. Seguridad hídrica. Alacant: Universitat d'Alacant, 2023. ISBN 978-84-1302-234-5, pp. 219-227
- Sarmiento Acosta, M. J. (2003) Los Cabildos insulares de Canarias, REAL 2003, n°291, 1085- 1107.
- Sarmiento Acosta, M. J. (2004). La insularización de la gestión del agua en Canarias: Los Consejos Insulares de aguas. *Revista Andaluza De Administración Pública*, (54), 89–119. <https://doi.org/10.46735/raap.n54.228>
- Thober, S., Marx, A., & Boeing, F. (2018). Effects of global warming on hydrological and agricultural droughts and floods in Germany. Helmholtz-Zentrum für Umweltforschung GmbH – UFZ Permoserstraße. Récupéré sur https://www.ufz.de/export/data/2/207531_HOKLIM_Brosch%C3%BCre_final.pdf
- Uehlinger, U., Arndt, H., Wantzen, K., & Leuven, R. (2009). The Rhine River Basin. Dans A. Akbulut, N. Akbulut, J. Aleksandrov, M. Alexevnina, C. Amoros, H. Andersen, . . . e. al., *Rivers of Europe* (pp. 199-245). Academic Press. doi:10.1016/B978-0-12-369449-2.00006-0
- Vaswani Reboso, J. (2022) estado actual de los recursos hídricos en las islas canarias, proyecto MITIMAC, cofinanciado por el Programa Interreg MAC 2014-2020 (MAC2/1.1a/263).

Websites consulted

National Climate Law 4936/2022.

https://www.et.gr/api/DownloadFeksApi/?fek_pdf=20220100105LIFE-IP AdaptInGR project

www.adaptivegreece.gr

<https://onebillionresilient.org/hot-cities-chilled-economies-athens/>

<https://news.gtp.gr/2021/02/05/athens-shines-spotlight-on-34-landmark-fountains/>

[https://www.c40.org/wp-](https://www.c40.org/wp-content/uploads/2021/11/C40_Annual_Report_2020_vMay2021_lightfile.pdf)

[content/uploads/2021/11/C40_Annual_Report_2020_vMay2021_lightfile.pdf](https://www.c40.org/wp-content/uploads/2021/11/C40_Annual_Report_2020_vMay2021_lightfile.pdf)

8.0 Annex

Interview guide for CS1 Athens

Interview Guide for the Analysis of the governance of heat waves in the city of Athens

Introductory questions

1. Can you introduce yourself, your role in the organization you represent?
2. Is your activity concerned by the consideration of extreme heats issue in the city of Athens or of climate change adaptation in general?

GAT Dimensions	Questions	Remarks
Problem perspectives and goal ambitions	- Extent Main qst: What are the most important issues in the urban area of Athens regarding heat waves? - in your opinion, what are the most severe effects of heat waves? - Is there a link with the amount of green space in the city or the availability of water? or with other issues? - Coherence Main qst: To what extent are the different perspectives and goals mutually supportive or do they compete and conflict - How are heat waves dealt with in urban policies (i.e. urban planning, public space planning, development of green spaces, creation of cooling islands) and/or more generally in the climate change adaptation programme?	

	- In your opinion, are objectives for the city of Athens complementary regarding the management of heat waves or in competition or explicitly in conflict? - Are there any possible trade-offs/solutions? - Flexibility Main qst: Which priorities and the possibility to reassess these priorities - Is there the possibility to reassess the priorities to put heatwaves at the top of the agenda? - Intensity of action undertaken Main qst: ambition to operate more heat waves management? - To your opinion, is there in your activity the ambition to operate more consideration of heat waves? - How to move forwards?	
Actors and networks	- Extent Main question: all key actors are taken into account, (which one is missing)? - Who are the main actors, and also networks, involved in the management of extreme heats? (Check whether there is a multi-agency body dealing with the issue at city or regional level) - To what extent is your organization involved in the decision-making process concerning heat waves? And what role does play or could play in the decision-making process for heat wave management (crisis or more permanently)?	

	- What are the key stakeholders that could be involved? - Which stakeholders are currently excluded? Why? - Coherence Main qst: What type of relationship do these actors have? Cooperation? Synergies? Rivalry, conflict? - Which organizations do you interact with the most? For what purposes? - How would you define the quality of these relationships: rather cooperative? competitive? based on dependence? trust? Not fully trusting? - Flexibility Main qst: Is it possible to involve new actors/institutions? - Is it possible to involve new actors/organizations in the current resource management system? - If yes, which ones? - If not, why? - Intensity of action undertaken Main qst: is there an institution or body that strongly supports a change to structure heat wave peaks management? - In your opinion, is there an organization or actor that strongly supports the permanent management of heat waves and not only during crisis? - In your opinion, who are the most influential actors in this?	
	- Extent	

Levels and scales	Main qst: What are the different administrative and territorial levels currently involved in the management of heat waves? - In your opinion, which level or scale is missing? - In your opinion, what would be the right scale and administrative level to deal with heat waves? - Coherence Main qst: Are their collaborations and influences between different levels and scales dealing with heat waves management? - To your knowledge, are administrative levels working together? - Are there mutual influences and dependencies between the different administrative levels and territorial scales involved in heatwaves controlling? - Flexibility Main qst: Is it possible to change scale depending on the issue? - Permanently or only during crisis? - If there is, how are national or regional directives (in the sense of guidelines, recommendations) transferred to the local level? - Do you have any recent or past examples? - Intensity of action undertaken	
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	Main qst: Is there a particular administrative level or territorial scale that is currently pushing/urging for heat waves management? - Is there a particular administrative level or territorial scale that is currently urging for a permanent consideration of the <u>prevention or mitigation</u> of heatwaves? - Do you think this is the most appropriate level	
Strategy and instruments	- Extent Main qst: which strategies and measures do exist to take extreme heats into account - What are the adaptation and mitigation measures (short, medium and long term)? - opening parks at night, water fountains, demineralising, de-permeabilization, creating fresh areas in the city, tree planting, etc. - Check whether there is an indicator (from the CC) / threshold to measure the impact of heat waves on human health? - who generates it? - Check the strategies to : - Heatwave alert systems i.e. (Management of the risk associated with heat waves) - How is your sector involved in these strategies and measures? - Coherence Main qst: Do the existing instruments/measures reinforce or hinder each other? - What your sector learned from extreme heat events?	

	- What strategies have been put in place as a result of this experience? - In your opinion, are those coherent with climate change adaptation strategy / with the general / particular land planning of the city? - Flexibility Is it possible to propose new strategies / measures (or to combine them) or instruments to limit negative impacts of heat waves? - To what extent it is possible to propose new (or combine) strategies or instruments to help limit negative impacts of extreme heat events? -To what extent are there legal barriers to implement these new or combined policies? Intensity of action undertaken Main qst: to what extent do the available instruments and measures stimulate actions to face heat waves - Are these instruments and measures sustainable (e.g. robust, well supported financially, legally...) over time? - If not, why? - What measures should be encouraged to be more efficient to consider heat waves when planning the city of Athens?	
Responsibilities and resources	- Extent Main qst: Are the responsibilities clearly assigned and supported with sufficient resources? - How are responsibilities defined and assigned (according to the alert system's alert levels i.e. regarding heat waves)?	

	- Is there a lack of expertise or responsibilities or resources to develop sustainable heat waves management? - Coherence Main qst: to what extent do assigned responsibilities / and resources create rivalries or promote cooperation within or between organizations? - Flexibility Main qst: Can responsibilities and resources be easily reallocated as contexts change? - During crisis for instance? - What additional responsibilities or resources would be needed to facilitate management of heat waves for prevention or mitigation or crisis management? - Intensity of action undertaken Main qst: Do the responsibilities and resources currently allocated stimulate a change - Is the current distribution of responsibilities and resources sufficient to meet the challenges of facing heat waves in Athens in the context of climate change?	
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Wefe nexus governance assessment - Interview Guide

Introduction

3. Presentation of project and interview goals (ARSINOE consortium)
4. Question to the interviewee : Can you introduce yourself, your role in the organization you represent.
5. In which resource management is your organization involved? (water, land, ecosystems) and for which sectors? (water, energy, food, ecosystems) in the river basin?

*Cross-sectoral= resource management based on an interconnexion/integration and collaboration of different sectors involved

GAT Dimension s	Questions	Remarks
Actors and networks	- Extent Main question: all key actors are taken into account, (which one is missing)? - To what extent is your organization involved in the decision-making process concerning the resources you mentioned? - Which other organization is involved in the management of these resources? - what are the key stakeholders that could be involved? - Which stakeholders are currently excluded? Why? - What role does your organization play or could play in the decision-making process for a cross-sectoral resource management? Sewage and drainage are not implicated in the elaboration of the RBMP	

	- Coherence Main qst: What type of relationship do these actors have? Cooperation? Synergies? Rivalry, conflict? - Which organizations do you interact with the most? For what purposes? - How would you define the quality of these relationships: rather cooperative? competitive? based on dependence? trust? Not fully trusting? - In your opinion, are there specific actors or groups that oppose a more cross-sectoral resource management in the river basin? - Do you interact (collaboration, knowledge exchanges...) with your counterparts in the catchment concerning resource management in river basin? - If yes - which ones and if not, why? - Flexibility Main qst: Is it possible to involve new actors/institutions? - Is it possible to involve new actors/organizations in the current resource management system? - If yes, which ones? - If not, why? - Intensity of action undertaken Main qst: is there an institution or body that strongly supports a change?	
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	- In your opinion, is there an organization or actor that strongly supports the interconnexion/integration and collaboration of different sectors (cross-sectoral) in the river basin? - In your opinion, who are the most influential actors in the decision-making process to move towards resource management based on an integration and collaboration of different sectors involved? (cross-sectoral)	
Levels and scales	- Extent Main qst: What are the different administrative and territorial levels currently involved in natural resource management in the basin? Which one is missing - What are the different administrative levels and territorial scales currently involved in resource management in the river basin? - In your opinion, which one is missing? - In your opinion, what would be the right scale and administrative level to deal with issues related to cross-sectoral resource management? - Coherence Main qst: Are the interdependencies and influences between different levels and scales taken into account - To your knowledge, are administrative levels working together? - Are there mutual influences and dependencies between the different administrative levels and territorial scales involved in resource management? If so, how do they affect resource management?	

	- Is the transboundary scale taken into account to manage natural resources at the scale of watershed? - Flexibility Main qst: Is it possible to change scale depending on the issue? - How is a local issue brought to the attention of the governing bodies of another level of decision making? - How are national or regional directives (in the sense of guidelines, recommendations) transferred to the local level? - Do you have any recent or past examples? - Intensity of action undertaken Main qst: Is there a particular administrative level or territorial scale that is currently pushing/urging for sustainable cross-sectoral management? - Is there a particular administrative level or territorial scale that is currently urging for sustainable cross-sectoral management? - Do you think this is the most appropriate level? - Is there one or several administrative levels that are decisive?	
	- Extent Main qst: what are the most important natural resource management issues in the basin? - According to you, what are the most important natural resource issues in the river basin?	

Problem perspectives and goal ambitions	- What are the main problems you are facing? In your opinion, which other sectors are facing the same? - These different problems are they taken into consideration in an interconnected and integrated (e.g. cross-sectoral) decision making process? - Coherence Main qst: To what extent are the different perspectives and goals mutually supportive or do they compete and conflict? - In your opinion, are the objectives of each sector complementary, in competition or explicitly in conflict? - Are there trade-offs? - According to you, are the different resource users aware of the interdependence between different sectors, between different resource users, interdependence in the context of the same use, between upstream and downstream of the river, bordering countries? - Flexibility Main qst: Which priorities and the possibility to reassess these priorities - Which type of resource uses are defined as priorities in your sector and in the other sectors? - Is there the possibility to reassess these priorities? - To what extent do current water/energy/agricultural/environmental policies take into account goals of different sectors?	
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	- If not, what opportunities exist to move towards sustainable (e.g. long-term, robust, well supported financially and legally) cross-sectoral management that including policy goals from other sectors? - Intensity of action undertaken Main qst: ambition to operate more cross-sectoral resource management - To your opinion, is there in your sector the ambition to operate more integrated and interconnected resource management? Do other sectors share the same ambition? - Is this likely to change in the future? - According to you, how urgent are the problems you mentioned before? Do other sectors, in your opinion, share this sense of urgency?	
Strategy and instruments	- Extent Main qst: which measures and strategies do exist to take other sectors into account - At present, which measures and strategies do exist to address your sector related resource issues? - How is your sector involved in the basin water management plan? - Coherence Main qst: Do the existing instruments from different sectors reinforce or hinder each other? - Do the existing instruments from different sectors reinforce or hinder each other?	

	- In your opinion, are currently the costs and benefits of trade-offs equally distributed between the different resource users? - What tools do you have to manage cross-sectoral conflicts about resource uses? Can you provide some examples? - Flexibility Is it possible to propose new (or combine) strategies or instruments to help limit negative impacts? - According to you, what measures are currently in place to limit the negative impacts on the resources (water, land, ecosystems...) in the basin and the river? - To what extent is it possible to propose new (or combine) strategies or instruments to help limit negative impacts on natural resources? - To what extent are there legal barriers to implement these new or combined policies? - Which sectors are innovating today? (to save resources) - Intensity of action undertaken Main qst: to what extent do the available policy instruments stimulate an interconnected sectors management - In your opinion, to what extent do the available policy instruments stimulate a cross sectoral management? - Do they promote a change in more collaborative behavior? - Are these instruments sustainable (e.g. robust, well supported financially, legally...) over time? - Do you think that the current integration of uses/sectors is sufficient? - If no, why?	
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	- What measures should be encouraged?	
Responsibilities and resources	- Extent Main qst: Are the responsibilities clearly assigned et supported - Are the responsibilities clearly assigned? - Are they supported by adequate resources? - Which institution currently has the responsibility and resources to promote cross-sectoral resource management? - Is there a lack of expertise or resources to develop sustainable cross-sectoral management? - Coherence Main qst: o what extent do assigned responsibilities create rivalries or promote cooperation within or between organizations - Do you have sufficient resources to ensure your responsibility and mission? - To what extent do the distribution of responsibilities create rivalries or promote cooperation, synergies between the different actors of the sectors involved? - In your opinion, is the distribution of responsibilities and resources appropriate and fair to the objectives of cross-sectoral resource management in the basin? - Are there organization with more responsibilities and resources than other organizations? And are they able to push their own agenda forward? - Flexibility	

	Main qst: Can responsibilities and resources be easily reallocated as contexts change? - What additional responsibilities or resources would be needed to facilitate management that takes into account the interconnections of different sectors? - Intensity of action undertaken Main qst: Do the responsibilities and resources currently allocated stimulate a change - To what extent are the institutions or organisations that you consider as a key to cross-sectoral natural resource management able to drive changes? - If no, why? - If yes, how? - Is the current distribution of responsibilities and resources sufficient to meet the challenges of cross-sectoral natural resource management?	
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Final questions:

1. If you were to score cross-sectoral management in the river basin concerning the problems we discussed, which score would you give between 0 and 3, with 0 there is no cross-sectoral management between the different sectors and 3 there is total cross-sectoral management between the four sectors on these problems?
2. According to you, what are the main changes to come in relation to these cross-sectoral issues in the River Basin?
3. Do you feel ready, well equipped to face these changes?
4. If you would have a magic stick, what changes would you recommend in relation to these cross-sectoral issues in the river Basin?





Guía entrevistas

La gobernanza del Nexus agua-energía-agricultura-ecosistemas en las Islas Canarias en un contexto de Cambio Climático

(Focus en las islas de El Hierro y La Palma)

Preguntas introductorias

1. ¿Puede presentarse y presentar su papel en la organización a la que representa?
2. ¿Qué recursos (agua, tierra, vegetales) gestiona su organización y para qué usos? (agua para usos municipales, energía, agricultura, ecosistemas)

Dimensiones	Preguntas	Observaciones
Actores y redes	- Alcance Pregunta principal: ¿qué actores están incluidos y cuáles excluidos? - ¿En qué medida su organización participa en el proceso de toma de decisiones relativo a la gestión de los recursos que ha mencionado? - ¿Qué otra organización participa en la gestión de estos recursos? - ¿Cuáles son las partes interesadas clave que podrían participar? - ¿Qué partes interesadas están excluidas actualmente? ¿Por qué? - ¿Qué papel desempeña (o podría desempeñar) su organización en el proceso de toma de decisiones para una gestión de los recursos más intersectorial? - Coherencia	

	Pregunta principal: ¿Qué tipo de relación mantienen estos actores? - ¿Con qué organizaciones interactúa más? ¿Con qué fines? - ¿Cómo definiría la calidad de estas relaciones: más bien cooperativas? ¿competitivas? ¿basadas en la dependencia? ¿confianza? ¿no de plena confianza? - ¿Existen actores o grupos específicos que no actúan para una gestión más intersectorial de los recursos en la isla? - Flexibilidad Pregunta principal: ¿Es posible implicar a nuevos actores/instituciones en el sistema de gestión actual? - En caso afirmativo, ¿cuáles? - En caso negativo, ¿por qué? - Intensidad de la acción Pregunta principal: ¿hay alguna organización o actor que apoye firmemente el cambio hacia una gestión más intersectorial? - ¿Existe alguna institución que empuje para cambiar la gestión tal y como se realiza actualmente? - ¿Quiénes son los actores más influyentes en el proceso de toma de decisiones para avanzar hacia una gestión de los recursos basada en la integración y la colaboración entre sectores?	
	- Alcance Pregunta principal: ¿Cuáles son los diferentes niveles administrativos y escalas territoriales implicados actualmente en la gestión de los recursos naturales en la isla? -¿Cuál faltaría? - ¿Cuáles serían la escala y el nivel administrativo adecuados para tratar las	

Niveles y escalas	cuestiones relacionadas con la gestión intersectorial de los recursos? - Coherencia Pregunta principal: ¿Se tienen en cuenta las interdependencias e influencias entre los distintos niveles y escalas? - ¿Los niveles administrativos trabajan juntos? - ¿Existen influencias y dependencias mutuas entre los diferentes niveles administrativos y escalas territoriales implicados en la gestión de los recursos? En caso afirmativo, ¿cómo afectan a la gestión de los recursos? - Flexibilidad Pregunta principal: ¿Es posible cambiar de escala en función de la cuestión en juego? - ¿Cómo se trasladan las directivas nacionales o regionales (en el sentido de directrices, recomendaciones) al nivel local? - ¿Cómo se hace llegar una cuestión local a los órganos de gobierno de otro nivel de decisión? - Intensidad de la acción Pregunta principal: ¿Existe algún nivel administrativo o escala territorial en particular que esté impulsando actualmente una gestión sustentable intersectorial? - ¿Qué escala tiene más peso? - ¿Cree que es el nivel más adecuado?	
	- Alcance Pregunta principal: ¿Cuáles son los problemas más importantes relacionados con la gestión de los recursos en la isla? - ¿Cuáles son los principales problemas a los que se enfrenta su sector?	

Percepción de los problemas y ambición de los objetivos	- ¿Qué otros sectores se enfrentan a los mismos? - ¿El cambio climático es algo que le preocupa? - Coherencia Pregunta principal: ¿En qué medida las diferentes perspectivas y objetivos se apoyan mutuamente o compiten y entran en conflicto? - ¿Los objetivos de cada sector son complementarios, compiten o entran explícitamente en conflicto? - ¿Los diferentes usuarios de los recursos son conscientes de la interdependencia entre los diferentes sectores, entre los diferentes usos? - ¿Existen usos prioritarios? ¿Las partes interesadas están de acuerdo o tienen un punto de vista diferente sobre la priorización de los usos? - Flexibilidad Pregunta principal: ¿Existen oportunidades para reevaluar/cambiar la percepción de los problemas y los objetivos asociados? - ¿Hasta qué punto las políticas actuales en materia de agua/energía/agricultura/ecosistema tienen en cuenta los objetivos de los diferentes sectores? - ¿Qué oportunidades existen para avanzar hacia una gestión intersectorial sustentable (por ejemplo, a largo plazo, sólida, bien respaldada financiera y jurídicamente) que incluya los objetivos políticos de otros sectores? - Intensidad de la acción: Pregunta principal: existe la ambición de llevar a cabo una gestión más intersectorial de los recursos	
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	- ¿Existe en su sector la ambición de operar una gestión de los recursos más integrada e interconectada? - ¿Comparten otros sectores la misma ambición?	
Estrategias e instrumentos	- Alcance Pregunta principal: ¿Cuáles son las estrategias y herramientas para afrontar los retos de una gestión intersectorial y sustentable en un contexto de Cambio Climático? - En la actualidad, ¿qué medidas y estrategias existen para tener en cuenta los problemas de recursos relacionados con su sector (Cantidad y calidad de agua, producción de energías, ocupación de las tierras, producción alimentaria de calidad...) en un contexto de Cambio Climático? - Coherencia Pregunta principal ¿Los instrumentos existentes de los diferentes sectores se refuerzan o se obstaculizan mutuamente? - En su opinión, ¿se distribuyen actualmente los costes y beneficios de las compensaciones de forma equitativa entre los diferentes usuarios de los recursos? - ¿De qué instrumentos dispone para gestionar los conflictos intersectoriales sobre los usos de los recursos? ¿Puede aportar algunos ejemplos? - Flexibilidad Pregunta principal: ¿Es posible proponer nuevas estrategias o instrumentos (o combinarlos) para ayudar a limitar los impactos negativos sobre los recursos naturales (agua, tierra, ecosistemas) en un contexto de CC?	

	- ¿Qué medidas existen actualmente para limitar los impactos negativos sobre los recursos (agua, tierra, ecosistemas...)? - ¿Hasta qué punto existen barreras legales para aplicar estas políticas nuevas o combinadas? - ¿Qué sectores están innovando actualmente? (para proteger los recursos naturales y tener políticas más sustentables) - Intensidad de la acción Pregunta principal: ¿en qué medida los instrumentos de política disponibles estimulan una gestión interconectada de los sectores y que tome en cuenta los desafíos del CC? - ¿Promueven un cambio hacia un comportamiento más cooperativos entre sectores? - ¿Cree que la integración actual de usos/sectores es suficiente para enfrentar los problemas que hemos mencionado antes? - En caso negativo, ¿por qué razón? - Y qué medidas deberían fomentarse?	
Responsabilidades y recursos	- Alcance Pregunta principal: ¿Las responsabilidades están claramente asignadas y sostenidas (finanzas/personas) - ¿Qué institución/es tiene/n actualmente la responsabilidad y los recursos para promover la gestión intersectorial? - ¿Están claras las responsabilidades de cada actor/organización en la gobernanza? - ¿Faltan conocimientos o recursos para desarrollar una gestión intersectorial sustentable? - ¿Qué autoridades jurídicas y otros recursos se les otorgan para este fin?	

	- Coherencia Pregunta principal: ¿En qué medida las responsabilidades asignadas crean rivalidades o promueven la cooperación dentro de las organizaciones o entre ellas? - ¿Las responsabilidades asignadas para la gestión integrada del nexo FME crean tensiones o cooperación dentro de las instituciones y sectores o entre ellos? - ¿Dispone de recursos suficientes para garantizar su responsabilidad y su misión? - ¿La distribución de responsabilidades y recursos es adecuada y justa para los objetivos de la gestión intersectorial de los recursos en la isla ? - ¿Hay organizaciones con más responsabilidades y recursos que otras? ¿Y son capaces de impulsar su propia agenda? - Flexibilidad Pregunta principal: ¿A medida que los contextos cambian pueden reasignarse fácilmente las responsabilidades y los recursos? - ¿Qué responsabilidades o recursos adicionales serían necesarios para facilitar una gestión que tenga en cuenta las interdependencias entre los diferentes sectores? - Intensidad de la acción: Pregunta principal: ¿Las responsabilidades y los recursos actualmente asignados estimulan un cambio? ¿En qué medida las instituciones u organizaciones que considera clave para la gestión intersectorial de los recursos naturales son capaces de impulsar cambios? - ¿Cuáles los son?	
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	- ¿Es suficiente el reparto actual de responsabilidades y recursos para hacer frente a los retos de la gestión intersectorial de los recursos naturales en un contexto de CC?	
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Preguntas finales

1. El objetivo de esta entrevista es tomar una instantánea de la gestión de los recursos y sus interdependencias en la actualidad. Ahora me gustaría preguntarle ¿si usted tomara una foto en 2050 qué nos mostraría?
2. Si dispusiera de todos los medios y condiciones para cambiar la situación actual de la cadena de suministro -una especie de caja mágica-, ¿qué cambiaría?



Interview Guide

Governance sostenibile della filiera locale del grano duro

(Gestione sostenibile del grano duro locale per la sicurezza alimentare)

Introduzione

1. Può presentarsi e dirci quale ruolo ricopre nell'organizzazione che rappresenta?
2. Quali risorse (acqua, terra, ecosistemi) gestisce la vostra organizzazione e per quali scopi?

Dimensioni del GAT	Domande	Commenti
Attori e reti	- Portata Quali sono gli attori e le reti che contano nei processi decisionali che riguardano la filiera locale del grano duro? (autorità e organizzazioni locali ma anche nazionali, europee) Mancano degli stakeholders importanti? - In che misura la vostra organizzazione è coinvolta nel processo decisionale relativo alla filiera del grano duro? - In che misura questi attori di rilievo sono coinvolti nel dibattito sull'adattamento della filiera del grano duro ai cambiamenti climatici e sulla sicurezza alimentare? - Che ruolo hanno i consorzi di bonifica e di irrigazione?/le associazioni dei trasformatori (pastifici e panifici) / i produttori di sementi - Quale ruolo svolge (o potrebbe svolgere) la vostra organizzazione nel processo decisionale per una gestione delle risorse (acqua, terra, energia...) che porti a una filiera del grano duro più sostenibile e orientata alla sicurezza alimentare? - Coerenza	

	Qual è la natura delle relazioni tra questi attori? - Con quali organizzazioni la vostra organizzazione interagisce maggiormente? Per quali scopi? - Come definireste la qualità di queste relazioni: piuttosto cooperative? competitive? basate sulla dipendenza? sulla fiducia? Di sfiducia? - Flessibilità Se fosse necessario sarebbe possibile includere nuovi stakeholder nell'attuale filiera locale del grano duro? - Se sì, quali? - Se no, perché? - Intensità dell'azione C'è un'organizzazione/stakeholder che sostiene attivamente e con forza una filiera locale sostenibile del grano duro per affrontare le sfide dell'adattamento ai cambiamenti climatici e della sicurezza alimentare? - Chi pensa siano gli attori più influenti nel processo decisionale per passare a pratiche più sostenibili nella filiera del grano duro per garantire la sicurezza alimentare?	
	- Estensione Quali sono i diversi livelli amministrativi e le scale territoriali (europea, nazionale, bacino mediterraneo, regionale, locale) attualmente coinvolti (politiche, strategie, gestione) nella filiera locale del grano duro? - Ci sono degli stakeholder importanti che sono assenti?	

Livelli e scale	- Secondo lei, quale sarebbe la scala e il livello amministrativo giusto per affrontare le sfide legate alla filiera locale del grano duro? In questo senso - Che ruolo hanno i consorzi di bonifica e di irrigazione? - Ed è questo livello e questa scala che dovrebbero guidare l'adattamento ai cambiamenti climatici? - Coerenza Questi livelli lavorano insieme in un clima di fiducia? Sono in conflitto? - Avete qualche esempio recente o passato? - Flessibilità A seconda della questione in gioco, la scala può essere facilmente modificata? - Come vengono tradotte a livello locale le linee guida europee, nazionali o regionali (politiche, regolamentazioni raccomandazioni)? - Come si porta un'idea o una questione locale all'attenzione degli organi di governo di un altro livello decisionale? Come funziona per le attuali politiche sul grano duro? E per l'adattamento ai cambiamenti climatici? - Avete qualche esempio recente o passato? - Intensità dell'azione C'è un particolare livello amministrativo o territoriale che attualmente spinge per una filiera sostenibile del grano duro? - Ritieni che sia il livello più appropriato?	
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	- È sufficiente incoraggiare/promuovere una filiera di grano duro sostenibile a livello locale per garantire la sicurezza alimentare?	
Visioni dei problemi e ambizioni degli obiettivi	- Estensione Quali sono i principali problemi che state affrontando? - Secondo lei, quali altri attori stanno affrontando gli stessi problemi? - Gli stakeholder sono consapevoli di tutti i problemi che la filiera del grano duro sta affrontando o che dovrà affrontare? Rispetto ai problemi citati, quali soluzioni prevedete? - Quando si prendono decisioni sulla filiera del grano duro, si tiene conto di questi diversi problemi? - Coerenza In che misura gli obiettivi di ciascun attore coinvolto nella filiera del grano duro sono complementari, in competizione o esplicitamente in conflitto? - Ci sono compromessi? - Può fare degli esempi? - Flessibilità Esistono opportunità per rivalutare gli obiettivi della filiera locale del grano duro? - In caso contrario, quali opportunità esistono per passare a una filiera del grano duro sostenibile (ad esempio, a lungo termine, solida e ben sostenuta finanziariamente) inserita in un obiettivo di sicurezza alimentare più ampio??	

	- Intensità dell'azione I vari attori o reti coinvolti nella filiera locale del grano duro sono consapevoli delle sfide della filiera ? propongono azioni per renderla più sostenibile? - Secondo voi, qual è il problema che richiede un intervento urgente? Cosa si dovrebbe fare? - Gli altri settori e attori coinvolti condividono questo senso di urgenza? - Secondo voi, c'è sufficiente consapevolezza delle sfide della filiera del grano duro?	
Strategie e strumenti	- Estensione Quali sono le strategie e gli strumenti per affrontare le sfide della filiera locale del grano duro e più in generale della sicurezza alimentare? - Contratti di filiera del grano duro (garantire il made in Italy) a che scala? (nazionale, regionale?) - - Ci sono strategie o strumenti che dovrebbero essere inclusi? - E in che misura? - Coerenza Gli strumenti e le strategie esistenti si rafforzano o si ostacolano a vicenda? (leggi, strategie di sviluppo etc) - Ci sono politiche (strategie e strumenti) in contraddizione tra loro ? - A che scala? - Flessibilità È possibile proporre nuove strategie o strumenti per affrontare le sfide della filiera locale del grano duro e della sicurezza alimentare?	il Piano nazionale di ripresa e resilienza individua sei ambiti di intervento tematici. Tra queste, la Missione 2 “Rivoluzione verde e transizione ecologica” include la componente 2.1 “Agricoltura sostenibile ed economia circolare” all’interno della quale sono inseriti appunto i contratti di filiera. Obiettivi ambientali dettati dall’Europa ed in particolare dalla Politica Agricola Comune (PAC), dal Green Deal europeo e dalla strategia denominata “Dal produttore al consumatore”, ovvero quelli di combattere i cambiamenti climatici, proteggere le risorse naturali e migliorare la biodiversità.

	-In che misura esistono ostacoli legali all'attuazione di queste strategie nuove o combinate? - Quali attori della filiera del grano duro stanno innovando in termini di strategie e strumenti? - Intensità dell'azione In che misura le strategie e gli strumenti esistenti supportano le sfide della filiera del grano duro? O sono adattati per sostenere una filiera del grano duro locale sostenibile? E per garantire la sicurezza alimentare? - Questi strumenti dovrebbero essere permanenti?	
Responsabilità e risorse	- Estensione Le responsabilità sono chiaramente assegnate e supportate per gestire la filiera del grano duro e in particolare per affrontare la sicurezza alimentare? - Quale istituzione ha attualmente la responsabilità e le risorse per sviluppare una gestione sostenibile della filiera del grano duro? - Mancano le competenze o le risorse per sviluppare una gestione sostenibile della filiera del grano duro? - Coerenza In che misura le responsabilità assegnate creano rivalità o promuovono la cooperazione tra gli attori e i livelli? - Avete risorse sufficienti per svolgere le vostre responsabilità e i vostri compiti? - Secondo lei, la distribuzione delle responsabilità e delle risorse è in linea con gli obiettivi della filiera del grano duro? - Ci sono organizzazioni che hanno più responsabilità e risorse di altre? E sono in grado di promuovere la propria agenda? - Flessibilità Le responsabilità e le risorse possono essere facilmente riassegnate in base ai cambiamenti del contesto?	

	- Quali responsabilità o risorse aggiuntive sarebbero necessarie per facilitare una catena del grano più sostenibile? - Intensità dell'azione Le responsabilità e le risorse attualmente assegnate promuovono una filiera del grano duro sostenibile? Quali sono i legami con la sicurezza alimentare? - In che misura le istituzioni o le organizzazioni che considerate sono fondamentali per guidare il cambiamento verso una filiera del grano duro più sostenibile? - Se no, perché? - Se sì, come? - L'attuale distribuzione delle responsabilità e delle risorse è sufficiente per affrontare le sfide di una filiera sostenibile?	
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Domande finali:

1. Lo scopo di questa intervista è quello di fare un'istantanea della filiera del grano duro oggi. Ora vorrei chiederle cosa ci mostrerebbe un'istantanea della filiera del grano nel 2050.
2. Se avesse a sua disposizione tutti i mezzi e le condizioni per modificare la situazione attuale della filiera – una sorta di bacchetta magica – cosa cambierebbe?



This project has received funding from the European Union's Horizon H2020 innovation action programme under grant agreement 101037424.

Annex : Example of the consent form



Formulario de consentimiento para entrevistas -Proyecto ARSINOE

Usted ha sido contactado para participar en una entrevista en el marco del proyecto europeo ARSINOE que está llevando a cabo la Universidad de Tours y la Universidad de La Laguna con el fin de establecer un acuerdo sobre cómo se tratarán los datos recogidos en el proyecto, le rogamos que lea atentamente las siguientes frases y marque cada casilla, en caso de que esté de acuerdo con ellas.

Una vez más, muchas gracias por participar.

	<i>Por favor, marque cada casilla:</i>
Confirmando que he recibido información oral sobre el proyecto y los objetivos de esta entrevista y que he tenido la oportunidad de hacer preguntas.	☐
Entiendo que mis respuestas serán estrictamente confidenciales. Entiendo que mi nombre o el nombre de la empresa a la que represento no se relacionarán con el registro de la entrevista ni con ninguna documentación escrita o valoración en el contexto de la entrevista, y que no se identificarán ni serán identificables en el informe o informes que resulten de la investigación.	☐
Estoy de acuerdo en que se grabe esta entrevista. Entiendo que la grabación de audio anonimizada realizada de esta entrevista se utilizará únicamente para el análisis por parte de ARSINOE y que los extractos escritos anonimizados de la entrevista, podrán utilizarse en presentaciones de conferencias, informes o artículos de revistas desarrollados como resultado de la investigación. Entiendo que no se hará ningún otro uso de la grabación sin mi permiso por escrito y que no se permitirá el acceso a la grabación original a ninguna persona ajena al equipo de investigación.	☐
Estoy de acuerdo en que se grabe esta entrevista. Entiendo que la grabación de audio anonimizada realizada de esta entrevista se utilizará únicamente para el análisis por parte de ARSINOE y que los extractos escritos anonimizados de la entrevista, podrán utilizarse en presentaciones de conferencias, informes o artículos de revistas desarrollados como resultado de la investigación. Entiendo que no se hará ningún otro uso de la grabación sin mi permiso por escrito y que no se permitirá el acceso a la grabación original a ninguna persona ajena al equipo de investigación.	☐
Acepto que mis datos anonimizados (grabaciones de audio, extractos escritos) se conserven para futuros fines de investigación, como publicaciones relacionadas con este estudio, una vez finalizado el mismo.	☐

Entiendo que las grabaciones de audio anonimizadas de la entrevista sólo se conservarán durante 5 años (tras la finalización del proyecto), siguiendo las normas de la UE que exigen que los proyectos conserven todos los registros durante 5 años (tras la finalización del proyecto).	☐
Acepto participar en esta entrevista.	☐

_____	_____	_____
Nombre de quien participa	Fecha	Firma

_____	_____	_____
Nombre de quien participa	Fecha	Firma

_____	_____	_____
Nombre del investigador	Fecha	Firma

_____	_____	_____
Nombre del investigador	Fecha	Firma

_____	_____	_____
Nombre del investigador	Fecha	Firma

_____	_____	_____
Nombre del investigador	Fecha	Firma

_____	_____	_____
Nombre del investigador	Fecha	Firma

Copias: Una vez firmado por todas las partes, el participante debe recibir una copia del formulario de consentimiento del participante firmado y fechado, y de la hoja de información. Una copia del formulario de consentimiento firmado y fechado debe colocarse en el archivo principal del proyecto, que debe guardarse en un lugar seguro.

for the governance analysis in the Canary Islands (thus in Spanish language)

Annex : Consent form in English



You have been contacted to participate in an interview within the framework of the H2020 EU project Nexogenesis that is being implemented by University of Tours, KWR Water Research institute in Greece and Bulgaria.

In order to establish an agreement on how the data collected will be dealt with in the project, we ask you to read carefully the following sentences and to tick each box, in case you agree with them.

Once again, thank you very much for participating.

	<i>Please tick each box:</i>
I confirm that I have received oral information about the project and the objectives of this interview and have had the opportunity to ask questions.	☐
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.	☐
I understand that my responses will be kept strictly confidential. I understand that my name or the name of the company I represent will not be linked with the record of the interview and any written documentation or valuation in the context of the interview, and will not be identified or identifiable in the report or reports that result from the research.	☐
I agree for this interview to be recorded. I understand that the anonymised audio recording made of this interview will be used only for analysis by Nexogenesis and that anonymised written extracts from the interview, may be used in conference presentations, reports or journal articles developed as a result of the research. I understand that no other use will be made of the recording without my written permission, and that no one outside the research team will be allowed access to the original recording.	☐
I agree that my anonymised data (audio recordings, written extracts) will be kept for future research purposes such as publications related to this study after the completion of the study.	☐
I understand that the anonymised audio records of the interview will only be kept for 5 years (after the project finalization), following the rules of the EU that requires the projects keep all record for 5 years (after the project finalization).	☐
I agree to take part in this interview.	☐

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of researcher	Date	Signature

Copies: *Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, and the information sheet. A copy of the signed and dated consent form should be placed in the main project file which must be kept in a secure location.*

Systems Innovation Approach (SIA) addresses the growing complexity, interdependencies and interconnectedness of modern societies and economies, focusing on the functions of the cross-sectoral system as a whole and on the variety of actors. The Climate Innovation Window (CIW) is the EU reference innovations marketplace for climate adaptation technologies. ARSINOE shapes the pathways to resilience by bringing together SIA and CIW, to build an ecosystem for climate change adaptation solutions. Within the ARSINOE ecosystem, pathways to solutions are co-created and co-designed by stakeholders, who can then select either existing CIW technologies, or technologies by new providers (or a combination) to form an innovation package. This package may be designed for implementation to a specific region, but its building blocks are transferable and re-usable; they can be re-adapted and updated. In this way, the user (region) gets an innovation package consisting of validated technologies (expanding the market for CIW); new technologies implemented in the specific local innovation package get the opportunity to be validated and become CIW members, while the society (citizens, stakeholders) benefits as a whole. ARSINOE applies a three-tier, approach: (a) using SIA it integrates multi-faceted technological, digital, business, governance and environmental aspects with social innovation for the development of adaptation pathways to climate change for specific regions; (b) it links with CIW to form innovation packages by matching innovators with end-users/regions; (c) it fosters the ecosystem sustainability and growth with cross-fertilization and replication across regions and scales, at European level and beyond, using specific business models, exploitation and outreach actions. The ARSINOE approach is show-cased in nine widely varied demonstrators, as a proof-of-concept with regards to its applicability, replicability, potential and efficacy.



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