D1.1. Stakeholder Mapping and analysis

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Date: 21/05/2021

Public

GOTHAM is part of the PRIMA Programme supported by the European Union. The PRIMA programme is supported under Horizon 2020 the European Union's Framework Programme for Research and Innovation.

Grant Agreement number: 1922

Project deliverable

Project Number	Project Acronym	Project Title
1922	GOTHAM	Governance Tool for sustainable water resources allocation in the Mediterranean through stakeholder's collaboration. Towards a paradigm shift in groundwater management by end users.

Instrument	Thematic Priority
Research and Innovation Action	Mediterranean water co-operation

Title

D1.1. Stakeholder Mapping and analysis

Contractual Delivery Date	Actual Delivery Date
October 2020 (M8)	21.05.2021

Organisation name of lead contractor for this deliverable	Document version
GAC Group	V1.0

Dissemination level		Deliverable Type	
Public	X	Document, Report	X
Confidential		Demonstrator	

Authors (organisation)

GAC, CETAQUA, ICU, MoA, NARC

Reviewers (organisation)

CETAQUA

Abstract

The overarching objective of the GOTHAM project is to develop and validate a user-driven tool that enables effective groundwater governance to ultimately preserve the quantity and quality of this strategic resource in the Mediterranean basin. The GOTHAM Tool (GTool) uses an integrated methodological approach that targets optimal allocation of water resources from an environmental, social and economic perspective, including stakeholder knowledge, priorities and behaviour. One of the main strengths of the tool is that it provides a common framework for collaboration and engagement of the different water users (mainly, agricultural communities but also municipal and industrial users), as well as other relevant stakeholders such as water producers/operators and regulator(s).

Stakeholder engagement requires stakeholder mapping and analysis which is the very purpose of this deliverable. The current deliverable provides an overview of the three use cases in Lebanon (Iaat Baalbeck-Hermel), Spain (Campo de Dalías) and Jordan (Azraq Basin) and provides respectively stakeholder mapping for each of the areas, outlining the main actors and organisations in the respective area and their roles. Based on

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extensive interviews that were conducted with these local stakeholders, their views on water management in the respective areas, needs and expectations in general in regards with water, and also the GTool proposed by the GOTHAM project are detailed and analysed. A concluding part provides a cross-analysis of the use cases.

Keywords

Stakeholder mapping, stakeholder analysis, water basin, water quantity, water quality

Disclaimer

GOTHAM has been financed by the European Commission.

Project summary

The overarching objective of the GOTHAM project is to develop and validate a user-driven tool that enables effective groundwater governance to ultimately preserve the quantity and quality of this strategic resource in the Mediterranean basin. The GOTHAM Tool (GTool) uses an integrated methodological approach that targets optimal allocation of water resources from an environmental, social and economic perspective, including stakeholder knowledge, priorities and behaviour.

One of the main strengths of the tool is that it provides a common framework for collaboration and engagement of the different water users (mainly, agricultural communities but also municipal and industrial users), as well as other relevant stakeholders such as water producers/operators and regulator(s). The GTool will enable them to exchange information to reach the optimal water governance at each point in time as well as in future scenarios.

The concept of the proposed GTool targets effective groundwater governance for the improvement of the management and preservation of this essential and strategic resource. This effective groundwater management remains an important and complex challenge in the Mediterranean and elsewhere but is essential to ensure long-term sustainable use of the resource.

In this regard, GOTHAM integrates multicriteria decision methods for stakeholder group decision making and social learning and use the socio- hydrological water balance framework as a theoretical foundation for water allocation to evaluate the dynamic balance between the societal and ecological systems in catchments. GOTHAM project presents a bottom-up decision-making approach inspired by this methodological framework.

GOTHAM project presents a scalable and user-specific tool for decentralising water resources management, using big data analysis. The proposed user-based tool leverages six analytical modules:

- The **water balance and water quality dynamics modules** use advanced investigation of the main aquifer formations and real-time monitoring (on-site and distant), including a preliminary analysis of the background hydrogeological and hydro-meteorological information to create a baseline.
- The **water availability and demand forecasting modules** predict different water scenarios and assess their impact on groundwater quality and quantity status using remote-sensing measurements to model agriculture water demand and assess water availability.
- The **Managed Aquifer Recharge (MAR) and aquifer remediation module** mobilises multicriteria analysis (QGIS environment), including hydrogeological, economic, and chemical (water quality) indicators as well as regulatory restrictions to evaluate the feasibility of MAR schemes.
- The **agro-economic module** simulates the effect of different economic instruments, such as water tariff structures, water markets contexts and incentives for water savings (water demand management) and assessing the economic use values and trade-offs between users in alternative resource allocation scenarios.
- The **user's engagement module** enables to fix water priorities (water boundary conditions) by water users, taking into consideration water resources to meet water demands.

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- The **optimised water allocation module** calculates the optimal mix of water sources satisfying their requirements.

GTool uses data visualisation techniques to deliver the results into customisable dashboards tailored for the needs of each stakeholder.

Broad outreach activities will take place in Europe, Lebanon, and Jordan, therefore contributing to GOTHAM impact maximization.

The further development and exploitation (beyond the project) of the GTool will be done by CETaqua, both on B2B and B2C approaches.

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Table of content

Executive Summary 8

1. Introduction 10

1.1. Background 10

1.2. Concept 11

1.3. Methodology 13

2. Use case 1 - Iaat Baalbeck-Hermel Lebanon 16

2.1. Description of the basin 16

2.1.1. Water budget 18

2.1.2. Causes of overexploitation of water 19

2.1.3. Impact of the Agricultural sector on water 20

2.1.4. Data 20

2.2. Objectives of GOTHAM for the basin 21

2.3. Stakeholder mapping and analysis at basin level 22

2.3.1. End-users 23

2.3.2. Water Producers 27

2.3.3. Water Utilities/ Suppliers 32

2.3.4. Water Regulators 37

2.3.5. Intermediary organisations 40

2.3.6. Interviews - conclusions 43

3. Use Case 2 – Campo de Dalías 47

3.1. Description of the Basin 47

3.1.1. Upper aquifers 48

3.1.2. Lower Aquifers 49

3.1.3. Water Budget 49

3.1.4. Causes of overexploitation of water 50

3.2. Objectives of GOTHAM for the basin 51

3.3. Stakeholders mapping and analysis at basin level 52

3.3.1. End-Users 54

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3.3.2. Water Producers 55
3.3.3. Water Suppliers 56
3.3.4. Water Regulators 58
3.3.5. Other relevant actors and organisations 60
3.4. Interviews - conclusions 62
4. Use case 3 - Azraq Basin, Jordan 65
4.1. Description of the Basin 65
4.1.1. Water Budget 66
4.1.2. Causes of overexploitation of water 67
4.1.3. Impact of the Agricultural sector on water 68
4.2. Objectives of GOTHAM for the basin 69
4.3. Stakeholders mapping and analysis at basin level 69
4.3.1. End-users 70
4.3.2. Water Producers 74
4.3.3. Water Suppliers/utilities 75
4.3.4. Water Regulators 76
4.3.5. Intermediary Organisations 77
4.3.6. Interviews - conclusions 79
5. Conclusions and next steps 82
6. Bibliography 87
7. Annex – Interview guidelines 89
7.1. General information 89
7.2. Methodology and aim of the interviews 89
7.2.1. Individual interview per stakeholder type 90
7.2.2. Generic interview – to be filled out by all stakeholder types 96

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Table of figures

Figure 1: Conceptual workflow with bottom-up decision-making as a key issue in water resources management 11

Figure 2: GOTHAM work flow 13

Figure 3: Location of the Iaat Municipality in Lebanon 16

Figure 4: Hydrogeological map of the Iaat Municipality area 17

Figure 5: Conceptual model and water budget of the aquifers located in the Upper Litani River-Orontes River Basins (USAID-LRBMS, 2013) 18

Figure 6: Change in Water Level between 1970 and 2010 (Upper Beqaa and Anjar) (IWMI-USAID, 2013) 19

Figure 7: Stakeholders at basin level 22

Figure 8: Location of the Campo de Dalías-Sierra de Gádor region 47

Figure 9: Hydrogeological map of the Amman Zarqa-Azraq region. Taken from Al-Hadidi et al. (2013) 65

Figure 10: Water budget in Azraq basin 67

List of tables

Table 1. Water budget of the aquifers located in the Upper Litani River-Orontes River Basins. Data in hm^3/year (USAID-LRBMS, 2013) 19

Table 2: Stakeholder mapping in Iaat Baalbeck-Hermel 23

Table 3: Fees and services charged by Water Utilities/Suppliers 33

Table 4 Summarized water budgets in previous researches in the Sierra de Gádor-Campo de Dalías groundwater body 50

Table 5: Stakeholder mapping in Campo de Dalias 52

Table 6: Stakeholder mapping in Azraq Basin 70

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Executive Summary

GOTHAM aims to bring together different stakeholders and to create Communities of Practices across the three case studies of Iaat Baalbeck-Hermel (Lebanon), Campo de Dalías (Spain) and Azraq Basin (Jordan) to better manage the groundwater bodies that are threatened by overexploitation. The project will develop an innovative groundwater governance tool (GTool), specifically designed under the consensus of all relevant water actors (water regulators, water producers, water utilities, end-users, and other relevant organisations), that will use an integrated methodological approach that targets an optimal allocation of water resources from an environmental, social, and economic perspective including stakeholder knowledge, priorities, and behaviours. The Community of Practices provide a practice-based framework for collaborative social learning and promoting engagement with local communities. It can be defined as groups of participants who *"share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis"* (Wenger et al., 2002).

To set the groundwork for the Communities of Practices and the bottom-up decision-making approach for water resources management, stakeholder mapping and analysis had to be conducted, which is the very purpose of this deliverable. As a first step, for each case study, the description of the basin (including information on geography, water budget, causes of overexploitation of water, etc.) is provided with the support of the GOTHAM local partners and their expertise and knowledge, to familiarise the reader with the case study and the issues at hand. Following, the objectives of GOTHAM for the basin are outlined very briefly. Finally, and most importantly stakeholder mapping and analysis were conducted. In the context of GOTHAM and the three use-cases, stakeholders were considered those key actors who have an interest in the issue of groundwater, either because they are affected/impacted by the subject or because they have influence, knowledge or experience related to groundwater. As such, the stakeholder groups to be analysed were identified as:

- Water end-users (e.g. farmers, urban users)
- Water producers (e.g. drinking water treatment plant, wastewater treatment plant and seawater desalination plant)
- Water suppliers (e.g. water utilities, water operators, irrigation communities, etc.)
- Water regulators
- Intermediary organisations (e.g. NGOs, associations, etc.)

The exact composition of the groups depended on the case studies and their specificities, for instance, in Jordan, the Ministry of Water and Irrigation is responsible for most groundwater management issues, it is a regulator and a water supplier, whereas in Lebanon there is a larger variety of stakeholders having different functions, the regulators and suppliers are separate actors. All case-study leaders identified stakeholders at different levels, and stakeholder mapping was conducted. Following this, in-depth interviews were conducted in the three case-study areas with overall more than 70 respondents, which aimed at understanding:

- The respondents/stakeholders' preliminary roles and expectations, influence, and interests regarding water resources management.
- Their main drivers and the elements that can be used to effectively engage them in the GTool design process.

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- Their needs regarding GTool capabilities, and preparation of the first co-creation workshop.
- Their interest in participating in Communities of practices for the sake of the GOTHAM project.

The interview data was thoroughly analysed, and findings are presented in the current report. The three uses cases can be shortly summarised as follows:

Iaat Baalbeck-Hermel in Lebanon is known for its freshwater deposits, which have now dried up due to inadequate water management. Pumping has resulted in a reduction in the water table and, as a result, a decline in water quality in the basins over the past ten years. Only in the case study area, there were about 200 wells drilled, most of them illegally, that farmers use to irrigate their agricultural lands. Most lands are irrigated using surface irrigation method, wasting large amounts of water, while modern irrigation systems, drip irrigation or sprinkler are limited. Some of the main actors include the end-users, suppliers e.g. Bekaa Water Establishment, Iaat Municipality, regulators e.g. the Ministry of Energy and Water and the Ministry of Agriculture, amongst others. Overall, 25 interviews were carried out in the region. Based on the interviews, end-users have difficulty affording water, sometimes do not have access to water, and have reservations about water safety. There is little water use monitoring (and therefore possible overconsumption) by private well owners, as well as a lack of law enforcement – such wells are mostly illegal and do not pay fees. There are problems with water treatment in general. Nevertheless, most of the stakeholder groups continue to work together and have a positive outlook, including about the GTool and the positive changes that it could bring.

Campo de Dalías in Spain is in Almería region of Spain and is one of the most developed irrigated agricultural areas of the world. There are 8 different aquifers in the region. Intensive pumping has led to overexploitation of water resources and affected the overall quality of water in the region. Pumping in the area, to satisfy agricultural and urban demands, has resulted in aquifer degradation since the exploitation started. End-users (farmers, urban users), JCUAPA end-users' association, suppliers such as Hidralia Roquetas de Mar, and regulators such as the Regional Ministry of Agriculture, Livestock, and Fisheries are some of the most important stakeholders identified in the area. In Campo de Dalías seven interviews were conducted. The results of the interviews suggest that water is mostly accessible and affordable for end-users. Most stakeholders agreed that water quality could be improved. The interviews suggested that there is limited collaboration amongst the different stakeholders, and some suggested that there was lack of communication and transparency. Most stakeholders are open towards the GTool and Communities of Practices.

Azraq basin in Jordan is a semi-desert area characterised by hot and dry summers and wet and cold winters. The region consists of three aquifer systems. The mismanagement of groundwater by both the government, through its lack of control, and private users who still engage in illegal drilling, caused continuous deterioration of water quality and quantity in the region. The agriculture sectors started cultivating crops such as grapes and pomegranates despite of the high-water consumption of these plants. The important stakeholders identified in the region include end-users, Ministry of Water & Irrigation, etc. Based on the interviews, there is a consensus among the stakeholders about shortage of water during the summers. There is unjust pumping in the areas which further increases the problems for the basin. Similar to the other case studies, most stakeholders are enthusiastic to participate in the creation process of the GTool and are quite open to the concept of making use of a smart tool and be involved in Communities of Practices.

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1. Introduction

1.1. Background

Water resources around the Mediterranean basin are depleting due to overuse. Underground water bodies are seriously threatened by overexploitation and, in coastal areas, salinisation due to seawater intrusion. GOTHAM project will develop an innovative groundwater governance tool (GTool) specifically designed under the consensus of all relevant water actors (water regulators, water producers, water utilities, end-users, etc.), which will allow for a new groundwater management framework based on users (bottom-up approach), as opposed to the current top-to-down model in which the regulator establishes the enforcing rules on an -almost- single basis. As such, it boosts the establishment of a new and revolutionary groundwater management scenario and laying the foundations for an innovative water users-based governance.

The concept of the bottom-up decision-making approach proposed by GOTHAM can be found in scientific studies, some examples illustrated hereafter. (Sabina et al., 2010) suggest that public participation is a recognised tool to support natural resources management since the 1960s and that there is a need for an integrated water resources management, which should be participatory, technically, and scientifically informed and which should be based on a bottom-up approach. Stakeholder participation is expected to improve the efficiency, equity, and sustainability of natural resource management research and development (R&D) projects by ensuring that research reflects users' priorities, needs, capabilities, and constraints (Johnson et al., 2004). The findings of (T. P. Karjalainen et al., 2013) propose to integrate multicriteria decision methods for stakeholder group decision making and social learning. Furthermore, the European Water Framework Directive (Directive 2000/60/EC, WFD) puts a strong emphasis on stakeholder and public participation in water management and the (European Commission (EC)., 2003) asserts that the involvement of stakeholders is key to achieve sustainable water management. Overall, public participation is becoming an increasingly important aspect of natural resource management and that to achieve sustainable natural resource management, the involvement of individuals and communities is necessary.

As such, the integration of the GTool is expected to lead to effective groundwater governance for the improvement of the management and preservation of this essential resource (Figure 1: Conceptual workflow with bottom-up decision-making as a key issue in water resources management) and ensure its long-term sustainable management in the three case studies in Campo de Dalías (Spain), Iaat Baalbeck-Hermel (Lebanon) and Azraq Basin (Jordan). It shall have a positive impact on the chemical and quantitative status of aquifers, avoiding or reducing water salinization and water table drops, increasing the guarantee of supply for the different water uses as well as the resilience of the system -as a whole- against future adverse climatic situations.

As displayed in *Figure 1: Conceptual workflow with bottom-up decision-making as a key issue in water resources management* throughout the decision process of current groundwater governance models, doubts are raised, and knowledge is generated at each decision level. Since currently there is no exchange of meaningful information between different agents. In this sense, there is a need of a tool capable of allowing data exchange between the different stakeholders and water users and the integration of this highly valuable information in groundwater governance decisions. The benefits of this exchange of information together with the end-users collaboration are wide and would allow

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overcoming critical current governance limitations regarding groundwater management by for example improving the information on water balances at the basin scale. The tool will also enable to establish the responsibilities and competencies of each water user, depending on their role in water management.

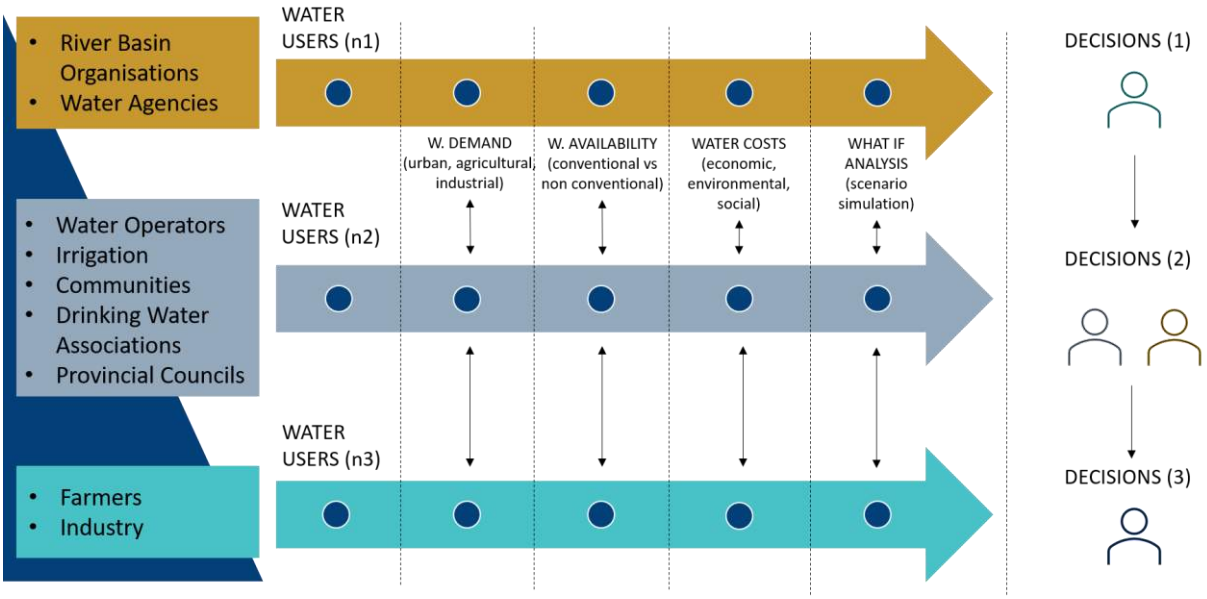

Figure 1: Conceptual workflow with bottom-up decision-making as a key issue in water resources management

1.2. Concept

The first question concerns what exactly one might understand under stakeholder. The EC (2003), in the Common Implementation Strategy Guidance Document n. 8 which refers to stakeholder participation in relation to the implementation of the Water Framework Directive states that*: "A stakeholder can be any relevant person, group or organisation with an interest in the issue, either because they will be affected by the subject (victim, gainer) or because they have influence, knowledge or experience with the subject"* (European Commission, 2003: 63). Stakeholders can also be defined as *"persons or groups that have, or claim, ownership rights, interest in a corporation and its activities, past, present or future"* (Clarkson, 1995). They can collaborate or on the contrary have conflicting interests. This is important in the context of water management, as mismanagement of water, for example, overuse of water resources, is often the result of conflicting interests between stakeholders.

Stakeholder mapping & analysis is instrumental to policymaking. It enables to better understand actors' needs, expectation, agendas and interest, interrelations, and influence onto the decision-making process. Knowing stakeholders' viewpoint on a given issue, as well as between each other, is key to understand the policy context, assess the feasibility of future policies and ultimately conduct change.

The mapping of stakeholders can be a dynamic mechanism that helps organisations to represent all stakeholders graphically, the political context in which the project is and also the stakeholder relationships. (Miller et al, 2015).

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Stakeholder analysis is commonly identified as an approach or a tool to obtain knowledge and information about stakeholders, their interests, importance, influence, resources and so on (Grimble et al, 1997). In carrying out the analysis, questions can be asked about the position, interest, influence, interrelations, network and other characteristics of the stakeholders, with reference to their past, present positions and also their involvement in the future (Freeman, 1984).

In GOTHAM, stakeholders are gathered around one issue, the depletion, in terms of both quantity and quality of the groundwater resources in three use cases around the Mediterranean basin:

- Laat Baalbeck-Hermel in Lebanon
- Campo de Dalías in Spain
- Azraq Basin in Jordan

This report aims at mapping the relevant stakeholders in the three use cases and understanding:

- The stakeholders' preliminary roles and expectations, influence and interests regarding water resources management
- Their main drivers and the elements that can be used to effectively engage them in the GTool design process
- Their needs regarding GTool capabilities, and preparation of the first co-creation workshop.
- Their interest in participating in Communities of practices for the sake of the GOTHAM project

The stakeholder mapping and analysis supports two complementary components of the GOTHAM project:

- The community engagement strategy of the project and the creation of "communities of practices" in the use cases
- The preliminary assessment of needs to prepare the co-creation workshops enabling to design the GTool.

GOTHAM will work with Communities of Practices (CoP),i.e. groups of participants who *"share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."* CoPs provide a useful practice-based framework for collaborative social learning and promoting engagement with local communities. In the context of the project, stakeholders share a domain of interest (management of the water resource) and will work towards the creation of the GTool (practice pooling resources towards a common goal), but a trustful community based on ongoing interactions between members is yet to be created: indeed, users are likely to have conflicting interests over the use of water. The community of practices' framework, centred on social learning, will thus help to better understand each other's needs, to create shared interests and co-create the solution aiming at better water management, the GTool. In addition, by knowing and interacting with each other, members of the CoPs will set the basis for long-term fruitful collaboration in the field of resource management, sharing knowledge on how to better manage resources and ensuring a long-term positive impact of the project. Stakeholder mapping is a preliminary step to the construction of CoPs. The steps that follow after stakeholder mapping and analysis are displayed in *Figure 2: GOTHAM work flow.*

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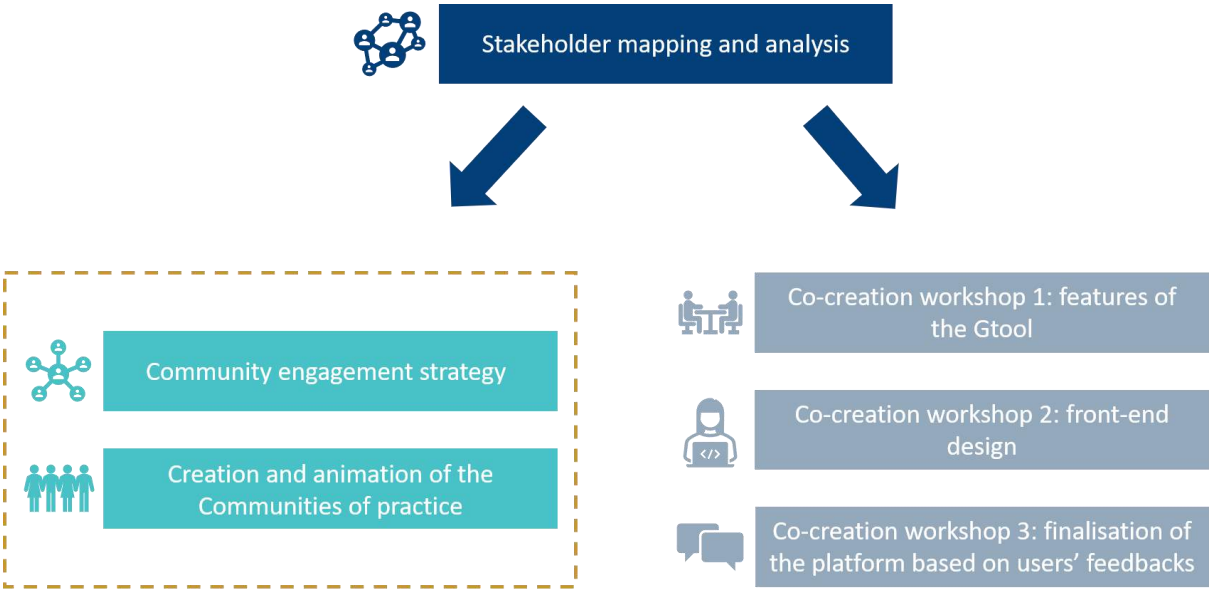

Figure 2: GOTHAM work flow

1.3. Methodology

As a first step, for each case study, the description of the basin, including information on geography, water budget, reasons for overexploitation of water, and other criteria, is provided with the support of the GOTHAM local partners and their expertise and knowledge, to familiarise the reader with the case study and the issues at hand. Following, the objectives of GOTHAM for the basin are outlined very briefly. Finally, the stakeholder mapping and analysis is undertaken for each case study. A five-step process is used for stakeholder mapping and analysis as suggested in Brugha et al. (2000), outlined below.

1. **Identification and mapping of stakeholders**

The first step consisted of understanding the issue at stake and pre-identifying the relevant stakeholders for the three use-cases, who would be interviewed at the next phase.

In the context of GOTHAM and the three use-cases, stakeholders were considered those key actors who have an interest in the issue of groundwater, either because they are affected/impacted by the subject or because they have influence, knowledge or experience related to groundwater. These can be stakeholders who hold influence and/or power to make decisions or steer the community of stakeholders or control the supply of water in the region (Murray-Webster et al, 2006). In this context, the stakeholder groups to be analysed were identified as:

- Water end-users (farmers, urban users)
- Water producers (e.g. Drinking Water Treatment Plant, Wastewater Treatment Plant and Seawater Desalination Plant)
- Water suppliers (e.g. water utilities, water operators, irrigation communities, etc)
- Water regulators
- Intermediary organisations (NGOs, associations, etc.)

All case-study leaders (local GOTHAM partners in the three areas) identified stakeholders at different levels, as such the stakeholder mapping was conducted. It is important to note that in some cases the

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same actor can belong to several categories, for example an organisation might be a water regulator, but also act as a water supplier. In such case, in the stakeholder mapping, the actor appears in both categories (if there is a sub-branch of an organisation which has a clear function, this is indicated). If people were interviewed from such organisations which have several functions, the interview of the person can be found in the relevant stakeholder category, depending on the function of the person in the organisation.

2. Data collection

The data collection was conducted by the local partners. Based on the stakeholder identification and mapping, their role was to find relevant contacts within each of the stakeholder groups and conduct interviews. Interviews aimed at gathering information about:

- The stakeholders' preliminary roles and expectations, influence and interests regarding water resources management.
- Their main drivers and the elements that can be used to effectively engage them in the GTool design process
- Their needs regarding GTool capabilities, and preparation of the first co-creation workshop.
- Their interest in participating in Communities of practices for the sake of the GOTHAM project.

Data collection (interviews) were conducted by local partners who are trusted by the local stakeholders, to obtain accurate results. The local stakeholders conducted semi-structured interviews, the framework of which was provided by GAC. These interview guidelines can be found in *Annex – Interview guidelines*. Interviews were conducted in the local language. Due to the COVID-19 sanitary crisis, and the different regulations in the three case-study areas, the number of interviews that could be taken differ per case study, for example in Spain less interviews could be conducted compared to the two other case studies. In some cases, it was more difficult to establish interviews with representatives of some stakeholder groups, for example end-users in Spain.

The interviews presented an opportunity to engage with stakeholders. Stakeholders are likely to be mobilised beyond the interview stage to participate in co-creation workshops and communities of practices. As such, the aim was to also understand their interest and their relevance for the process. All the interviews for all three case studies remain anonymous.

In the case of Campo de Dalías in Spain, the stakeholder interviews began in December 2020 and were concluded in February 2021. Approximately 15 interviews were planned across all types of stakeholders, however, finally overall 7 interviews were carried out, representing the following stakeholder groups: 1 end-user, 1 water producer, 1 water supplier, 2 water regulators and 2 intermediary organisations. and in terms of gender, all interviewees were male. Nevertheless, interviews were conducted with senior people with extensive experience in the field in order to get in-depth information. The majority of the interviews that were not carried out belong to Aqualia, the water distribution company in Almeria, which is a direct competitor of Hidralia, to which Cetaqua belongs. All interviews were conducted through digital platforms due to the current situation. The problems derived from the inability to meet physically have been solved by using the camera and facilitating the creation of meetings adapted to the needs of each person. This did not pose a problem for conducting the interviews, except for the inconvenience of not being able to access the facilities of each of the people. Another inconvenience derived from COVID-19 is not being able to carry out more interviews with many end-users as they did not trust the digital platforms to answer some questions.

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In the case of Laat Baalbeck-Hermel in Lebanon, the interviews started at the beginning of November 2020 and were concluded in early February 2021. Interviews with overall 25 people were conducted, representing the following stakeholder groups: 9 end-users (8 males, 1 female), 8 water producers (7 males, 1 female), 4 water suppliers (4 males), 2 water regulators (2 males) and 2 intermediary organisations (2 males). The selection of stakeholders was done in close collaboration with Iaat Municipality. During meetings held between project team and the Municipality, criteria have been set in order to ensure the selection of stakeholders active in community activities, open to dialogue and discussion and represent a lever for CoP activities and not hinder. Interviews and the questionnaire sheets were translated into Arabic to ensure better understanding and increase participation form all users. Unfortunately, the slow pace in the implementation of these interviews was caused by the COVID-19 pandemic in addition to the lockdown of the country during the last two weeks of November 2020.

In the case of Azraq Basin in Jordan, the interviews started at the beginning of November 2020 and were concluded in March 2021. Over 45 stakeholders were interviewed which included 38 end-users (20 females, 18 males), 1 water producer, 3 water suppliers (2 males, 1 female), 1 regulator (male), and 5 representatives of intermediary organisations (2 males, 3 females). The meetings were held face-to-face taking into consideration all the protective measures in the COVID-19 pandemic situation. Interviews and questionnaire sheets were translated in Arabic for better understanding and increased participation form all users.

3. Organisation and analysis of data

GAC team collected data from each use case leader, in the form of translated interviews. The local partners translated the content of the interviews into English and sent the translated interviews and/or interview summaries to GAC. GAC team discussed with the local partners the content of the interviews. Interviews were carefully read to ensure that respondents are not biased and that answers are accurate.

4. Presentation of findings

The interview findings are presented in the form of summaries per stakeholder group, within all of the case studies. For example, in the case of Lebanon, the aggregate findings from the interviews with the 8 water producers are presented in the form of a summary of the views of the 8 people, which permits to create an overall vision on the point of view of the given stakeholder group. Nevertheless, the individual points of view are highlighted in the summaries, especially when they are contradictory or there are very few interviewees. While these summaries reflect purely the content of the interview questionnaires in the form of coherent, fluid text, and are presented in a factual and neutral way, the deductions of the authors of the deliverable, based on the interview responses are summarised in yellow boxes to distinguish the data from the authors' subjective comments, analysis and conclusions. As a final step, for each case study, a chapter "*Interviews- conclusions"* was written where the points of views of all the stakeholder groups are summarised and compared to each other in the form of a matrix.

5. Cross-analysis

The cross-analysis of the analysis of the interviews in the three case-studies is the last step of the process and is presented in *Chapter 5 Conclusions and next steps*.

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2. Use case 1 - Iaat Baalbeck-Hermel Lebanon

2.1. Description of the basin

Iaat is a town and municipality located in the Beqaa Valley of Lebanon in the Northeastern part of the country with an area of about 2845 ha[1]. Administratively related to Baalbeck-Hermel Governorate (Baalbeck district), the capital city of which, Baalbeck comprises impressive archaeological sites designated as UNESCO world heritage site in 1984. The study area is the Iaat municipality -28.5 km^2-, located in the upper part of the Orontes River Basin and close to the city of Baalbek, where approximately 1,700 ha of irrigated agriculture exist (UN-ESCWA and BGR, 2013).

Iaat is famous for its richness in freshwater resources, which unfortunately have dried up in recent years due to poor water management. It is also known for its natural (Al-Massil, Wardine, Berket Al-Louz) and archaeological sites as the ancient Roman road that passes through, where a Corinthian victory column stands in the middle of the road.

Iaat and Baalbeck district is a semi-deserted area characterized by hot and dry summers and cold winters. The annual rainfall average is 450 mm/year and the altitude is 1040 m. The total population of Iaat is estimated at around 22.000 inhabitants, among them 12.000 Syrian refugees, most of them live in sporadic camps.

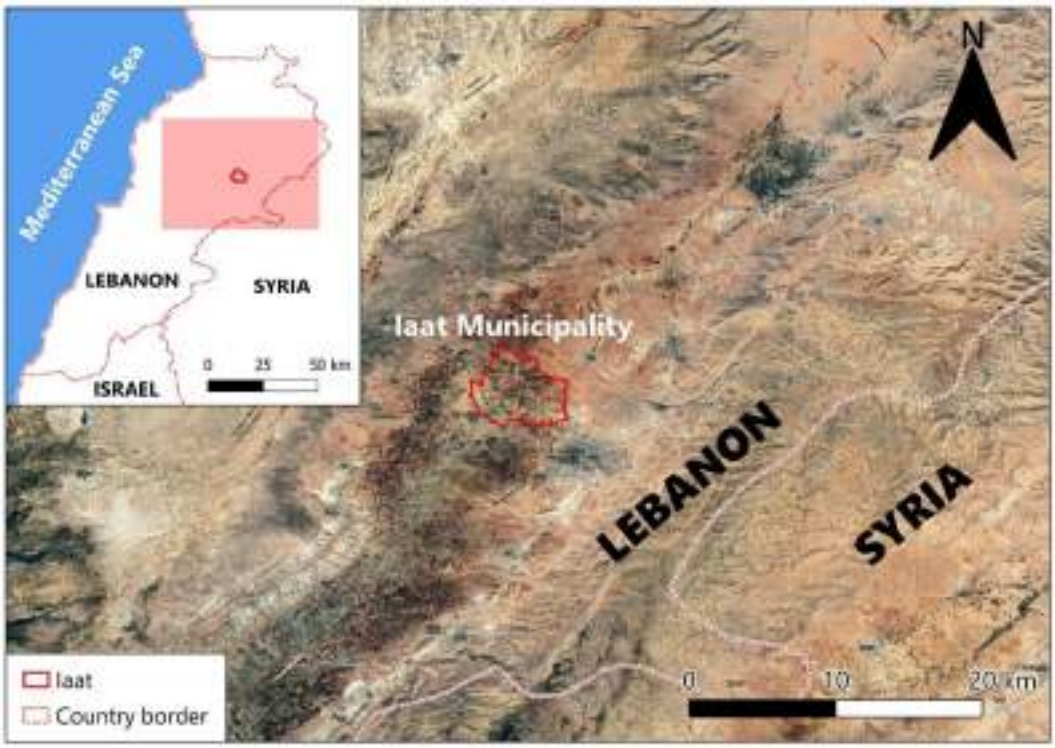

Figure 3: Location of the Iaat Municipality in Lebanon

[1] www.libandata.org

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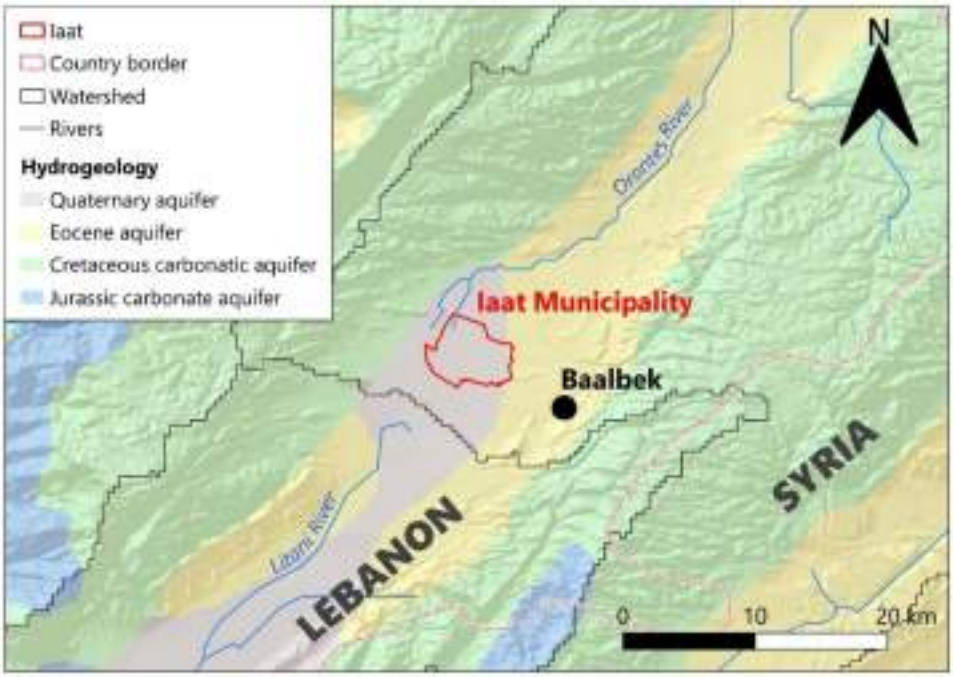

Figure 4: Hydrogeological map of the Iaat Municipality area

Ain-Zarqa and Ain-Labweb are the mainsprings in the area (>1,000 l/s) and constitute the first source of water of the Orontes River. They receive water from the Cretaceous limestone aquifer, which is mainly recharged by rainfall.

Several aquifers exist in this region and most of the existing springs have them as a source of water (Molle, 2017). The existing aquifers are:

- **Jurassic aquifer:** karstic materials located in the western part of the region, including Mount Lebanon, from Chtaura to Qaraoun Lake.
- **Cretaceous aquifer**: it is made of karstic limestone and covers part of the north-western flank of the basin and all the eastern flank (Anti-Lebanon mountain range).
- **Eocene aquifer**: it is also composed of karstic limestones and only appears around Joub Jannine and in thin stripes on the east and the west sides of the Beqaa Valley. This aquifer lies underneath a low transmissivity layer (Eocene marls) that separates it from the upper Neogene aquifer.
- **Neogene aquifer**: it is located above the aforementioned marls and under the Quaternary sediments, and alluvial deposits and conglomerates are the main composing aquifer materials. This aquifer outcrops on both sides of the valley.
- **Quaternary aquifer**: this is a layer of unconsolidated sediments (silts, clays, sands and gravels) that cover the centre part of the Beqaa Valley, where most of the agricultural soils are located.

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2.1.1. Water budget

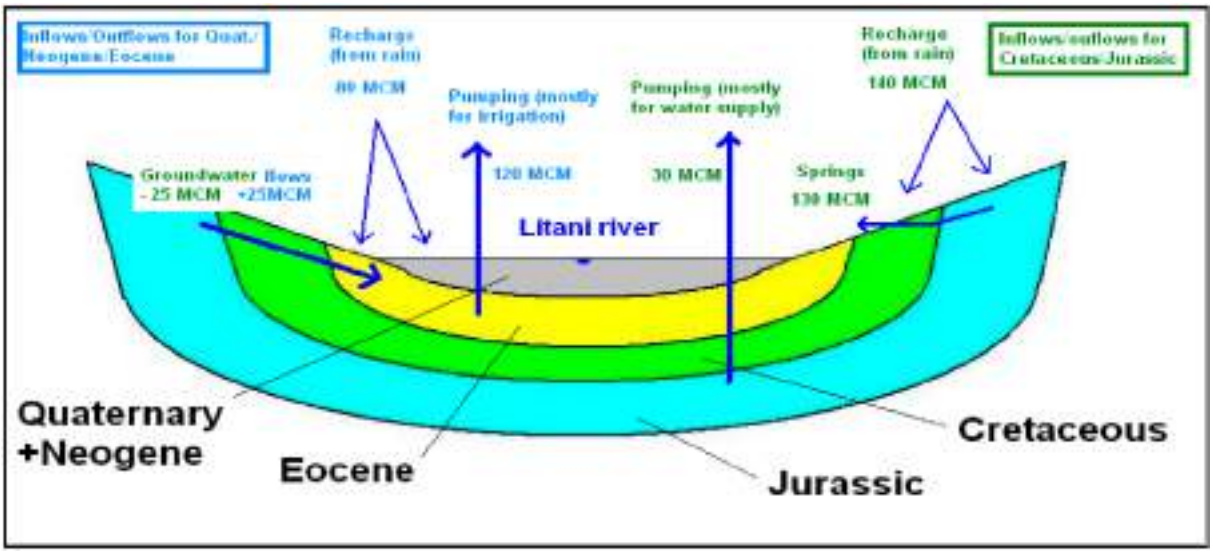

Figure 5: Conceptual model and water budget of the aquifers located in the Upper Litani River-Orontes River Basins (USAID-LRBMS, 2013)

Figure 5: Conceptual model and water budget of the aquifers located in the Upper Litani River-Orontes River Basins (USAID-LRBMS, 2013) illustrates the conceptual model of the aquifers in the study area, comprised between the Upper Litani River and the Orontes River Basins. This figure also shows the overall water budget of the aquifers but focusing on the Upper Litani River Basin (ULRB) region, south of the study area. However, it allows knowing the main inputs and outputs of the aquifers.

Regarding the karstic Cretaceous-Jurassic aquifers, recharge comes only from the precipitation fallen in the unconfined mountainous areas (140 hm3/year) and some wells pump water from them to provide water supply (30 hm3/year), as displayed in *Table 1. Water budget of the aquifers located in the Upper Litani River-Orontes River Basins. Data in hm3/year (USAID-LRBMS, 2013)*. Also, other outputs are produced towards the multiple springs (130 hm3/year) and towards the upper aquifers by lateral recharge (24 hm3/year). So, overall there is a negative water budget in these aquifers of -44 hm3/year.

On the other hand, recharge coming from rainfall in the Quaternary-Neogene-Eocene aquifers is 80 hm3/year and some lateral inputs are coming from the karstic aquifers (24 hm3/year), but there is an intense pumping of 120 hm3/year for irrigation of agricultural crops. Also, 7 hm3/year are drained to the Litani. So overall there is a lack of 23 hm3/year of water in these upper aquifers.

	Recharge from precipitation	Pumping	Springs	Transfers + to GW	Balance
Quaternary-Neogene-Eocene	80	-120	0	17 (-7 to Litani River, +24 from lateral aquifers)	-23
Creaceous-Jurassic	140	-30	-130	-24 (laterally to upper aquifers)	-44
Total	220	-150	-130	-7	-67

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Table 1. Water budget of the aquifers located in the Upper Litani River-Orontes River Basins. Data in hm³/year (USAID-LRBMS, 2013)

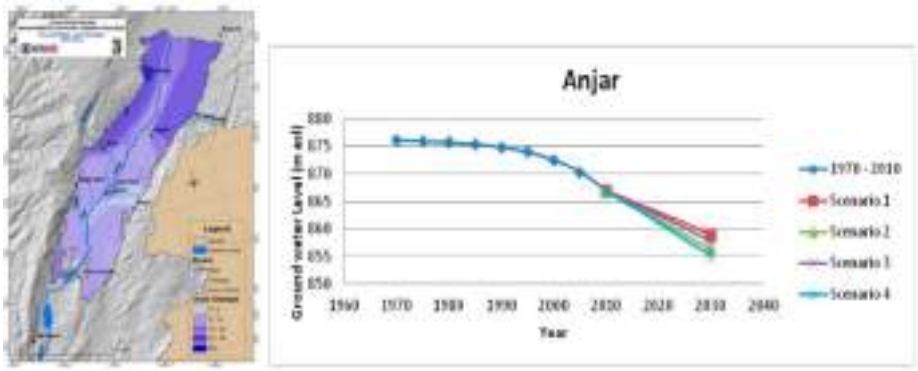

Figure 6: Change in Water Level between 1970 and 2010 (Upper Beqaa and Anjar) (IWMI-USAID, 2013)

In conclusion, 67 hm3/year of water is being overexploited in both upper and lower aquifers, which means that the groundwater table is falling down progressively (*Figure 6: Change in Water Level between 1970 and 2010 (Upper Beqaa and Anjar) (IWMI-USAID, 2013)*), but more intensively in the last few decades, with very dramatic scenarios forecast for the next years.

2.1.2. Causes of overexploitation of water

One may want to explore the causes of overexploitation of water in recent years in Iaat. The Iaat freshwater sources, both underground and superficial, were considered to be the richest in the area. Many springs were overflowing with large amounts of water and it was sufficient to dig tens of meters to reach the underground water. There are two water basins from which the town benefits, a northern basin that extends to the headwaters of the Litani river and a southern basin that feeds the springs in the area. More than 90% of water comes from groundwater, there are no sources of surface water in the region.

Starting in the late 1950s, well drilling and pumping technology started to unbalance the early natural equilibrium. Villages and farmers alike were gradually increasing the volume of both surface and groundwater resources for domestic uses and irrigation. From 1960 irrigation has almost quadrupled. Runoff to the Qaraoun dam decreased from 400 to 300 Mm^3/year on average.

Intensive pumping through the last 10 years has caused the lowering of the basins' water table and consequently decreasing the water quality. About 200 wells were drilled only in the area of the case study, mostly illegally, which farmers use to irrigate their agricultural lands. 95% of these wells are of limited capacity, pumping water from a depth of about 100 m, and only 5% of these wells reach more than 500m depth, which are the wells with high pumping capacity.

There is one well, owned by the Municipality, that pumps water all over the year and represents the only source of freshwater for civil use. The rest of the wells are used for agriculture activities and are pumped for about 5 months, from May to September. The Municipality estimates that the amount of groundwater pumped for agriculture reaches yearly about 9 million m^3 (60,000 m^3/day during 5

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months in summer) while unfortunately there is no exploitation of surface water including the treated water resulting from the Iaat wastewater treatment plant.

2.1.3. Impact of the Agricultural sector on water

All Iaat lands are flat and suited for agriculture like most of the fertile lands in the Bekaa valley. The soil texture provides great potential for crop production. The cultivated lands in Iaat are about 4000 ha, most of which are cultivated rain-fed Leguminosae (lentils, chickpeas …) and Gramineae (wheat, Barley …). As for irrigated lands that represent only 10%, mainly cultivated with potato and onion in addition to some stone fruits orchards. These lands are irrigated from May to September with underground pumped water, which consumed unfairly the groundwater and increases the cost of production. **Most lands are irrigated using surface irrigation method, wasting large amounts of water, while modern irrigation systems, drip irrigation or sprinkler are limited.**

Furthermore, the excessive use of chemical fertilizers and pesticides, especially in potato cultivation, has a major impact on groundwater pollution in addition to sewage pre-treatment plant and polluted treated water post-plant that some farmers use illegally to irrigate crops. The Municipality and security forces are suppressing this practice.

As such, the main challenges include:

- **Decline in water table level due to excessive underground water pumping**
- **The springs dried out, resulting in the disappearance of natural sites**
- **Leakage of polluted water in the southern water basin, coming from the wastewater treatment plant**
- **Increase in the pollution ratio in underground water, including the presence of Nitrate, BOD and microbiology pollution**
- **The country's economy is rapidly collapsing and the political situationis still complicated, consequently, the economic and social conditions have changed since the interview period. The economy will inevitably not return to its previous state, the prices have risen dramatically, and thus the cost of drilling wells, the cost of water extraction and transportation and agricultural production, which definitely will affect the choices that the stakeholders will make in the future.**

2.1.4. Data

Annual underground water pumped: about 10.000.000 m^3, from this 90% is used for agriculture.

- Total cultivated area (ha): 4.000
- Total rain-fed crops area (ha): 2.400 (60%)
- Total irrigated crops area (ha): 1.600 (40%)
- Total greenhouse crops area (ha): 3
- Total open-air crops area (ha): 3.997

Water price (€/m^3) during the interviews

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Water Price 1 m3	LBP	Euro - Official Exchange rate	Euro - Market exchange rate
Transported with cistern	1250	0.70	0.13
Transported with Pipes and flow-meter	834	0.47	0.08

Water price (€/m^3) during report preparation

	LBP	Euro - Official Exchange rate	Euro - Market exchange rate
1 m^3 of Water (transported with Citern)[2]	15.000	8.33	1

2.2. Objectives of GOTHAM for the basin

Current intensive pumping of groundwater resources will be shortened, and the aquifer's water table levels will be recovered. It is expected that 3 years after the GOTHAM project implementation in this replication site, the average water table of the aquifer will show a rise ranging from 1-3 m.

Furthermore, reclaimed water from the Iaat Waste Water Treatment Plant (WWTP)[3] will be considered as an additional source of water resources and will be incorporated into subsequent water management plans, increasing the total volume of available resources.

[2] *the price of 1m^3 transported with pipes and flow-metre not quantified yet, waiting the start of irrigation season.
Since September 2020, Lebanon suffers from an economic collapse and serious political complications, that led to the deterioration of the Lebanese pound (LBP) exchange rate against the USD. Nowadays, and in a very strange case, the LBP has several exchange rates, some of which are reasonable, and others are irrational. The official rate (1$=1500 LBP) especially for goods and services state-subsidized, the Bank's rate is (1$=3900 LBP) used for withdraws from bank accounts, the cheques in USD rate (25-30% of its value). The most traded value, used in commerce and in cash, is the black-market value (nowadays, 1$ = form 12.000 to 15.000 LBP), which fluctuates up and down, according to the political developments and for reasons that are not understood.

[3] According to the available information, the WWTP is out of service, and the wate water enters and comes out without treatment

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2.3. Stakeholder mapping and analysis at basin level

Figure 7: Stakeholders at basin level illustrates the main stakeholders in Iaat and the interrelations between their activities.

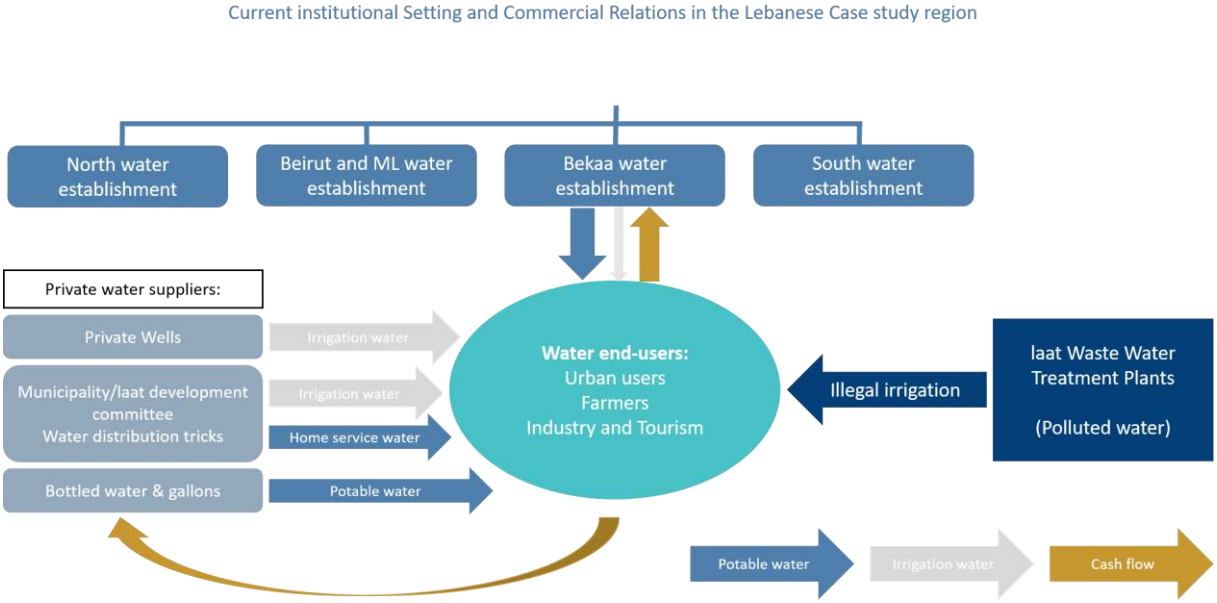

Figure 7: Stakeholders at basin level

Table 2: Stakeholder mapping in Iaat categorises the main organisations in the region per stakeholder type. Nevertheless, it must be noted that an actor might belong to several categories, for example, an end-user can also be a water producer if he/she owns a private well, which is often the case in the area.

Stakeholder type	Corresponding organisations in Iaat municipality
End-Users	Urban users, Farmers, actors in Industry and Tourism
Water Producers (e.g. Drinking Water Treatment Plant, Seawater Desalination Plant, Wastewater Treatment Plant and)	• Private well owners • Bottled water & gallons producers • Iaat Waste Water Treatment Plant (polluted water)
Water Suppliers/Water utilities (e.g. Water operators, Utilities, Water distributors etc)	• Bekaa Water Establishment (BWE) (public) • Iaat Municipality • Water distribution trucks (private)
Water regulators	• Ministry of Energy and Water (MoEW) • Ministry of Agriculture (MoA) - *involved only regarding irrigation and awareness-raising about rationalizing the use of water*

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Intermediary organisations (e.g. NGO's, local associations)	• Lebanese Organization for Studies and Training (LOST) • Iaat Development Committee (IDC)

Table 2: Stakeholder mapping in Iaat Baalbeck-Hermel

Water Management landscape

The tasks and responsibilities of the Ministry of Energy and Water (MoEW) and Bekaa Water Establishment (BWE) are very encouraging and promising, but the real situation on the ground is completely different. Given the current difficult circumstances, the weak financial, technical and human resources capabilities of the MoEA and the BWE, in addition to the failure to meet the big demands in water and many problems that the citizens suffer from, especially in the water sector, the Iaat Municipality has undertaken to carry out some tasks and responsibilities related to this sector. The Municipality drilled a well to provide end-users with drinking and domestic service water to overcome the shortage of water provided by BWE. The management of this well, the water distribution and the collection of fees were placed under the direct management of the Iaat Development Association in coordination with BWE.

Regarding the water used in agriculture, the main economic activity in Iaat, and with the absence of any irrigation projects in the region and the availability of fertile lands, the landowners and farmers took advantage of the lack of control and drilled during the last 10 years about 190 wells, most of them for irrigation, so used only during the drought months, from May to September. The main irrigated crops are potato, onion, vegetables and fruit trees.

A significant number of families in the area remain without any water sources. So small-scale water distributors transport water through tanks (of 5 m^3) from private wells to houses, especially for domestic service.

With regard to potable water, many families, especially those who have the financial capacity, use bottled water, which is water from the wells or the BWE water network, which is filtered and treated before it is distributed to houses by 10-20 litres of plastic bottles, or sold in supermarkets or shops. While other families, for economic reason, are obliged to drink water supplied by the Bekaa Water Establishment network.

In the sections below all the main actors and organisations (not just the ones with who interviews were conducted) within each stakeholder category in Iaat are listed and characterised. Following, the interviews with each of these stakeholder groups are analysed. Overall, 25 interviews with local stakeholders were conducted. Details can be found in the sections below.

2.3.1. End-users

2.3.1.1. End-users - actors and organisations in Iaat Baalbeck-Hermel

End-users in the region consist of main farmers and urban users, in addition to workers in minor productive sectors such as handicrafts, small industries, services and tourism. The farmers are among the vulnerable groups that suffer and will suffer more in the future from the economic crisis. Most of the farmers are small and medium-size, and they suffer from great challenges, the most important of which is the neglect and absence of government support, climatic factors, absence of irrigation

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projects and the high prices of agriculture inputs. All irrigated agricultural land in the region depends on groundwater wells, drilled in the last 10-20 years illegally by those who have financial capabilities, while others who could not afford to drill wells buy water from private service providers.

The urban users, employees and workers in the trade and services sectors are not in a better situation since they are no longer able to access their savings and the value of wages has deteriorated.

It is expected that the intractable crises in the country will make these groups, like the other population, face many challenges and will greatly affect their choices, habits and practices.

2.3.1.2. Interview summary and initial analysis

Nine end-users have been interviewed (4 farmers, 4 farmers and urban users at the same time, 1 urban user). From these nine end-users, 5 declared to be also water producers as they own a private well used especially for irrigation. Regarding gender, 8 males and 1 female were interviewed. The boxes below present short comments of the project team.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Based on the interviews conducted, the end-users mostly use groundwater for agricultural activities and household use especially in cases where the well is near the urban area. In cases where the wells are located in agricultural areas, groundwater is used only for irrigation. Only one interviewee claimed to use groundwater for tourism activities. The source of groundwater is in all cases borehole wells.

Quantity of the groundwater

Regarding the quantity of groundwater used, all interviewees declared to need annually less than 500.000 m^3. The end-users said that over **90% of the water they use comes from groundwater,** while the remaining 10% comes from BWE networks, and no sources of surface water are available in the region. End-users said that water shortage occurs during the summertime especially in the years when there is rain scarcity. Regarding water consumption, **only 20% use flow meters to monitor water consumption. The others use traditional and inaccurate methods of monitoring such as visual or by calculation**. 55% declared that they monitor how much water is needed / necessary and how much is used for irrigation or other purposes, though **45% do not adopt any means of monitoring**. Most of the interviewed stakeholders adopt more than one system of irrigation, 8 declared to use a sprinkler system, 5 drip irrigation and 2 manual irrigation. Irrigation season is about 5 to 6 months depending on crops, irrigation starts in April and terminates in October. Nevertheless, **100% of the interviewees declared to strive to use water efficiently and not to overuse it**. 78% declared to follow optimal water allocation recommendations, while 22% said they did not. Furthermore, 45% declared to be engaged in intelligent water use, while 55% said they were not engaged in such practices. In response to the question *"Do you face obstacles in obtaining water or face any issues with water",* **55% declared to face obstacles in obtaining the water or having issues with water**, especially in terms of regulations. 45% of stakeholders did not provide an answer to this question.

End-users said that water shortage occurs during summer and 55% declared to face obstacles in obtaining the water or having issues with water. Water consumption monitoring is still not a common practice in the region, with most end-users using inaccurate methods of monitoring, and some do not monitor at all, thus this is an aspect that certainly needs to be enhanced. Nevertheless, all the interviewees said they strive not to overuse water, which suggests that they

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are aware of water scarcity issues and the importance of consuming efficiently. End-users did not provide straightforward answers about the issues they are facing, which is likely because they preferred avoiding being critical about stakeholders, especially decision-makers and authorities.

Cost of groundwater use

Regarding **the affordability of groundwater,** 33% declared that they can afford water, 55% declared that they are not always able to afford water, while 12% declared that they cannot afford to pay for water. **55% of the interviewees declared that the cost of water is very high**, while 45% declared that the cost of water is reasonable.

45% do not pay, as they are the owners of the wells 33% pay to the water supplier (private wells), 22% pay to Iaat Development Committee (Municipality well) that supply water for household use via the network. 100% confirmed that the amount of water they use is regulated.

End-users who rely on water suppliers suggest that the price for groundwater is too high to be able to afford it which perhaps also leads to end-users preferring to have/ continue using their well for those who can afford and live in a place where this is feasible (e.g. farmers), rather than relying on water suppliers. If the price of water supplied by the utilities was lower (but of course high enough to cover the costs related to supplying water), perhaps end-users would be more open to relying on water suppliers (instead of obtaining water illegally), but a price that is too low could once again lead to overconsumption. The issue is that if the choice is between obtaining water illegally for free or paying to water suppliers, end-users might of course prefer the first option. Nevertheless, price optimization and perhaps reductions to vulnerable groups is something to be considered by water regulators. The fact that some of the end-users have difficulties affording water also reflects socio-economic problems in general.

Using water more efficiently would also result in less consumption and thus fewer costs, thus it is important to monitor the use of water and use it intelligently, which is often not the case.

Quality of the groundwater

More than three-quarters of the stakeholders, **77%, agree that the groundwater is potable and safe for usage**, leaving only less than a quarter, 23%, using the groundwater exclusively for agricultural purposes. In contrast, **only 34% of the end-users find that the quality is sufficient for the purpose of use**, leaving **66% of the end-users considering that improvement is expected regarding the quality of groundwater**. Nevertheless, none of the interviewed stakeholders are facing any specific issues related to the quality of groundwater. Concerns were raised by two of the interviewed stakeholders regarding the **pollution risks, especially in the wells located closer to the WWTP**. Ministry of Energy and Water is held responsible for most of them. It should also be noted that there are currently no studies related to the discussed issues.

There does not seem to be a general agreement concerning the quality of the groundwater, most of the end-users think it is potable but still consider that the quality could be improved. To tackle this, the authorities can try testing the groundwater quality regularly and share the results with all the involved end-users and other stakeholders, to create a common viewpoint. The authorities

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could try undertaking studies, if possible carried out by third-party conductors, checking if there are any problems or issues concerning the pollution of groundwater.

Collaboration with other stakeholders and possible conflicts

When asked about pre-existing coordination between stakeholders or the communities, **two-thirds of the interviewed stakeholders conveyed that cooperation exists especially when there is a problem or a crisis**. Even though all of them agreed that there is no dialogue between different types of stakeholders, 55% of the stakeholders consider "Iaat Development Committee" as the community manager of water resources, as this committee is in charge of the distribution of groundwater to houses and the collection of fees from the end-users. The water produced and distributed by the Iaat Development Committee is officially used only for household purposes. There was a general agreement that, while no synergies exist between stakeholders, there are neither any conflicts between them, 33% also noted that there exists a synergy of some extent between the Bekaa Water Establishment and the Municipality. There were varied answers about the structure of the water management system, probably because the interviewees were not able to completely understand the question before answering it. 22% noted that there is an established hierarchy within the system, 45% said that the competencies between the different stakeholders are not completely defined, while 33% agreed that there coordinated collaboration exists. According to 55% of the interviewed stakeholders, water producers are the most influential stakeholders. Some also mentioned that the President of Municipality and farmers had influence. While there are no clear synergies or coordination efforts, **89% of the stakeholders said that they are ready to be more involved within the system**.

It can be interpreted from the interviews that there is already a certain level of cooperation in place especially when there are issues, which could be further enhanced to hold a regular dialogue between the different stakeholders, not only in the time of a crisis. The majority of the stakeholders are ready for more involvement and think that cooperation is going to help them.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

Following the trend of Thematic 1, where the majority of the stakeholders of the same basin agree to cooperate, here **100% declared that they would be willing to cooperate for better sharing and managing water resources**. The use of GTool can result in more profit for all the stakeholders and monitor climate factors for diverse factors such as precipitation and fair water distribution among others. As the GTool is based for the community and used by the community, **89% of the stakeholders are also interested in participating in the design process of the GTool**. The factors that were found to be encouraging for stakeholders to participate include **interest in making data available; the opportunity to forecast problems before they happen and find the appropriate solution before the time; managing the permanent and growing water demands.**

The large majority of end-users agree to cooperation and have a great interest in the GTool.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

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Before conducting any co-creation workshop, the needs and expectations of the stakeholders were needed, and it was found that **none of the stakeholders made use of any smart tools to monitor the level of groundwater, except one of the interviewees who made use of a device to measure water table**. The reasons stated by the interviewees not making use of any smart device were a bit varied, where most of them agreed that they cannot access tools, followed by the reasons of no availability to the tool and for the ones who were aware of the tools said excessive prices are limiting them. Stakeholders suggested that laboratory analysis is the only activity conducted regarding water quality control. However, these analysis are not done frequently. 45% declared not to do any kind of analysis. **The information that will be required from GTool concerns water table level in the well, water availability, precipitation, temperature, humidity, irrigation timing, the quantity of water for irrigation available, water quality, daily water quantity available in the well, the quantity of water available in the well and sustainability, weather, direct analysis of water quality, estimate groundwater reserves, determine the appropriate crops for each soil, soil humidity.**

There is a general unawareness with respect to smart tools and a lack of knowledge about it.

Thematic 4: Involving the stakeholders into communities of practices

The involvement of stakeholders in the communities of practices could be useful to provide water when needed for the largest number of farmers, for fair distribution of water and overall for better management of water. There are some rules set for such Community of Practises for the motive of fair participation, however, the stakeholders' views in this regard were not clear and precise whereas others preferred not to answer. There was a suggestion for setting up Terms of Reference which would be followed by everyone. When asked about the frequency of the discussion about the water resources, there were mixed answers and the most common answers were *"once every two months"*, followed by *"during summers"* and "*once per month"*. Regarding means of communication, the **large majority had a preference for physical meetings**, a minority preferred Whatsapp and non of them chose "online" as the preferred means. Interestingly, regarding the agenda of such meetings, 66% of them inclined towards the discussion to be on pre-defined issues, while the remaining 33% were open for discussion on open topics.

Even though end-users are not very familiar with the concept of CoPs, they were generally open to the idea of holding regular meetings, and there was a large preference towards physical meetings, as opposed to online meetings.

2.3.2. Water Producers

2.3.2.1. Water producers - actors and organisations in Iaat Baalbeck-Hermel

Private well owners in the region, who are often farmers, can be considered water producers. Private wells are mainly used for agricultural activities and many of them are illegally drilled, and thus the owners do not account for the water consumed nor pay any fees nor taxes for water consumption. Some private well owners also sell water to other end-users.

Regulations and policies exist, as such, water monitoring and fee payment from well owners are in theory required, but these regulations are not well enforced and are not respected by most well owners

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in the region for many reasons. By law, a well owner must ask official permission, respecting specified drilling depth, and paying annual fees. For agricultural use, there is a quota that should not be exceeded, otherwise, fees must be paid. In case the well is illegal, in practice no monitoring from authority is done.

Bottled water & gallons corresponds to the production of Drinking water – filtered and treated water produced by private water suppliers.

Iaat Waste Water Treatment Plant (WWTP)

The Iaat wastewater treatment plant established in 2005 is dealing only with surface water coming from the sewage network from Baalbeck city and 8 towns including Iaat, with a daily capacity of 24,000 m^3/day of influent serving a population of 167,000 inhabitants. Unfortunately, this water is mixed with rainwater in the winter season which increases greatly its quantity. The water treatment plant represents the most serious environmental problems in the region. Due to design errors or misuse, the plant malfunctions. The treatment process is for domestic waste only, not industrial waste, the preliminary phase does not have grease removal capabilities. Urban sewage and industrial liquid waste goes into the plant, and gets out polluted water from it, with an unpleasant odour. A lake and a long channel of stagnant water can be seen snaking through kilometres of farmland in a different town, creating damage to people, the environment and agricultural land which generated conflicts between different villages and different communities[4].

The WWTP receives during the dry season about 10.000-12.000 m^3/day and in the rainy season about 15.000 m^3/day on average, and sometimes during strong torrential days about 30.000m^3/day.

Furthermore, there is no exploitation of the treated water resulting from the Iaat wastewater treatment plant. Regenerated water (from Iaat wastewater treatment plant): 7.000.000 m^3, is not used for agriculture but wasted in nature (as declared officially). Some farmers are using this polluted water for irrigation illegally.

2.3.2.2. Interview summary and initial analysis

Eight water producers were interviewed, out of which 7 are private well owners. In some cases these water producers are part of other stakeholder categories, three water producers are farmers at the same time and all are urban users. Regarding gender, 7 males and 1 female were interviewed. Almost half of those interviewed produce water for self-use in agriculture from underground wells. About a quarter of them sell a part of their water to other farmers in addition to using it for their cultivation. A smaller percentage of people use underground water for domestic purposes and garden irrigation.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Information regarding water producers in the region

The water producers do not pay any fees for the use of the water sources and there is no formal coordination between the producers and the water users over the issues that may arise except when water producers sell water to the users, in which case **the supplier discusses with beneficiaries the cost of production and consequently the required fees to pay**. From the answers provided by the

[4] https://www.dailystar.com.lb/News/Lebanon-News/2019/Apr-24/481763-foul-smell-illness-emanate-from-iaat-wastewater-plant.ashx

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interviewed water producers, **it can be concluded that there is no monitoring of the quantity of water produced.** Regardless, there is excessive extraction in the years of abundant rains, and producers monitor only in the scenarios of droughts for effective rationing of water. In general, everyone stated that water availability is sufficient as the farmers adapt their agricultural activities with regards to crops selection and cultivated area expansion according to the amount of water available. In Lebanon in general there are **no taxes on agricultural activities**, **the interviewees said that they do not pay any kind of fees or taxes for the use of groundwater**, noting that **most of these wells are without any permission**. Most agreed that the **public sector is the main water producer in the region, especially the owner of groundwater wells** which also include the **wells belonging to the Municipality**.

Since the public sector is the main water producer and owner of major groundwater wells, such production is regulated, the water production is monitored, and water is sold to end-users at a price that seems to be in some cases too high for the end-users to pay. Meanwhile, the majority of private well owners only rarely monitor the quantity of water produced and do not pay fees or taxes for the extraction of water.

Quantity, Cost and Quality of water

The water produced annually is less than 1M m^3 per year for the private owners and the pumping rate varies from 50 m^3/hr to 200 m^3/hr for the private well owners. **Three-quarters of the interviewee's said that there is not sufficient water for end-users in the region and neither it is accessible nor affordable to them**, while on the other hand, the remaining one quarter was affirmative with their answers. 75% of them use the water for their personal activities and 25% sell the water to farmers. The opinions were diverse regarding the **quantity of water and the overexploitation of the resources**. **One half of them agreed that there is excessive water wasting** while the other half disagreed with this statement saying that **water is not being wasted, due to several reasons, especially the high cost of pumping water (electricity/fuel/spare parts, maintenance for generator and pump) and the drought in some seasons**. The issues listed were bad water management, lack of modern irrigation systems adoption, climate change and precipitation decrease. Regarding the quality of water, the same trend was detected, **half of them agreed that there are no quality issues with the water** while **the other half said that there are many issues with the quality, namely, pollution, calcareous water**, malfunctioning of the WWTP which is one of the first installations in Lebanon which is old and frequently fails to ensure the required tasks, which leads to the production of polluted water that is coming out of it. One interviewee also raised the concern of sulphur in the water. Most of the participants expressed that there is a decrease in the quantity of water produced and water level drop, but some attributed it to the years of rain scarcity. As for one of the participants, who is an expert in this field, he said that the decline has reached 35m in the past seven years. Again, half of the interviewees said that they don't carry out any laboratory tests or analysis and the other half said that do carry out quality tests but with a frequency that may extend up to 5 years.

75% of water producers think that there is not sufficient water produced for the end-users in the region neither the water is accessible and affordable for them. The opinions are split between those who suggest that there are excessive water waste and those who say there is a shortage. Since private well owners' water consumption is usually not monitored, and there is no fee or charge for the extraction of water, this may result in overconsumption for certain of them,

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depending on whether they are aiming to use water efficiently or not, while others still seem to find that it is costly and there are seasons when there is drought, and as such consider that they do not wastewater.

Collaboration with other stakeholders and possible conflicts

Most of the interviewees said that there is no coordination or dialogue between actors regarding the use of common resources. Merely 25% of them agreed that there is a dialogue between institutions (regulator, utility, municipality) or between farmers and water producers. Surprisingly, **75% declared that there is no example of community management of water**, when in reality in Iaat the Municipality created the "Iaat Development Committee" which has the task to manage the municipality well, operating, organising, distributing and collecting fees. The produced water is distributed to houses through a network, in order to provide the population with drinking and household use water. Regarding the conflicts or synergies between the different categories of stakeholders, there was no common answer and everyone had different opinions where some of them said that there exists synergy and conflict while others did not agree with that statement. Concerning hierarchy, only two of the candidates provided answers, **one said that the Ministry of Energy and Water and Bekaa Water Establishment held the most influence**, while the other interviewee said that the well owners hold the most influence. To the question on how involved they are in water management at the territorial level on a scale from the answers were varied, three interviewees suggested that they are very involved, while on the other hand, two interviewees suggested they were not at all involved. Nevertheless, **most of the stakeholders confirmed that if there was an opportunity they would be ready to be more involved in the water management system**.

Three-quarters of the stakeholders are unaware of community management and the work of the "Iaat Development Committee" which might be due to limited efforts carried out by the Committee to raise awareness amongst stakeholders about its activities. Nevertheless, in general, there is motivation to get involved in water management.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

When questioned about the main drivers and elements that can be leveraged effectively to engage them and for more involvement in the GTool co-creation process, **all of them agreed to be open to the idea of cooperating with stakeholders of the same water basin to better share and manage resources**. According to the interviewees, after they were explained the concept of Gtool, they said the tool could be helpful for them in providing data, fair water distribution and in general more water availability for everyone, and for the society in a way of better water management, reduced wasting water, planning for the future and water resource sustainability. Again, **all of them were interested in participating in the design process of the GTool**, providing daily data and idea, participating in the project organisation and the role or contribution proposed by interviewers within the design process. Factors that would encourage participation include **discussing the issue of water wasting, exchanging experience, better management of water, conflict resolution between farmers and water producers, good water allocation, fair water distribution, conservation of groundwater and its management, for making the data available to everyone and in general benefits to everyone in the society.**

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There is a positive response from all the interviewed stakeholders and they are ready to participate and invest in the process of creation of GTool, as they think it will be helpful for them and would help make data more transparent and accessible.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

Most of the interviewees are not making use of any smart tools to monitor water use, except one of them who is an expert and who makes use of Terrameter SAS, Piezometer and Visual ModFlow. They suggested that the reason behind not using such a tool is that there are no tools available, one of them said that accessing the tool was not possible, while another one suggested that the tools are priced excessively. A mere 37% of the producers said that they monitor the quality of water through laboratory analysis and that such analysis is not done frequently. The information that the users expect from the Gtool consist of **monthly water table level in the well to manage it in the best way, water quality and possible uses, rationalising water consumption, water table level, the quantity of water available in the well and sustainability, water allocation for each crop, the quantity of produced water and distribution geographically, estimate groundwater reserves.**

The availability of tools seems to a major problem for most water producers.

Thematic 4: Involving the stakeholders into communities of practices

Two of the interviewees think that CoP is not useful as each water producer has his well and water exploitation is unorganised. According to them, the rules shall be well defined and set to ensure fair participation of all stakeholders, a guarantee of good and sustainable services, and to define responsibilities and distrusting the roles and to include the different stakeholders' categories. According to three of the interviewees, each had a different suggestion about the timeline for a meeting, where each said to talk about water resources, once per month, every 3-4 month or whenever the need arises. The rest did not make any suggestion, and the preferred means of communication by them, was physical face to face meetings, while one of them suggested the mode of WhatsApp. The majority of them preferred to have a predefined schedule for each meeting and to avoid any open discussion in these meeting as it may open a debate can be prolonged and may not reach a useful conclusion.

There seems to be scepticism by some of the producers that the concept of CoPs would work but the participants are ready to try the CoPs and everything that can help with better water management.

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2.3.3. Water Utilities/ Suppliers

2.3.3.1. Water Utilities/ Suppliers - actors and organisations in Iaat Baalbeck-Hermel

The Bekaa Water Establishment (BWE)[5]

BWE is one of 4 water establishments that manage water all around Lebanon. It is the official water utility which is supposed to be the exclusive and the only one active in all Bekaa Valley. It currently provides water supply services to an estimated population of 525,066 people in Bekaa valley, and limited irrigation services in the areas of Yammouneh and Deir Al Ahmar. The population officially registered as customers of the Establishment, and receiving water supply service (Service Coverage), represents approximately 69% of the estimated total population within the service area of BWE. The Establishments work under special regulations and are steered by the Oversight Department of the Ministry of Energy and Water (MoEW).

Currently, BWE serves a geographic area of approximately 4,000 square kilometres that is organised, for service and management purposes, into eleven water supply "Branches". The law defined the role and tasks of the Water Establishments as follows:

- The study, implement, operate, maintain and renew all potable water, wastewater and irrigation infrastructure, based on the general master plan for water supply and wastewater
- Propose tariffs for water supply, wastewater, and irrigation services, taking into consideration the general socio-economic conditions in the country
- Monitor the quality of supplied drinking water, irrigation water and discharged treated wastewater at the outfalls and outflows of wastewater treatment plants

However, due to weak financing and human capability and many other chronic reasons, BWE cannot perform its full duties and tasks, which created substitutes at a local level to provide services to the citizens due to the absence or lack of services provided by BWE.

The minimum charges that subscribers pay for BWE is 240.000 LbP/year about 134 € (official exchange rate) or 16 € (black market exchange rate). The higher the consumed quantity, the higher the paid fees. BWE distributes annually more than 5 M m^3. As for the social fees for the vulnerable groups, the BWE has a unified tariff for all beneficiaries.

Fees & Services

SERVICE	NEEDED TIME (DAYS)	COST *1 EURO = 1800 LBP (OFFICIAL EXCHANGE RATE)* *1 EURO = 15.000 LBP (MARKET EXCHANGE RATE)*
Inspection	3 to 15	Total including VAT and stamp duty 15,000
Water Utility Subscription	5 to 20	Subscription fee: 180,000*/12 months + sewer charge: 15,000 or 60,000 depending on the region* /12 months + contract fees 6,000 + plate fee 5,000

[5] http://bwe.gov.lb/

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		+ installation fees 20,000 + meter fees (if applicable) 65,000 + VAT + rounding + stamp duty 1,000
Subscription in water irrigation	-	6000+12000+1800TVA+200rounding+1000stamp=21000L.L
Freezing	5 to 20	Subscription freezing fee 30,000 + inspection 12,000 + VAT 4,200 + rounding 800 + stamp duty 1,000 = 48,000
Cancellation	5 to 20	Cancellation fee 24,000 + inspection 12,000 + VAT 3,600 + rounding 400 + stamp duty 1,000 = 41,000
Reduction	5 to 20	Reduction fee 24,000 + inspection 12,000 + VAT 3,600 + rounding 400 + stamp duty 1,000 = 41,000
Name Transfer	Administrative/Immediate	Free of charge
Statement	-	15000
Irrigation tariffs	-	Winter: 60m3/h at 10000L.L//Spring:60m3/h at 12000L.L//Summer:60m3/h at 15000L.L

Table 3: Fees and services charged by Water Utilities/Suppliers

Iaat Municipality

Iaat Municipality assumed a large part of the responsibility of supplying water in the region, it covers about 30% of the need in the town, consequently, about 400 families (out of about 1200 families) benefit from these services. The Municipality drilled a well of 625m depth, so the extracted water is pumped in the network to provide water to 400 houses in Iaat. This water is used for the purpose of drinking, household services but sometimes is used also for irrigating gardens. The quantity of consumed water is controlled via flow meters, therefore most of the beneficiaries pay a fixed tariff for 30m^3/month, If they consume more, they pay more. For the management of these activities, the Municipality created Iaat Development Committee (IDC).

Regarding the pricing, Iaat Municipality charges a minimum of 30 m^3/month = 25.000 LBP, which translates to about 2€ (black market rate) or 13.8€ (official exchange rate) for 30 m^3/month. The higher the consumed quantity, the higher the paid fees. This service is provided to about 400 houses, where only 240 beneficiaries pay the charges and the others refused to pay. 40 vulnerable families are exempt from payment. The Municipality has exemptions for vulnerable families.

Private water distributors

The private water distributors (water distribution trucks) buy water from private well owners, transport and distribute the water to houses. Regarding the pricing, the good owners charge 10.000 LBP (or 0.66€, black market exchange rate) to the private water distributors for 1 m^3, while the end-users pay 75.000 LBP (or 5€) to the distributors for one truck (tank capacity= 5 m^3). The private sector has exemptions for vulnerable families.

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2.3.3.2. Interview summary and initial analysis

Four interviews have been conducted with representatives of water suppliers active in the region, including private water distributors. All of them are male.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Information regarding water utilities/suppliers in the region

The interviewees said that the public sector is the main water utility actor in the region, but due to the weak or absence of Bekaa Water Establishment (BWE) services, the private sector and the Municipality took this role and are now providing the services to the local residents. They also said that no taxes or fees are paid to the government, the only fees paid are by the mobile tank owners who pay for the water they buy from the well owners. They shared that the minimum charges that subscribers pay, the higher the consumption, the higher is the payment required.

The BWE and the Municipality adopts a variable tariff method which is according to the consumption and based on the scale of charges were higher the consumption, higher are the charges.

Quantity, Cost and Quality of water

The BWE covers the whole region of Bekaa Valley while the municipality and the private distributors are active only in the Iaat region. **Most of the interviewees think that water is accessible and affordable to the end-users.** The tariff imposed on the citizens is to cover the cost of water-extracting from the sources, transportation to the tanks after ensuring its safety and suitability for drinking (treatment and sterilisation in some places), delivering it to houses through clean networks as well as the cost of maintenance for all the equipment and networks. When asked if the **quantity of water** produced is sufficient or not, for the private distributers the water produced is sufficient as they are dealing with very limited water quantity and customers, while according to other water suppliers quantity of water produced is not perceived as sufficient, as the urban-users always complain about water shortages, in addition to lack of resources. Such shortages are said to be mostly caused by various issues such as:

- Infringements on the water network, where a large number of citizens benefit from water without subscribing and paying fees
- Using potable water to irrigate gardens and some crops
- Poor water management at towns' level and lack of control and violations suppression
- Wasting water daily due to network malfunctions or excessive consumption and household uses.

As for the question regarding whether the stakeholders noticed a decrease in the amount of water available (a drop in groundwater level), half of them said that they did not notice any decrease in the amount of water being produced, while one interviewee stated that they are facing this problem annually, especially in the summer when the demand for water rises, as well as the need to irrigate garden and crops, and the population increases with the arrival of those who wish to spend the summer in their towns. As such, water levels in the wells begin to decline, specifically in August and during September of each year. As for the **quality of water**, almost all of them claimed that the water

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quality does not possess any issues and it is used without any treatment, while one of them said that there are a few issues with the quality like calcareous water and sulphuric water All interviewees claimed to do laboratory tests for water quality.

The interviewed water suppliers consider that the problem of water shortage can be explained by infringements on the water network – many end-users using water without paying any fees and using potable water for agricultural purposes, amongst other reasons. Most of them think that the price of water is affordable to end-users. This statement is in contradiction with some of the end users' point of view, who claimed that the cost of water is too high. There is an agreement between the end-users and water suppliers regarding the shortage of water during the summertime. While end-users and water producers often referred to issues regarding water quality, the majority of water suppliers claimed that there is no issue with the quality of water.

Collaboration with other stakeholders and possible conflicts

Most of the interviewees said that there is no coordination neither dialogue between actors regarding the use of water and for that 25% who did admit the existence of such a dialogue, said that this coordination is between the Municipality, the Iaat Development communities and the BWE. Again following the trend, **75% said that there is no example for community management of water**. As for issues or synergies regarding the relationship between stakeholders, most of the interviewees spoke about existing conflicts, especially between end-users and BWE. The end-users complain regarding the quantity of water they receive. There is also a struggle to convert all the "aggressors" of the water network to regular subscribers and urge the beneficiaries to pay all their dues to improve the service as well as to take advantage of these funds to carry out new projects that help raise the quality and quantity of the service provided. There was no agreement on the existing water system whether it's hierarchical or collaborative. Only one of the interviewees said the most influential are the Municipality and Iaat Development Committee. Three of the interviewees declared to be highly and actively involved in water management and the fourth one said he is not active. **Most of them confirmed, if there is an opportunity, they would be more effective and more involved in water management than they are at present.**

Following the trend of end-users and water produces, most water suppliers agreed that there was no example of community management of water even though in Iaat, the Municipality created "Iaat Development Committee" which has the tasks to manage the Municipality well, operating, organizing, distributing and collecting fees. The biggest conflict seems to be between end-users and BWE. Most of the water suppliers claimed to be open to collaboration.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

In the case of identifying the main drivers and the **elements which can be used to effectively engage and involve stakeholders in the GTool co-creation process, most of them declared that they are open to the idea of cooperation with stakeholders of the same water basin to better share and manage the water resources and they would use the GTool**. **All of the interviewed candidates are interested in participating in the design process of GTool**, and they see their role and contribution within the

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design process by providing data and proposing ideas. They said that **factors that encourage them to participate are providing service to the community, exchange of experience, good management of water and conflicts resolution.**

The interviewed water suppliers are open to the idea of cooperation with stakeholders and are highly interested in participating in the design process of GTool.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

For the preparation of the first co-creation workshop, the information that was obtained was that **most of the interviewees use flow-meters as a smart tool to monitor water user** and a sole interviewee said that he doesn't make use of any tool stating the reason that no tools are available **while all of them declared that they monitor water quality through laboratory analysis which they carry out frequently**. The information that they require/expect from GTool is the **quantity of water available in the wells and sustainability, estimate groundwater reserves in the aquifers, rationalising water consumption, planning for the future and find solutions for water issues and identifying the best way to manage groundwater**.

Most of the water suppliers use smart tools to monitor water use and claim to monitor water quality through laboratory analysis.

Thematic 4: Involving the stakeholders into communities of practices

The CoPs are perceived to be important for many reasons, they are useful and help in the exchange of information and experiences regarding the quantity and quality of water, to resolve the conflicts between stakeholders related to the quantity and quality of groundwater, to facilitate cooperation and dialogue between actors, and to explain the water end-users about the importance of water and the difficulties that water utilities face to secure water, as well as the dangers which could be faced in the future if stakeholders do not control water consumption and develop a clear and effective strategy to preserve water in quantity and quality. They said that for a CoP, the rules should be set in order which would ensure fair participation of all stakeholders and the stakeholders of different categories, for long-lasting communication and dialogues between them, for restoring to good governance and establishing stable and consolidated water regulation systems from sources to end-users and for spreading awareness about avoiding water waste and doing all that is necessary to maintain the groundwater reserves. While two of them said that a meeting once per month is necessary the other two said that a meeting every three-four months would be necessary. Half of them preferred to have a predefined schedule for each meeting and the other half were good with an open debate.

The water suppliers are highly interested in CoPs and see them as a tool to resolve conflicts and raise awareness about the importance to preserve water in the region.

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2.3.4. Water Regulators

2.3.4.1. Water Regulators - actors and organisations in Iaat Baalbeck-Hermel

Ministry of Energy and Water (MoEW)[6]

MoEW is the organisation responsible in the region and the whole country for water regulation. MoEW has the mission to monitor, control, measure, study water resources, and estimate water needs and the quality of surface and groundwater, as well as setting quality standards. Also, MoEW is in charge of developing and updating a national master plan for the allocation of potable and irrigation water resources and developing wastewater management. They are mainly concerned with extending domestic water networks in rural areas but are also in charge of supervising communal irrigation schemes. In the water sector, the MoEW's authorities and tasks include amongst others:

- Monitor, control, and study water resources and estimate water needs and areas of use in all regions.
- Monitor the quality of surface and groundwater and define its standards
- Developing a general design project for allocating and distributing water resources for drinking and irrigation nationwide, developing a draft general outline for water and sanitation, constantly updating it and submitting it by the minister to the cabinet.
- Designing, studying and implementing major water installations such as dams, mountain lakes, tunnels, straightening river courses, water networks, etc., and putting them in investment.

Ministry of Agriculture (MoA)

The Ministry of Agriculture is responsible for the formulation of the strategic framework for the agricultural sector and develop practical policies and programs to promote this sector and develop the legal and legislative frameworks of the organization and the infrastructure to facilitate the operations of investment, production and marketing. As such, MoA is responsible for the construction of ponds, hill lacks and dams with capacities less than 100,000 m^3, while MoEW manages dams, larger ponds and major irrigation projects. The task of MoA regarding the water sector in the Baalbek-Hermel region also includes awareness-raising regarding water irrigation rationalization through seminars aimed at raising the efficiency of irrigation water use at the field level, reducing pollution resulting from the indiscriminate use of fertilisers and agricultural pesticides among farmers.

2.3.4.2. Interview summary and initial analysis

Two interviews have been conducted with representatives of water regulators in the region.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Information regarding water regulators in the region

The interviewees claim that on a practical level, the pumping of groundwater is not regulated. In terms of groundwater consumption, it was claimed that 70% of the water consumption is used for Agriculture, 10% for Industry, 5% as potable water, 10% for home use and 5% for Tourism. The main objective of water regulation in the region is **effective coordination among all the users to achieving sustainable water resources management**. The urban demand for water is the top priority followed

[6] energyandwater.gov.lb

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by agricultural demand, industrial demand and ecological demand. This priority list stays the same irrespective of the time and the climate change in the region. Even in years when there is drought, the priority is domestic usage as the quantity of the usage is lower and can not be compared to the level of water required for agricultural purposes. Therefore, the focus is on securing the residents' water needs and avoid any social disorder or conflicts between users. The presence of refugees, in some towns, has led to a doubling of the population which has led to an increase in the demand and stress on the existing resources. **The water from rain and torrents is a resource the use of which is not completely regulated, but which can become an important source of water for irrigation or industry if exploited through water harvesting techniques.** This also applies to water resulting from sewage and water from WWTP that usually travels through soil or river banks without bringing further benefits. In some cases, they become a major source of pollution. Furthermore, there are contradictions between public policy and property rights (IPR) or environmental regulation related to the use of water. As an example of this, there are illegal drilling of wells without an official license, and conflicts over water rights between individuals benefiting from the same water source, which the authorities are unable to resolve, particularly in the Baalbek region. **While Lebanon has laws and regulations against emissions (Environmental Protection Law 444), application and enforcement of these rules, as well as pollution prevention measures are absent.** There are programmes in the region that international organizations and bodies are implementing, such as the construction of WWTP in Iaat, or small scale projects to reduce water pollution, such as installing potable water sanitation stations, especially for the Syrian refugees. Regulations regarding overexploitation of groundwater are available, but there is a need to issue application decrees for wells above 150m and against the excessive use of these sources.

According to the regulators, the laws and regulations for pumping groundwater and environmental protection, in reality, are not well enforced, pollution prevention measures are absent, and illegal drilling of wells and conflicts over water rights between different stakeholder is a frequent phenomenon. It is also suggested that water from rain and torrents is a source of water that is not exploited and that could become important.

Quantity, Cost and Quality of water

According to the interviewees, the water availability in the region is between low and intermediate. At national levels, groundwater accounts for approximately 30% of total water use, while in the case study area it accounts for 90%. **Currently, the administration is attempting to determine the region's illegal/unregulated groundwater use** and according to the interviewees, the aquifers in the region are in a state that could be defined as regular. "The promotion of Groundwater User Communities for participatory and productive water governance" is one of the steps being applied in the context of water planning to increase the quantitative and chemical condition of aquifers. According to the interviewees, water quality problems are mostly due to **sewage leakage, industrial water and rainwater that carries pollutants**. The wells were subject to a major drop in the volume of available water, many springs have dried up as a result of the water level fall, which could exceed a hundred meters. This has been going on for around ten years. **The decline in well water level began about two decades ago, due to a rise in farming operations, population development, and the low cost of drilling and equipping wells**. This has evolved dramatically in the past few years, as shown by the

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drying of surface wells and the need for farmers to go far in search of water. Periodic and in some circumstances, monthly analyses are carried out by some of the water regulators.

Water regulators explain the major drop in water quantity in the wells by a rise in farming operations, population development, and the low cost of drilling and equipping wells, which started about two decades ago. As previously seen, this highlights the issue of lack of monitoring of water usage by private well owners. Water regulators identified problems related to the water quality and see the problem in sewage leakage, and industrial and rainwater that carries pollutants. This sheds light again that there are problems related to the regulation of pollution.

Collaboration with other stakeholders and possible conflicts

When asked if they collaborate with other stakeholders, the interviewees said that the regulators work together to organize the use of water and that the various Ministries and agencies responsible for coordinating water services work together. Regarding cases of community water management, an interviewee stated that such communities had been cancelled and that water management had been delegated to Water Establishments in different regions (4 Water Establishments in Lebanon) under the MoEW's supervision. According to an interviewee, there are local models under which a consortium of beneficiaries from a single shared water supply manages water and organises quotas. Sometimes there are conflicts between different types of stakeholders, and in some cases or specific situation, there is a kind of synergy between these different groups to achieve the common interest. **They claimed that the water system is rather collaborative than hierarchical, where the MoEW has the most influence.** One of the interviewees is directly engaged in water conservation at the provincial level. **Both declared ready to be more involved than they are at present time.**

Water regulators are generally open to collaborating with other stakeholders.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

Both of the interviewees declared that they are open to the idea of cooperating with the stakeholders or the same water basin to better share and manage the resources. According to them the use of GTool could lead to gaining more experience, serving as a platform to exchange information, awareness and guidance for the stakeholders, and for the society could lead to better water management and availability of information. **They both said that they are interested in participating in the design process of the GTool** and that they see their role/contribution in the design process through presenting data and experiences, as well as facilitating the process. For the interviewees the factors that inspire them to participate include the **development of intelligence, collaboration, and a sense of accountability for a very important problem that is considered unsustainable in the current reality.**

There is a high interest from regulators to participate in the design of the GTool.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

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The interviewees stated that they don't make use of any smart tools to monitor the water use and the reasons for that are the unavailability and the excessive prices of such tools. The information required from the GTool according to them is to know **the current state of the availability of water and how it will be in the future given the current information, the threshold required to reach sustainability, the available alternative, suggested solution and economically feasible crops under the current reality as of now and in the future.**

Regulators do not make use of smart tools but are very interested in GTool and the information that it could provide.

Thematic 4: Involving the stakeholders into communities of practices

According to the interviewees, CoP is important for many reasons, namely, for exchanging experience, listening to the opinions of each member of the group, drawing the results of each experiment and reach a unified result. **They said that rules should be set to ensure fair participation of all stakeholders, to respect different opinions and to ensure fair and efficient representation among actors of the sector and those with experience, who are in direct contact with water issues.** It was suggested that at a strategic level, the CoPs should meet every five years, but at a follow-up level every 6 months. Another suggestion was to hold one meeting per month. As for the means of communication, one of the interviewees preferred the physical face to face meeting whereas the other one preferred WhatsApp. For the program of the meeting, both of them prefer to have a predefined schedule for each meeting and to keep a short time slot vacant for open debate.

In general, the water regulator considers CoP to be important and are open to getting involved.

2.3.5. Intermediary organisations

2.3.5.1. Intermediary organisations - actors and organisations in Iaat Baalbeck-Hermel

Lebanese Organisation for Studies and Training (LOST)

LOST is an association active in local development, providing services to the vulnerable groups and raises the level of services provided by institutions and Municipalities, as well as strengthening the role of governance, empowering women and preserving children's rights.

Iaat Development Committee (IDC)

IDC is created by Iaat Municipality with the main goal to manage the well drilled by the Municipality, operating, organising, distributing and collecting fees, and provide water supply services to about 400 houses in Iaat. Its goal is to be in charge of community management of water, promote awareness among citizens in Iaat and pursue with donors to implement development projects.

2.3.5.2. Interview summary and initial analysis

Two interviews have been conducted with local associations/NGOs.

Thematic 1: definition of stakeholders' preliminary roles and expectations

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Information on water management in the region

The Bekaa Water Establishment and Municipality, according to interviewees, are the institutions in charge of water control in the city. As for pumping of groundwater, they stated that currently, it is not regulated as the governing framework is not respected by private water producers and end-users in some cases. The principal objective of water regulation in the region is to establish the basis of water planning for different water resources availability and demand scenarios. The interviewees stated that there is no consideration about the amount of groundwater pumped in terms of water use, quantity, or restrictions, and the quotas are not respected. **In general, water regulations exist but are not respected. The regulations against pollution are not respected either.** There is also a contradiction between public policy and property rights.

Beneficiaries of the intermediary organization

When asked about the beneficiaries, for one of the interviewee's the beneficiaries are the Syrian refugees in Iaat, Baalbeck city and surrounding towns, while for another interviewee the beneficiaries are all the residents in Iaat.

Quantity, Cost and Quality of water

According to the interviewees, farmers in Iaat are facing water scarcity, while urban consumers have fewer concerns. This problem has been more critical for Syrian refugees because there is no network supplying water directly to their camps. In general, the amount of water available per capita in the area is approximately 3000-4000 m^3/capita/year. According to the two interviewees, **the amount of water provided in the region is not sufficient, neither accessible nor affordable for the end-users.** They said that groundwater provides approximately 90% of the water used and that the urban users, farmers and some SMEs are charged for the use of water. Only a small portion of the community can afford to dig a well and pump groundwater. **They also suggested that there are many issues regarding the quantity of water produced, the most important of which is the excessive consumption of resources, the unfair distribution and the absence of control. In addition, the cost of drilling a well and extracting water is only available to the wealthiest. According to the interviewees, there is no issue with the quality of water** and they did not notice any decrease in the amount of water available unless there is a decrease in the level of precipitation. They also stated that laboratory tests are performed on water quality on a six- to twelve-monthly basis.

According to the interviewees, the amount of water is not sufficient nor affordable to the end-users. However, surprisingly the interviewees suggest that there is no issue with the quality of water to their knowledge, which is in contradiction with the opinion of some of the other stakeholder groups.

Collaboration with other stakeholders and possible conflicts

When asked about the coordination with other stakeholders, one of the interviewees stated that they are attempting to achieve this coordination through joint meetings. Another stakeholder denied any form of cooperation or even dialogue. When asked whether there was any practical example of community water management, one of the interviewees claimed that there was none, and the other did not respond. **The interviewees consider that there is more conflict compared to synergies generated.** The explanation, according to the interviewees, is the BWE's constant effort to regulate

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the wells used for drinking and domestic service water in the town, without having any successful strategy to manage it, nor the unequal distribution of water, nor the negligence that afflicts certain regions, both of which cause disputes. In terms of whether the water infrastructure is hierarchical or collaborative, one of the interviewees said that the competencies between the various stakeholders are not completely defined, while the other said that organised cooperation occurs. They consider that the Ministry and the end-users have influence. They claimed that they are actively involved in territorial water conservation and that they can be more involved than they are at present.

The NGOs consider that overall there is more conflict than cooperation, which is in contradiction with the opinion of other stakeholder groups.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

When asked about the stakeholders' needs of the GTool, the **interviewees said that they were open to collaborating with partners from the same water basin to efficiently distribute and leverage resources**. The use of GTool was considered as a tool that can bring more expertise for stakeholders and community, improved resource quality, assurance and stability of water delivery service, etc. The interviewees see their role/contribution within the design process through providing data and managing the tool. **They consider that factors that encourage stakeholders to participate or drivers for participation are community responsibility, civil sense and citizenship.**

The interviewees are open to collaboration and would like to be a part of GTool's creation process.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

When asked about the stakeholders' needs regarding the GTool and data that could help with the creation of the GTool, **one interviewee claimed to use flow meters as smart instruments to monitor water usage, while one representative said that the reason for not using any smart tools was due to the high cost**. Both interviewees said that they **track water quality by laboratory testing**, which is conducted every 6 to 12 months and that the findings of these analyses showed that the water quality was appropriate for use. Information that is required from Gtool includes the **quantity of water available in the wells and sustainability; the best management for the available water regarding extraction and distribution; making available accurate data and statistics that is reliable**.

The interviewees' most important needs regarding the Gtool concern the quantity of water available in the wells and sustainability; best practices for management; enabling the availability of accurate data and statistics.

Thematic 4: Involving the stakeholders into communities of practices

According to the interviewees, priorities include defining responsibilities, rights and duties, as well as defining roles of various stakeholders. They suggested that **guidelines should be established to ensure that all parties participate fairly in the water management process.** They suggested holding meetings **once per year** to talk about water resources. **They favoured face-to-face sessions** as a means of

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contact. One representative favoured a predetermined agenda for each meeting, while the other one preferred free dialogue to generate a large number of proposals and find the necessary solutions.

The interviewees suggested establishing guidelines to ensure that all parties participate fairly in the water management process. However, they had a preference to hold meetings rather rarely, once per year.

2.3.6. Interviews - conclusions

Thematic 1: definition of stakeholders' preliminary roles and expectations

In terms of **quantity and cost of groundwater**, the opinions between the different stakeholders vary.

End-users said that water shortage occurs during summer and over half of them declared to face obstacles in obtaining water or having issues with water. For *end-users*, water consumption monitoring is not a common practice, and most of those who own private wells (mostly illegally) do not account for the quantity of water consumed nor pay any fees or taxes for the use of water. End-users (often urban users) who rely on water public or private water suppliers suggest that the price for groundwater is too high to be able to afford it, which reflects socio-economic problems. The prices within the public sector were in general considered to be high previously, but this is currently changing. Moreover, in the current economic situation in Lebanon, the cost of water extraction and transportation, especially if fuel is used, is increasing dramatically, so the prices of the private sector will likely increase. The public sector will most likely keep the old prices to avoid social problems. Even though end-users mostly referred to shortages only during summer, which could be understood that they have enough water the rest of the year, translated from Arabic, this can rather be understood more as in contrast to the words "drought or thirst", thus does not mean complete satisfaction or fulfilment of needs, neither permanent availability.

The interviews with *water producers*, mostly private well owners, as in the case of end-users, suggested that they only rarely monitor the quantity of water produced, and do not pay fees or taxes for the extraction of water (many of such wells are without any permission). In the case of farmers, using water more efficiently would result in reduced consumption and also fewer costs, thus it is important to monitor the use of water and use it intelligently, which is often not the case. As such illegal wells and the lack of water consumption monitoring poses a huge problem in the area. Most of the producers think that water produced for the end-users in the region is not sufficient and that water is neither accessible nor affordable for them.

In contrast to the first two stakeholder groups, *water suppliers* tend to think that water is affordable to the end-users, nevertheless, they say that there is a problem of water shortage that can be explained by infringements on the water network and many end-users using water without paying any fees and using potable water for agricultural purposes, and other issues, in addition to lack of resources. According to the *regulators*, the laws and regulations for pumping groundwater and environmental protection, in reality, are not well enforced, pollution prevention measures are absent, and illegal drilling of wells and conflicts over water rights between different stakeholders is frequent. It is also suggested that water from rain and torrents is a source of water that is not exploited and that

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could become important. Water regulators suggested that the major drop of water quantity in the wells by a rise in farming operations, population development, and the low cost of drilling and equipping wells, which started about two decades ago. According to *intermediary organisations*, the amount of water is not sufficient, nor affordable to the end-users.

Concerning **water quality**, the majority of end-users, producers and regulators think that the quality of water could be improved. They also indicate that there is pollution related to the malfunction of WWTP and problems such as sewage leakage, and industrial and rainwater that carries pollutants. In contrast, the majority of water suppliers and intermediary organisations claimed that there is no issue with the quality of water.

The interviews highlight that end-users, who rely on public or private water suppliers, have difficulties affording water, do not always have available water supply, and there are also concerns regarding water quality. Regarding private well owners, there is an issue of no or very limited water consumption monitoring (and thus potential overconsumption), as well as lack of law enforcement – as these wells are mostly illegal and do not pay fees. In general, there are issues with the management of water, and issues in particular with WWTP which causes pollution. While regulations are in place, in reality, they are not well enforced.

Regarding **collaboration with other stakeholders and possible conflicts,** end-users suggested that there was already a certain level of cooperation in place, while water producers were more sceptical about existing cooperation and the majority of them were unaware of community management. Following this trend, most water suppliers agreed that there was no example of community management of water even though the Iaat Development Committee shall be officially in charge of this. Regulators claimed that the water system is more collaborative than hierarchical. The intermediary organisations consider that there is more conflict than cooperation, which is in contradiction with the opinion of other stakeholder groups. The biggest conflict seems to be between end-users and Bekaa Water Establishment. Based on the interviews, the Ministry of Energy and Water and Bekaa Water Establishment hold the most influence. All stakeholder groups expressed interest to be involved in water management and think that cooperation will help them.

	End-users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Perceived water accessibility (available water for use)	Mostly sufficient (in contrast with the words “drought or thirst”)	Insufficient	Insufficient (shortage)	Insufficient	Insufficient
Perceived affordability of water (price)	Price too high	Price too high	Affordable	-	Price too high

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Perceived water quality	Insufficient	Insufficient	Sufficient	Insufficient	Sufficient
Perceived cooperation with stakeholders	Cooperation	Lack of cooperation	Lack of cooperation	Cooperation	Conflict

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The large majority of all stakeholder groups interviewed agree to cooperate, have a great interest in the GTool and are highly interested in participating in the design process of GTool. Some of the most important drivers that motivate them to participate include exchange of experience, good management of water and conflict resolution, fairwater distribution, addressing the issue of water waste, conflict resolution between farmers and water producers, making data available to everyone, conservation of groundwater, development of intelligence, managing the permanent and growing water demands, developing a sense of accountability, community responsibility, etc.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Willingness to cooperate	Yes	Yes	Yes	Yes	Yes

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

The majority of end-users and water producers do not make use of any smart tools to monitor the level of groundwater. Most of the water suppliers use flow meters as a smart tool to monitor water use. Regulators do not make use of smart tools but are very interested in GTool and the information that it could provide. Some of the intermediary organisations use smart tools.

The information that was required from GTool by most stakeholders includes information on monthly water table level in the well to manage it in the best way, rationalizing water consumption, water allocation for each crop, quantity of produced water and distribution geographically, estimating groundwater reserves, water availability, precipitation, temperature, humidity, irrigation timing, the quantity of water for irrigation available, water quality, daily water quantity available in the well, the quantity of water available in the well and sustainability, direct analysis of water quality, soil humidity, estimate groundwater reserves in the aquifers, the current state of the availability of water and how it will be in the future given the current information, the threshold required to reach sustainability, economically feasible crops under the current reality, the best management for the available water regarding extraction and distribution; making available accurate data and statistics that is reliable, etc.

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	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in obtaining information from GTool	Yes	Yes	Yes	Yes	Yes

Thematic 4: Involving the stakeholders into communities of practices

Even though end-users are not very familiar with the concept of CoPs, they were generally open to the idea of holding regular meetings, and there was a large preference towards physical meetings, as opposed to online meetings. There seems to be scepticism by some of the producers that the concept of CoPs would work but they are ready to try the CoPs and everything that can help with better water management. The water suppliers and regulators are highly interested in CoPs and see them as a tool to resolve conflicts and raise awareness about the importance to preserve water in the region. Intermediary organisations were highly interested as well and considered that it is important to establish guidelines to ensure that all parties participate fairly in the water management process.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in participating in the CoP	Yes	Yes	Yes	Yes	Yes

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3. Use Case 2 – Campo de Dalías

3.1. Description of the Basin

The Campo de Dalías is located in the Almería region of Spain with an area of 971 km2 and is one of the most developed irrigated agricultural areas of the world. The Campos de Dalías-Gador, with an extension of 330 km2 constitutes a coastal plain constrained between a mountain range to the North and Northwest, and the Mediterranean Sea to the South, East and the West by the Mediterranean coastline.

Figure 8: Location of the Campo de Dalías-Sierra de Gádor region

There are 10 municipalities in the pilot site (Adra, Berja, Balanegra, Dalías, El Ejido, La Mojonera, Vícar, Enix, Roquetas de Mar and Felix), which account for a total population in January 2019 of 261,115 inhabitants.

Sierra de Gádor is a mountain range located in the southwest of the province of Almería. It is a dome-shaped anticline, with an area of around 900 km2. The highest peaks are located in the western sector (Morrón Alto 2,246 m.a.s.l.). The geographical limits of the range are the Andarax river corridor at the north and east, the low valley of the Adra river at the west and the coastal plain of Campo de Dalías to the south. Morphologically it is characterized by a central flat surface enclosed by very vertical slopes generally formed by tectonic features.

The case study includes the aquifers present in the coastal plain and the southern face of the Sierra de Gádor. Therefore, it is the main body of water in the province due to the volume of underground contributions.

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In the Sierra de Gádor, beneath an impermeable substrate, there is a very large aquifer layer of highly fissured carbonate rocks, more than 1000 m thick. It emerges in the Sierra and towards the South, it sinks. Above this rock formation, there are other materials, more recent in general, mainly impermeable. The main recharge zone is in the Sierra de Gádor (by infiltration of rainfall and a probable underground transfer from the Alto Andarax) which ends up accumulating in the lower aquifers under the plain of Campo de Dalías. Above this deep aquifer, there are impermeable layers with intercalated permeable sections that form layers of upper or intermediate aquifers, of a porous nature and smaller thickness.

- In Campo de Dalías there is low brine water from the lower aquifer that is with a mixture of desalinated groundwater, superficial water and sometimes water from the upper aquifer which is said to be comparatively more brine.
- In Vega de Almería it is brine groundwater with regenerated water.
- In Campo de Níjar the water is brine groundwater mixed with desalinated groundwater.

8 different aquifers were detected in the area and some of these are interconnected. These aquifers can be divided into two classes: upper aquifers and lower aquifers.

3.1.1. Upper aquifers

- **Escama de Balsa Nueva Aquifer (EBNA):** This aquifer is located in the western part of the study area and it is not very extensive (11 km2). It is composed of Miocene (limestones) and Pliocene (sands, calcarenites) materials which rest over phyllites (very low permeability). Limestones are confined under Pliocene marls, while the most permeable sediments (sands and calcarenites) are in the unconfined sector of the aquifer. It is hydro geologically connected with the Lower Western Aquifer (LWA) and the Mediterranean Sea.
- **Upper Central Aquifer (UCA):** It covers 225 km2 of the region and unconfined calcarenites, sandstones, sands and silts of the Pliocene are the main aquifer materials. The thickness of this aquifer is ~100 m and is located over impermeable Pliocene marls. Due to the proximity of the groundwater to the surface, most of the wells of the area pumped water from this aquifer, until the quality started to decline.
- **Middle Central Aquifer (MCA):** The main constituent materials of this aquifer are conglomerates, sandstones, reef limestones and gypsum, confined between Miocene (below) and Pliocene (above) marls. Its small size makes it not very relevant.
- **Guardias Viejas Horst Aquifer (GVHA):** It is an aquifer composed of the same materials as the MCA, but it is located over phyllites, mica schists and quartzites (very low permeability). Its extension is not very large, so it is not interesting from the point of view of hydrogeology and water exploitation.
- **Upper Northeastern Aquifer (UNA):** This aquifer (41 km2) consists of calcarenites, conglomerates, sandstones, marls and gypsum, resting over Pliocene marls. Currently, is one of the most salinized and polluted aquifers.

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- **Middle Northeastern Aquifer (MNA):** Reef limestones, conglomerates, sandstones and gravels, with some local volcanic rocks, are the main materials that compose this aquifer, which is partially confined between Paleozoic phyllites (below) and Pliocene marls (above). It is one of the most pumped upper aquifers nowadays.

3.1.2. Lower Aquifers

- **Lower Western Aquifer (LWA):** This is one of the most important aquifers of the region, constituted by Triassic dolostones, limestones, calcschists and marly limestones. It rests over Permian-Triassic phyllites and is unconfined in all the area corresponding to the Sierra de Gádor mountains. It gets confined below the EBNA, UCA, MCA and GVHA materials, showing thicknesses of 300-1000 m. The existing faults make this aquifer to be very compartmentalized and it presents a connection with the Mediterranean Sea through the EBNA.
- **Lower Northeastern Aquifer (LNA):** It is composed of the same materials as the LWA but confined by phyllites, in the North area, and by the UNA and MNA materials, in the rest. It is, currently, the most important aquifer, due to its large extension, its thickness and its groundwater storage potential. It is connected with the Mediterranean Sea directly in the Aguadulce area, as well as through the MNA.

The Lower Western Aquifer (LWA) and Lower Northeastern Aquifer (LNA) are the main aquifers in the area because of the good quality of groundwater and the high hydraulic conductivity and transmissivity.

There is a lack of precipitation in this area which makes for very scarce surface water sources that lead to providing water to agriculture for irrigation with different methods, such as groundwater extractions, desalination of seawater and the use of treated wastewater. From 1960, the main water resource is the groundwater coming from the subjacent aquifers (>90%), whose extraction became higher over the years. Currently, desalination and regenerated wastewater are rising as alternatives, thanks to several desalination plants located in the area.

3.1.3. Water Budget

Despite the numerous and detailed studies made about the geometry and behaviour of the aquifers of the region, just a few works have addressed the water balance. (IGME., 1977) did the first approach to the water budget of the whole Sierra de Gádor-Campo de Dalías aquifers (Table 4 Summarized water budgets in previous researches in the Sierra de Gádor-Campo de Dalías groundwater bod), assessing the water balance separately in the carbonate materials (Sierra de Gádor) and the sedimentary ones (Campo de Dalías).

In the Sierra de Gádor carbonate materials (767 km2), a total volume of 74 hm3/year of recharge by precipitation was accounted, while only 33 hm3/year were calculated to flow towards LWA and LNA, as well as 86 hm3/year of pumped water. In the Campo de Dalías aquifers (middle and upper aquifers), the inputs were constituted by rainfall (12 hm3/year), surface runoff infiltration (12 hm3/year), water leaking from irrigation channels (1 hm3/year), irrigation returns (6 hm3/year) and lateral recharge, coming from the carbonate aquifer (9 hm3/year), that made a total of 40 hm3/year. Outputs were characterized by pumping (44 hm3/year) and by flow towards the Mediterranean Sea (6 hm3/year),

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making a total quantity of 50 hm3/year. So, in 1977, a deficit of 12 hm3/year and 10 hm3/year were calculated for the carbonate and the sedimentary aquifers, respectively.

In (IGME., 1998), a water budget was made corresponding to the 1986/87 hydrological year (Table 4 Summarized water budgets in previous researches in the Sierra de Gádor-Campo de Dalías groundwater bod), where global recharge for all the aquifers was constituted by precipitation (75 hm3/year) and irrigation returns (22 hm3/year), and output was, mainly, pumping (110 hm3/year), flow to the sea (8,5 hm3/year) and discharge towards galleries (4,5 hm3/year). This made a total recharged volume of 97 hm3/year and a discharged volume of 123 hm3/year (26 hm3/year deficit). Within these values, the lower aquifers hold 64 hm3/year of the inputs and 82 hm3/year of the outputs.

The (DHCMA, 2009) assessed the water budget for all the aquifers -including the north part of the area- (Table 4 Summarized water budgets in previous researches in the Sierra de Gádor-Campo de Dalías groundwater bod): recharge was determined by rain infiltration (92,3 hm3/year), irrigation returns (3,6 hm3/year) and recharge coming from other aquifers, rivers and reservoirs (26 hm3/year). On the other hand, groundwater pumping ascent to 153,12 hm3/year, as the unique output of the systems. So, groundwater used for agriculture and urban uses exceeded the recharge in 31,22 hm3/year.

	Total input	Total output	Deficit
	hm^3/year		
IGME (1977)	114	136	22
IGME (1998)	97	123	26
DHCMA (2009)	121.9	153.12	31.22

Table 4 Summarized water budgets in previous researches in the Sierra de Gádor-Campo de Dalías groundwater body

3.1.4. Causes of overexploitation of water

3.1.4.1. Quality

Intensive pumping has led to changes in the behaviour of aquifers and the overall quality of water. Most of the returns from agriculture have led to the inflow of pollutants carried by irrigation from excessive human activities on the ground. These are mostly salts and nitrates used as fertilizers, as well as phytosanitary substances. Nitrate concentrations exceed 300 mg/l mainly in the Central Surface Aquifer. The rest of the surface aquifers present values between 50 and 300 mg/l, with the ASN being the only one that presents values below 50 mg/l although the salinity in this sector exceeds 5 mS.

Irrigation returns are an important component of recharge for the aquifer. This fact has been reflected in the rise of piezometric levels, even in free surface aquifers. Therefore, the overall volumes of the aquifers have increased (from 90 to 140 hm3/year).

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This process is also influenced by the introduction into the water system of water from non-conventional sources and the contribution of the Beninese reservoir to the irrigation of the Campo de Dalías, with an average value of around 10 hm3 /year between the 1980s and 2010.

Under natural conditions, the water levels circulating by gravity were higher than the sea level discharging into the sea. However, as a consequence of the high exploitation negative levels have been reached, resulting in the entry of seawater. The geometric arrangement of the materials also allows for the relationship between lower and cover or surface aquifers in specific areas, leading to a complex set of interrelated aquifers and connections with the sea.

The existing geometric distribution of permeable and impermeable materials has allowed the connection of the carbonate layer (AOI and AIN) with the sea only in the western (indirectly through a small porous aquifer) and eastern (directly, and indirectly from a coastal sector of the northeast of Roquetas through cover aquifers ASN and AitN.

3.1.4.2. Quantity

The first studies carried out in Campo de Dalías (IGME, 1982) show positive water balances and even show the existence of freshwater surges in the northeast sector (ASN and AIN). Pumping to attend to agricultural and urban demands has led to the deterioration of these aquifers since their exploitation began between the 60s and 70s, bringing the system to the present state of over-exploitation.

The trend of pumping rates in the cover aquifers ASC, ASN and AItN shows a decrease in the volume extracted. In the 1980s, between 15 and 20hm3/year were extracted, but in the mid-1990s these extractions fell to values of between 6 and 12 hm3/year. The main cause of the reduction in the pumped volume is the deterioration of water quality, which also conditions the evolution of the operation of the system.

The extractions of the AIN were initially carried out in the coastal area of Aguadulce. Pumping was greatly reduced then due to an increase in salinity as a result of the marine contributions generated by the " gap " generated by the extractions from the aquifer. The values extracted went from 30 hm3/year in the 80s to 5hm3/year at the beginning of 2000. The extractions from this aquifer were transferred to inland areas, mainly from El Águila, with a very significant increase of 35hm3/year between 1990/91 - 93/94, and from El Viso with a progressive increase between 1989/90 and 1999/00, reaching 20 hm3/year in 2009.

The evolution of pumping in the AIO has led to an increase in the volume extracted in all its areas, most markedly in El Tomillar and Pampanico. In these sectors, the volumes extracted increased significantly from the 1990s and early 2000s due to the loss of quality of the surface aquifers, rising from 10 to 30 hm3/year extracted in less than 5 years. This aquifer has been below sea level since 1980.

3.2. Objectives of GOTHAM for the basin

GOTHAM project implementation will reduce seawater intrusion in Campo de Dalías aquifers by 5-10%, quantified as the volume of groundwater affected by salinization. It is estimated that 5 years after the implementation of the GTool this percentage will reach the range of 15-25%.

Aquifer overexploitation will be lessened by 2-4% in terms of aquifer water budget during the project's implementation and by 5-10% 5 years after.

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3.3. Stakeholders mapping and analysis at basin level

The table below classifies the region's major organisations according to stakeholder type. However, it should be noted that an actor can fall into more than one category; for example, an end-user can also be a water producer if he or she owns a private well.

Stakeholder type	Corresponding organisations in Campo de Dalías
End-Users	• Farmers, urban & industrial users • JCUAPA (supplier and end-user, central Association of end-users of the Western Aquifer)
Water Producers (e.g. Drinking Water Treatment Plant, Seawater Desalination Plant, Wastewater Treatment Plant and)	• Hidralia, Gestión Integral de Aguas de Andalucía, S.A. • Desalination Plants (Almería & Campo de Dalías)
Water Suppliers/Water utilities (e.g. Water operators, Utilities, Water distributors etc)	• Hidralia Roquetas de Mar (urban & industrial water demands) • JCUAPA & Irrigation Communities (agricultural water demand) • Remaining municipalities (urban & industrial water demands)
Water regulators	• Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development • Consortium for the management of the Integrated Water Cycles of the Poniente de Almería • City Council (Roquetas de Mar) • Hydrology Area of the H.D. of the Andalusian Mediterranean Basins
Intermediary organisations (in this case the focus is on universities and research centers that undertake research related to water resources, because of the importance of their explanations and the value that can be acquired from their advances)	• University of Almería • Centro experimental Las Palmerillas • IFAPA Centro La Mojonera

Table 5: Stakeholder mapping in Campo de Dalias

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Water Management overview

The Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development is the regulator in charge of managing transport infrastructures for discharging surface water at the water supply network.

In the area, there is the Benínar dam, which was originally intended to supply the capital of Almería but currently is used to support the agriculture demand of the Campo de Dalías. Also, in this area of western Almería, other smaller infrastructures also play a key role in supplying private initiative irrigation, such as the numerous large-scale tanks that provide the necessary regulatory complement for irrigated areas.

The regulation of the surface water resources of the area is insufficient to satisfy the strong agricultural demand, for which reason a transfer infrastructure of the Benínar-Aguadulce Channel has been used to support the communities of the Poniente region.

Desalinated water is another important source of supply. The Almería desalination plant has a capacity of 20 hm^3 / year destined to water supply, the Campo de Dalías desalination plant with a capacity of 30 hm^3 / year intended to cover both water supply and irrigation demand, and finally, the construction of a small treatment plant at "La Balsa del Sapo" of 2 hm^3 / year only for irrigation purposes.

The incorporation of effluents from the treatment plants - equipped with tertiary treatment - of Roquetas de Mar, El Ejido and Adra is also planned for irrigation purposes.

The *Junta Central de Usuarios del Acuífero del Poniente* (JCUAPA) currently manages a total of 18,868 hectares of irrigation in the Poniente region of Almería and the water supply of 8 towns (Almería, El Ejido, Vícar, Balanegra, Enix, Dalías, Roquetas de Mar and La Mojonera).

In the current water plan, an irrigated area in Campo de Dalías (subsystem III-4) of 26,580 Ha. has been devoted to growing vegetables in greenhouses. The origin of this water is mainly groundwater with an annual demand of 175.22 hm^3. On the other hand, livestock farming is not very relevant in this sector, with around 5000 animals in 2009. Campo de Dalías has the highest concentration of horticultural crops under greenhouses in Europe, which makes the region an agricultural powerhouse, where intensive agriculture under greenhouses.

In the water plan, the highest current water demand is concentrated in agricultural use with 175.22 hm^3/year of water for irrigation of greenhouses, followed by the demand for urban consumption with 45.91 hm^3/year, finally, the industrial demand is 0.04 hm^3/year.

In the sections below the main actors and organisations within each stakeholder, category is listed and characterised. Following, the interviews with each of these stakeholder groups are analysed. Overall 7 interviews with local stakeholders were conducted, all of which are male. Details can be found in the sections below.

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3.3.1. End-Users

3.3.1.1. End-users - actors and organisations in Campo de Dalías

As written in the table above, end-users in the region consist of farmers, urban and industrial users.

JCUAPA Junta Central de Usuarios del Acuífero del Poniente de Almería (Central Association of end-users of the Western Aquifer) represents the end-users in the region and acts as their united voice (but can also be considered as a supplier). It has a total of 166 users: 7 municipalities, 38 Irrigation Communities, 3 companies and 118 individual users. The best way to find out the opinion of the majority of water end-users is to interview the entity that unites them and gives voice to each of them. It has a vision of its own as it is created by the end-users themselves and is managed by them. Range: Almeria

3.3.1.2. Interview summary and initial analysis

One interview was conducted with a representative (male) of the end-users. The boxes below present short comments of the project team.

Thematic 1: definition of stakeholders' preliminary roles and expectations

The interviewee suggested that currently there are no water demand problems, 100% of the area is covered, and all the entities are perfectly coordinated with each other to avoid water supply problems. He said that users requested a desalination plant in the Hydrological Plan in 1994 without the support of any entity and it was completed in 2018 because the water in the higher aquifer had high salinity. The water from the lower aquifer is of good quality for now, but it could get worse due to marine intrusion. The aim is to recover the aquifer by 2024 and not by 2027 as stated in the Hydrological Plan. He said that the aim is to recover the aquifer by 2024, which is 3 years earlier than the planned target date of 2027 in the Hydrological Plan.

It can be deduced based on the interview that end-users have sufficient access to water, and do not face water demand problems.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The interviewee said that what the irrigators value most is transparency in water management and water quality. He explained by saying that the desalinated water is potentially corrosive, but they have no problems because the water is mineralised.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

The irrigators communicate with each other via WhatsApp and as such they inform each other about new technologies and new mechanisms they have in their crops. He added for the medium of communication, word of mouth method works very well with irrigators. If they see that something works, they have no problem adding it to their crops. He stated that a vast majority of farmers are in the JCUAPA, but there are also some exceptions.

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Thematic 4: Involving the stakeholders into communities of practices

The interviewee suggested that communities of practices would be a good mechanism to keep the contact and the irrigation community active.

There is a positive feedback from the representative of the end-users regarding the GTool and Communities of Practices.

3.3.2. Water Producers

3.3.2.1. Water Producers – actors and organisations in Campo de Dalías

Hidralia, Gestión Integral de Aguas de Andalucía, S.A.

Hidralia manages a drinking water network of 2,547 km, which distributes more than 57.95 hm^3 per year to 12 cities, with nearly 545,000 inhabitants, employing 315 professionals. It is the entity that best knows the management of water resources in the area because it is dedicated to the entire area of the autonomous community.

Hidralia is the entity responsible for the management of the Roquetas de Mar wastewater treatment plant (WWTP) since 2002. It is located on the right bank of El Vínculo watercourse and was designed for the treatment of the wastewater coming from the municipalities of Roquetas de Mar, La Mojonera, Vícar and San Agustín (El Ejido), adding up a total served population of almost 200,000 inhabitants. The Roquetas de Mar WWTP can treat up to 39,000 m^3 /day of wastewater and remove a contaminant load of up to 13,600 kg/day of DBO_5 and 14,600 kg/day of solid waste. Range: Andalusia

Desalination Plants (Almería & Campo de Dalías)

It has a treatment capacity of 97,200 cubic metres per day, the Campo Dalías seawater desalination plant is one of the largest desalination plants in Europe.

The desalination plant consists of:

- Raw water intake
- Pre-treatment by means of a double filtering cover
- Reverse osmosis process
- Post treatment
- Pumping
- Storage and distribution of treated water

3.3.2.2. Interview summary and initial analysis

One interview was conducted with a water producer (male).

Thematic 1: definition of stakeholders' preliminary roles and expectations

Use of Groundwater

The interviewee suggested that there are no groundwater supply problems in the area. He also added that there are more operational limitations by the network than by the administrations' intention which is regarding the use of desalinated and reclaimed water. He considers that there is growth in

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the area in regards with the use of desalinated water and hence his organisation is investing in facilities to improve this.

It can be deduced that there are no issues concerning groundwater and as for the reclaimed water there is still development being carried on.

Quality of Groundwater

The interviewee suggested that there are water quality varies depending on the time of the year and that in general there are problems in the aquifers due to overexploitation. He also added that projects are being promoted to make use of regenerated water so as not to damage the aquifer.

Collaboration with other stakeholders and other possible conflicts

The interviewee said that they do not communicate with all the end-users as it is not in their interest and they only communicate with their customers. He does not know JCUAPA very well and said that he has never been in a meeting with them. He also added that there is no fluid communication between the different entities and it is not known where the main communication problem lies. He confirmed that the main problems are that it is not known what everyone is doing and there is a lack of communication flow.

It can be observed that there is a lack of transparency between the different stakeholders and there is a lack of communication between the entities involved unless they are pursuing their self-interest.

Thematic 4: Involving the stakeholders into communities of practices

The interviewee suggested that COP would be a good opportunity to improve communication between JCUAPA and the administration as communication has not been very fluid so far.

3.3.3. Water Suppliers

3.3.3.1. Water suppliers – actors and organisations in Campo de Dalías

Hidralia

Hidralia manages a drinking water network of 2,547 km, which distributes more than 57.95 Hm3 per year to 12 cities, with nearly 545,000 inhabitants, employing 315 professionals. It is the entity that best knows the management of water resources in the area because it is dedicated to the entire area of the autonomous community.

Hidralia is responsible for the supply of drinking water in 3 out of the 10 municipalities located in Campo de Dalías: Roquetas de Mar, Adra, and La Mojonera. Drinking water in Roquetas de Mar comes from two different sources: Campo de Dalías desalination plant, located in Balanegra, and groundwater abstracted from 5 pumping wells. In Adra, drinking water comes from 3 pumping wells and one spring (Fuente Marbella), whereas in La Mojonera two pumping wells provide the necessary water resources. Range: Andalusia

JCUAPA & Irrigation Communities (agricultural water demand)

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JCUAPA is the Central Association of end-users of the Western Aquifer, but can also be viewed as a water supplier. JCUAPA brings together irrigation communities and regulates some water infrastructures. Most of the farmers in Campo de Dalías are members of the JCUAPA, although there are still a few of them that have not joined it.

Remaining municipalities (urban & industrial water demands)

Urban and industrial water demands in the 7 remaining municipalities are satisfied by public, joint-venture and private companies. In the smallest towns such as Vícar, Enix and Felix, as well as in Dalías, drinking water supply service is directly managed by the City Council. The private company Aqualia is responsible for the urban water supply in Berja and Balanegra, while Aguas de El Ejido, a joint-venture, manages the water supply service in El Ejido.

3.3.3.2. Interview summary and initial analysis

One interview was conducted with a water supplier (male).

Thematic 1: definition of stakeholders' preliminary roles and expectations

Use of Groundwater

The interviewee suggested that there is more public management in Almería but some private companies are operating as well as water suppliers.

Quantity, Cost and Quality of Water

The interviewee said that there is sufficient water with the addition of desalinated water and their own resources. He also said that the water extracted from the aquifers has many quality problems and they are trying to solve them with the use of desalinated water.

The interviewee suggested that there is support for vulnerable groups like allowances for pensioners, certain groups are supported but it also depends on the municipality. He said there are also leakage aids when there are extraordinary leaks and very high water bills, modifications are also made to minimise impacts by such leakages. He stated that there is a progressive cost model, where the higher the consumption, the higher is the cost. This is to generate awareness of water consumption. He added that the purification fee is a fixed fee.

Regarding the quantity of water, the interviewee said that it depends on the year, and the lack of rain is more pronounced in that year. There are also quality problems in Adra and Mojonera, so an application is made to the town halls to request a flow of desalinated water. As previously mentioned, there is a desalinated water project in the Hydrological Plan.

The suppliers have a progressive costing method and a fixed fee for purification charges. While affordability is not discussed, there is support to vulnerable groups and aids against leakage etc. There is an agreement regarding sufficient water supply with the addition of desalinated water.

Collaboration with other stakeholders and possible conflicts

The interviewee suggested that there is a lot of collaboration and they carry out joint tariff studies, he added that the JCUAPA also helps the irrigators with this.

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Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The interviewee said that there are many stakeholders involved and each of them has a different interest, which is often complicated to fit in with the rest.

From the administration's point of view, the processes are very slow. There is a certain political paralysis due to the political party involved and there is no record of meetings or a provincial body that brings together the policies made by the different entities. According to the interviewee, there is a lack of integrated management and a union of all points of view.

There is no collaboration found but there is an involvement in some form or other because of the common interest in groundwater use.

3.3.4. Water Regulators

3.3.4.1. Water regulators - actors and organisations in Campo de Dalías

Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development

The Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development is the department of the Regional Government of Andalusia responsible for the autonomous competencies in the areas of agriculture, livestock, agri-food, rural development, fisheries, aquaculture, agricultural research, environmental protection, water, natural areas, livestock trails, public forests, hunting reserves and hunting control.

Regional Government of Andalusia is the institution that organises the self-government of the Autonomous Community of Andalusia.

Range: Andalusia

Consortium for the management of the Integrated Water Cycles of the Poniente de Almería

The consortium is responsible for the management of non-conventional water sources. It is also responsible for the implementation and creation of water regulations. It belongs to Almeria (province in Andalucia).

Hydrology Area of the H.D. of the Andalusian Mediterranean Basins

Responsible for the management of water resources in Andalusian river basins. It belongs to the Regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development.

City Council (focused on non-conventional water resources – public regulator) in Roquetas de Mar

3.3.4.2. Interview summary and initial analysis

Two interviews were conducted with two water regulators.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Use of Groundwater

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One regulator said that the entity responsible for managing water resources is the JCUAPA in the region.

Quality of Groundwater

One regulator said that in Campo de Dalías, 8-9hm3 of water per year is supplied for drinking water. In recent years, water was taken from the aquifer but is now highly salinated. Now desalinated water is being used thanks to the change in the distribution network and about 90% of the water comes from the desalination plant. He added that the water that is used is regulated through the JCUAPA in which agricultural water predominates, so the cities are in a way supplying subsidised water to irrigators. The water companies that use water from the aquifer pay the aquifer recovery fee.

The other regulator suggested that there are approximately 250 litres of water per inhabitant per day available in the region per year and that 60% of the water supply depends on groundwater, although in theory this should be increased to 45% and the rest should be desalinated water. He included that there are some water quality problems, although attempts are being made to control them with taxes and charges. Water quality is not a problem thanks to the good organisation between the different entities.

There are contrasting views between the two regulators where one of them is saying that 90% of water is desalinated while the other says that 60% of the water comes from groundwater sources. One of them says that there are some problems with the water quality.

Collaboration with other stakeholders and possible conflicts

One of the regulators mentioned that the Roquetas Town Council asks the Junta de Andalucía to become more involved in the management of water resources, as it is a common resource for all. According to him, there is not enough transparency in the management because JCUAPA is private and the accounts were not audited until recently. Now it does this because it is being required to do so by regulation. Most of the town councils that are part of the zone agree to have a more real external audit and results to know if the reports are completely reliable. There is no presumption of fidelity in the documents that happen because it is not formed by public employees.

The same problem as observed within the supplies and producers is that the JCUAPA is a closed entity where the records and reports are not shared as they are not required due to lack of regulations.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The stakeholder said that currently the reports are not even made visible resources in the area. The problem with the JCUAPA is that it is regulated by the irrigators, so they don't have enough transparency. The consumption of the irrigators is not reported in a verifiable way, there is a report, but there is no way of checking it. It should have been established by law a long time ago, as is the case with the Spanish electricity grid. If at a technical level all the necessary data were available, it would be published because it is required by law, therefore, it is not being done. Everyone is currently obliged to do so except JCUAPA.

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While the other stakeholder suggested that as he is a part of the current water regulatory bodies, he has a fairly comprehensive view. In his opinion, right now there are enough measures to monitor the quantity and quality of water, but not enough mechanisms to control that these measures are being implemented and complied with. Today, there is a lack of clear coordination between users to achieve sustainable management of water resources, although work is being done daily to achieve this.

The stakeholders agree that there is a lack of transparency with the JCUAPA and they expect that technical data is made available to them and there are mechanisms to control and monitor the quality and quantity of water.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

One of the interviewees stated that he would like there to be a tool to know the availability of water resources to know what consumption is being carried out by one of the actors involved, as well as the quality levels of the aquifers.

The need is to have a comprehensive view of water management.

Thematic 4: Involving the stakeholders into communities of practices

One of the interviewees said that he would like to be a space where the different points of views could be seen but that he did not see it as possible. The other interviewee said that he considers communities of practices a great initiative to promote the proper management of water resources.

3.3.5. Other relevant actors and organisations

3.3.5.1. Other relevant actors and organisations in Campo de Dalías

University of Almería

University of Almería has expertise in Water in Agriculture, Irrigation and Agrifood. Water resources research projects are carried out, as well as analysis of future trends. Its research is done both internally with the university itself and in collaboration with other research centres.Range: Almeria

Centro experimental Las Palmerillas

The experimental center Las Palmerillas is a benchmark technological center in intensive Mediterranean agriculture, from where technology and knowledge are transferred to the sector.

IFAPA Centro La Mojonera

Agricultural and fisheries research and education institute. The Centre's research, training and technology transfer activities are directed towards the intensive greenhouse horticulture sector. Range: Almeria

3.3.5.2. Interview summary and initial analysis

Two interviews were conducted for two local organisations.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Use of Groundwater:

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The first interviewee said that 85-90% of water consumption is in agriculture and the agricultural production of Campo de Dalías is basically for exports. While the other interviewee said they have a working relationship with JCUAPA thanks to the demand for research projects on specific water issues as well as with the public administration.

Contrary to the other groups of stakeholders, one interviewee said that he has a good working relationship with the JCUAPA.

Quality, Quantity and Cost of Groundwater:

One interviewee said that water in three main regions of Almería, in Campo de Dalías had low brine groundwater with a mixture of desalinated water, superficial water and at moments water from the aquifer which is more brine, in Vega de Almería the brine groundwater is mixed with regenerated water and in Campo de Níjar the water is brine and mixed with desalinated water.

The other interviewee said that the quality problems for irrigation are in line with the concessions. The origin of the water is fundamentally groundwater. Most of the water catchments are located on the slopes of the Sierra de Gádor and capture the deep carbonate aquifer where the water is of good quality. This groundwater is supplemented by desalinated water (e.g. the Poniente desalination plant), plus reclaimed water from tertiaries, although the latter represents a minimal proportion. Mixtures are made at two levels to achieve ideal quality, in distribution reservoirs and mixes of each farmer in his own reservoir. This water mixture is currently used to irrigate a mixture composed mainly of groundwater and desalinated water. Both have very good quality. More desalinated water, as well as regenerated water, will be added soon. He added that in the Poniente Almeriense there are currently no quantity problems thanks to good planning and the needs are covered.

The water quality from the aquifers is generally saline and the groundwater is supplemented with the desalinated water and reclaimed water.

Collaboration with other stakeholders and other possible conflicts:

One of the interviewees indicated that 'The Water Users' Council (JCUAPA) only has a working relationship with the University of Almería. He added that conflicts may occasionally arise, but that is why the Water Juries are in charge of resolving these conflicts within the JCUAPA itself. He even considers this to be a model that could be applied worldwide. He said that the region of Campo de Dalías stands out for its high level of organization and structure.

While one of the interviewees said there is a good relationship with JCUAPA, the other one did not agree with this. And the Water Juries are there to solve conflicts and the interviewee is very confident in this system and he might be biased.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

One of the interviewees said that it is necessary to replace groundwater with desalinated and reclaimed water to guarantee the sustainability of the aquifers, as they are being over-exploited and this is already included in hydrological planning. He also said the social aspect of the Almería model is many small owners, associated in the form of cooperatives, which manage a common but scarce

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resource (water) through a Central Users' Board. Another aspect he pointed out is that to be able to irrigate with regenerated water, two things needs must first be covered:

- To scientifically prove that irrigation with a higher proportion of reclaimed water does not have harmful effects either from the point of view of product quality or from a health point of view. Here it would be necessary to incorporate European universities - from the countries that receive Spanish products - so that they can carry out a parallel verification, and in this way, the results are more credible in those markets.
- That there is social acceptance of irrigation with regenerated water. The policy should be involved here through regulations - it seems that this is already covered - and, why not, through awareness campaigns.

The interviewee said there is a need to scientifically prove that reclaimed water is not harmful, which can be tested and needs social representation where CoPs can carry out this by inculcating trust within the different stakeholders.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

One of the interviewees talked about the creation of a lobby/consortium at the Andalusian level made up of universities, research centres, to give greater visibility to the agricultural model (models) in Andalusia.

Thematic 4: Involving the stakeholders into communities of practices

One of the interviewees thinks that "lobby/consortium" could be created through the CoP.

3.4. Interviews - conclusions

Thematic 1: definition of stakeholders' preliminary roles and expectations

The views of the different stakeholders about water quality, quantity, and cost are presented in this section. End-users seem to have enough coverage in terms of water availability. In general, end-users are aware about technological developments in the irrigation systems and are open to adapt their methods and usage accordingly. They do not seem to have a problem with the cost of water and can afford it, however, their view is that the quality of groundwater could improve. The producers refuted any issues with groundwater supplies, stating that groundwater quality varies and that problems are caused by overexploitation of aquifers. To combat this, new programs to facilitate the use of regenerated water are underway, as shown by the increased use of regenerated water by end-users. The suppliers, in this case, two suppliers operating in the area, on the other hand, pointed out that there is more public management and there are also private suppliers and added that there is sufficient coverage of water supply with the addition of desalinated water to the supply. Suppliers have stated that the quality is fine, but that it can deteriorate due to maritime interference, while also noting that allowances and assistance to vulnerable groups of the population are in place and that they bill their consumers using a progressive cost system.

However, there are differing perspectives about JCUAPA and its measures to track water use, with the majority of stakeholders complaining that JCUAPA does not release any data or publish reports on

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their behaviour. According to some stakeholders, there is a lack of transparency. Better implementation measures and sharing of reports and information would solve these problems and increase trust. Nevertheless, many stakeholders are proud of the conflict resolving initiative by the JCUAPA, while the regulators do not seem to agree to that idea and suggest that the JCUAPA is a sort of a private end-users organisation and they should be obligated to conduct audits and publish their reports. The producers also stated that there is an absence of fluid communication between the different groups of stakeholders. The interviewed water supplier suggested that different stakeholders have different interested and that there is a lack of integrated management and a union of all points of view. Nevertheless, the majority of stakeholders agree that communication doesn't exist and if it does then it is not good enough and there is room for improvement.

	End-users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Perceived water accessibility (available water for use)	Sufficient	Sufficient	Insufficient, (depends on rainfall)	Sufficient (because of desalination plant)	Sufficient
Perceived affordability of water (price)	Affordable	-	-		
Perceived water quality	Sufficient but can improve	Depends on the time of year, mostly good	Depends on the time of year, mostly good	Sufficient	Sufficient (because of desalination plant)
Perceived cooperation with stakeholders	Cooperation but can improve	Lack of cooperation	Mixed views	Lack of cooperation	Cooperation

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The idea of collaboration and the development of the GTool to help share and administer water resources was well received by most stakeholders. The GTool could help the community with sharing information and for them to access the information.

	End users	**Water producers**	**Water suppliers**	**Water regulators**	**Intermediary organisations**
Willingness to cooperate	-	-	-	-	Yes

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Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

The organizations mentioned the need to create a coalition that would include numerous scientific and educational institutes as well as various basin stakeholders, while the regulator mentioned the need for water supply, usage habits and developments, and quality standards, as well as end-user interest in the instrument.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in obtaining information from GTool	Yes	-	-	Yes	Yes

Thematic 4: Involving the stakeholders into communities of practices

The stakeholders had a basic understanding of how the Communities of Practices would work for their benefit and accept the tool to support a fair and transparent distribution of water.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in participating in the CoP	Yes	Yes	-	Yes	Yes

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4. Use case 3 - Azraq Basin, Jordan

4.1. Description of the Basin

The Azraq basin is a semi-desert area characterized by hot and dry summers and fairly wet and cold winters. The mean annual rainfall ranges from 50 mm/year in the Azraq Oasis area to 500 mm/year in the Jabal Al Arab area (Hydrology of the Azraq Basin). The Azraq Basin forms the largest resources of good quality groundwater in the northeast of Jordan. Intensive pumping through the last 20 years has caused the lowering of the basin's water table and consequently increasing the salinity of the water. Because of the priority given to domestic supply, the government policy is now to reduce the use of groundwater by agriculture in the highlands. Groundwater in the Azraq basin is a major source of drinking water for the cities of Amman, Irbid and Zarqa as well as the Azraq area itself.

Azraq is located in Zarqa Governorate, belongs to Zarqa Town District and served by the New Municipality of Azraq. It has a population of 15,000. The province includes a mixture of citizens from different backgrounds, such as Druze, Chechens and Bedouins. The Municipality covers three areas: the first area - Northern Azraq and its surroundings, the second area - Southern Azraq and its surroundings, and the third area- borders of Al-Omari. The first area is about 6 km away from the second area and the second area is about 50 km away from the third area, while Azraq is about 80 km away from Zarqa. The population of Azraq people is about 3.8% of the total population of the Zarqa Governorate. Azraq town includes one of the largest Syrian refugees camp, which hosts at least 34,918 Syrian refugees.

Figure 9: Hydrogeological map of the Amman Zarqa-Azraq region. Taken from Al-Hadidi et al. (2013)

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Average precipitation in the basin ranges from 100 to 150 mm/year in the north western part, from 50 to 100 mm/year in the middle part and is less than 50 mm in the southeaster part. Rains usually take place during the winters, which are cold, while summers are hot and dry. So, no surface flowing water will occur, except during extremely heavy storms.

The Azraq basin consists of three aquifer systems hydraulically connected in certain parts. The upper aquifer, middle aquifer, and deeper aquifer systems. Soils are primarily composed of limestone or covered by basalt boulders that resulted from volcanic out crossing centred on Jabal Al Arab.

The groundwater in the Azraq Basin is found in different aquifer systems ranging from recent deposits to deep sandstone aquifer complexes. The groundwater in the different aquifers, from the shallow one to the deep complex, is hydraulically interconnected. Two zones in the Azraq basin are identified:

- The north part of the basin for basalt aquifer (annual recharge rate around of 13%)
- The south for B4/B5 formation (annual recharge rate around 3%).

In the Azraq area, the B4 aquifer is extensively exploited for domestic and agricultural purposes and water have significantly depleted over the past decade.

The main aquifers are the unconfined quaternary basaltic sediments and the carbonatic ones (B4/5), which occupy most of the surface of the Azraq basin and have nice hydraulic properties for groundwater flow. The A7/B2 carbonate aquifer is confined under part of the basaltic aquifer, being hydro geologically connected with it (Figure 9: Hydrogeological map of the Amman Zarqa-Azraq region. Taken from Al-Hadidi et al. (2013) -more than 1,500 m thick in some areas-, and it is one of its main groundwater sources.

4.1.1. Water Budget

The water budget for the Azraq Basin was estimated by MWI (2010), which provided the total number of 24 hm^3/year of recharge from precipitation (11% and 3% of annual recharge rate in the northern and the southern part of the basin, respectively), as well as 18 hm^3/year of lateral groundwater recharge, coming from Syria (Figure 10: Water budget in Azraq basin). Groundwater abstraction for drinking, agricultural and other purposes was estimated at 24.8 hm^3/year, 27.5 hm^3/year and 0.89 hm^3/year, respectively. So, by 2010 there was an over-pumping of 11 hm^3/year. Most of the abstraction wells are located in the proximity of the Azraq Oasis to irrigate several, approximately, 29,000 ha of olives trees mainly, which set a big pressure over water resources of this wetland.

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Figure 10: Water budget in Azraq basin

4.1.2. Causes of overexploitation of water

Groundwater in Jordan has been used since the early 1960s for different purposes, including domestic, industrial, agriculture and environmental use. Groundwater in the Azraq basin is a major source of drinking water for the cities of Amman, Irbid and Zarqa as well as the Azraq area itself. Irrigated agriculture was the major consumer of groundwater in Jordan up until 1995, especially in the Highlands, the main irrigated area in the country after the Jordan Valley, but its share has now dropped to 42% (2015). The development of modern groundwater-based agriculture over the years in the Highlands has been driven by the improvement in well-drilling techniques, the decrease in energy costs, land affordability and accessibility, and good water quality and quantity. All these factors helped make irrigated agriculture a prime investment option. But this expansion has also been kick-started and encouraged by the government who freely awarded licenses for wells in the 1980s and early 1990s. Even though investors and farmers enjoyed a good economic return on these activities, in the mid-1990s the government, sensing the increase in groundwater use in the area, tried to control abstraction by banning new wells and introducing metering in the Highlands. This concern went in parallel with the strategic necessity of preserving the resource, given the dependency of Amman's drinking water supply on the same groundwater, and incipient environmental concerns regarding the preservation of the internationally renowned Azraq Wetland.

The measures aimed at monitoring groundwater abstraction and reducing over-abstraction in the late 1990s, and later with the By-Law of 2002 that introduced dramatic changes, remained largely ineffective due to the weak monitoring of actual use on the ground. The mismanagement of groundwater use by both the government, through its lack of control, and private users, who still engaged in illegal drilling, caused continued deterioration of water quality and quantity. Water tables dropped by 25 meters on average during the last 28 years. In some aquifers, abstraction is close to three times the estimated safe yield. Yet, in the past 4 to 5 years, the government has shown unprecedented resolve and political will to enforce existing regulations but also passed stringent new ones, in particular about the control of illegal wells.

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4.1.3. Impact of the Agricultural sector on water

The expansion of agricultural land continued in the 1990s with the introduction of new cropping patterns in Azraq, e.g. grapes, and pomegranates later in the early 2000s, diversifying away from olive trees. More recently, farmers have attempted to cultivate alfalfa due to its high yield and high revenue, despite its high water consumption. It was found during fieldwork between 2013 and 2014 that alfalfa cultivation in the Azraq area is mainly dependent on illegal wells, or wells without meter so that farmers can avoid paying water consumption fees. The increasing trend in groundwater abstraction was reduced during the mid-2000s due to the decline in water table levels, the decrease in well productivity, and an increase in water salinity. Accordingly, many farms were abandoned, especially in south Azraq area which is underlain by a saline aquifer. Nevertheless, agricultural expansion continued in Azraq north and eastern farm area with the introduction of new crops such as alfalfa. According to the Ministry of Agriculture, cultivated land surface increased between 2005 and 2011 from 61,195 dunum to 114,325 dunum (MoA, 2012).

Following the increase in agriculture leading to environmental problems in the wetland, the Azraq basin has been a focal area attracting several international initiatives. The Azraq wetland reserve has an important social and economic role for the local community, as it provides a permanent source of income for 40 locals employed by the park. Remote sensing data and geospatial techniques act as good sources and tools for providing data needed for managing the scarce water resources of drylands, as the information provided through remote sensing and geospatial techniques may provide solutions that optimize cropping pattern and water use. The remaining challenge, however, will be the capacity building needed for adopting and implementing these techniques. Once this target is achieved, then it is hoped that remote sensing and geospatial techniques are taken one step further towards the development of water accounting systems for the different basins in Jordan.

When agriculture first started in Azraq, well licenses did not exist. With the introduction of groundwater laws and water prices, farmers were forced to obtain licenses for their wells. Wells in Azraq are divided into three types depending on their legal status; 1) legal well (well drilled with a license from the Water Authority of Jordan (WAJ). WAJ is one arm of the Ministry of Water and Irrigation (MWI) and is responsible for managing the groundwater in Azraq; 2) registered illegal well (well with a permit registered in the WAJ database) and; 3) not registered illegal well (wells drilled illegally and not declared by the owner, which is either known to the WAJ or not). Well drilling is normally done by licensed drillers with rotary drilling machines that are registered in the database of WAJ. The depth and well location is approved by the WAJ and written in the well license. Almost all functioning wells in the basin are drilled wells, while in the past they were dug wells. Wells have a depth between 30 m and 350 m, depending on the area and the water table. The installation of a casing and a screen is needed to prevent the inflow of sediment and the collapse of the well. Given the fact that groundwater is the only source of water in Azraq, the number of wells has increased over the years following the expansion of land cultivation and agricultural activities. Official abstraction rates are calculated based on meter readings of legal and illegal registered wells, and estimated based on the cultivated area and cropping patterns in un-metered wells.

Nowadays, all shallow wells have been closed or turned into boreholes wells. According to official statistics, the number of wells reached 1,316 in 2009 and abstraction volumes reached around 51 MCM, 28 MCM of which for agriculture. Recent surveys conducted in the Azraq basin have found that

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actual groundwater use for agriculture in the basin exceeds three times the official recorded data (Al Bakri, 2015; USAID, 2014). Illegal wells affect the basin negatively, as it has been established that users abstract via illegal wells almost one and a half times more than what legal wells are licensed. Abstraction from legal wells seemingly decreased after 2005 possibility due to the new water tariff and the enforcement of bill payments which had been neglected before 2004. Accordingly, farmers have tended to increase groundwater abstraction via illegal wells to avoid paying the water price.

4.2. Objectives of GOTHAM for the basin

As a result of the GTool implementation, measures aiming at reducing groundwater salinity will be set up in this replication site during the project's duration. It is expected that these measures will lead to a reduction of water salinity by 5-10% after 3 years of implementation.

Also, there will be Identification of illegal wells through the combination of data related to agriculture (vegetation indices obtained with remote sensing techniques) and the current legal wells distribution, making use of geospatial techniques. It is expected to conduct this procedure in the complete extension of the aquifer and it will be subject to the available data.

4.3. Stakeholders mapping and analysis at basin level

The table below categorises the main organisations in the region per stakeholder type. Nevertheless, it must be noted that an actor might belong to several categories, for example, the Ministry of Water and Irrigation (MWI) represented by the Water Authority of Jordan (WAJ) is a water supplier, but also a regulator.

Stakeholder type	Corresponding organisations in Azraq Basin
End-Users	• Urban users • Farmers • Industry-related actors
Water producers (e.g., Drinking Water Treatment Plant, Seawater Desalination Plant, Wastewater Treatment Plant and)	• Private well-owners • Al-Musafer desalination plant (treating groundwater and selling it for drinking purposes)
Water suppliers/Water utilities (e.g., Water operators, Utilities, Water distributors etc)	• Ministry of Water and Irrigation (represented by Water Authority of Jordan) • Area of private wells managed by the Ministry (Water utilities) • Water suppliers (private sector)

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Water regulators	Ministry of Water & Irrigation (represented by Water Authority of Jordan)
Intermediary organisations (e.g., NGO's, local associations)	• Charitable organisations and NGOs o Al Aoun Charitable Society and Rabe'e Al-shomare o Al-Irfan Charitable Society o Cooperative Association Women of Alazraq (NGO) • Nature reserves o Royal Society for the Conservation of Nature (RSCN) - reserves and wetlands o Shaumari Reserve o Azraq Wetland Reserve

Table 6: Stakeholder mapping in Azraq Basin

Water Management landscape

The main problems faced by the Ministry of Water and Irrigation come from illegal wells, meter tampering, and unpaid water bills. To control illegal well drilling, the Ministry has adopted two types of procedures: 1) radical, by closing the well (recently with dynamite so it is never used again; 2) more progressive, by increasing the water tariff of illegal (but registered) wells, so that farmers reduce consumption, and also by improving inter-departmental coordination forcing users to legalize or otherwise close illegal wells and pay due bills. Despite these regulatory powers, local enforcement is difficult since it requires direct contact with users. To that effect the WAJ has few field staff, making it difficult to control on the ground the application of rules. The lack of staff can also bring corruption as the users will be familiar with the authority representatives. The social proximity of WAJ staff and farmers in some cases (they are from the same area or live in the area) can also limit the effectiveness of rule enforcement and control.

In the sections below all the main actors and organisations (not just the ones with who interviews were conducted) within each stakeholder category in Azraq are listed and characterised. Following, the interviews with each of these stakeholder groups are analysed. Over 45 stakeholders were consulted through interviews/field surveys. Details can be found in the sections below.

4.3.1. End-users

4.3.1.1. End-users – actors and organisations in Azraq

As indicated in the section above, end-users consist of urban users, farmers, industry-related actors.

4.3.1.2. Interview summary and initial analysis

Field survey/interviews were conducted to poll the opinions of the Azraq city residents (end-users) in the northeast of Jordan, where groundwater is used for multiple purposes, by taking a representative community sample of 38 end-users. Out of the 38 people, 20 people (females) use the water for

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domestic purpose, 16 people use it for agriculture purposes (farmers, males), and 2 people (males) use water for industrial purposes. The boxes below present short comments of the project team.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Quantity, Quality and Cost of Groundwater

To give an overview of the sample of the 38 end-users who took the field survey overall, all of them stated that the groundwater is their daily source of water that covers all of their needs and 70% of them said that they estimated their annual consumption to around 500,000m^3 and it is used from artesian wells. 60% of the representative sample stated that the amount of water is insufficient for their daily use, especially during the summers. All the surveyed members complained of the high salinity and high sulphur concentration in the water along with turbidity.

The 16 farmers who took the survey/were interviewed said that their annual water consumption is less than 500.000m^3. 90% of the water consumption accounts for groundwater and a negligible 10% for surface water. The farmers said that there is sufficient water for their activities, and they monitor their consumption with the use of flow meters. The farmers stated that their agricultural activities include the cultivation of fruit trees such as olives, pomegranates, and palms. Some use drip irrigation system while others use surface irrigation system, and the irrigation season lasts the whole year. Only 50% of them use smart drip irrigation systems to rationalize water using. They also conveyed that the biggest problem with the quality of water is the saline nature of it and the shortage of water during summers – during this period 25% of the surveyed farmers make use of desalinated lake to cover the shortfall. They said that the cost of water is quite reasonable so they can afford it, and they added that it is the water authority to whom they pay the bills which also regulates the amount of water. It was suggested by one farmer that the among of water is insufficient for use. It was also suggested by farmers that the problem underlies in the unjust pumping and the lack of natural feeding wells in the region.

As for the domestic water users, their water consumption is less than 500.000 m^3 and 90% of water usage comes from groundwater, 10% from surface water and they monitor the consumption using monitoring tanks. The biggest difficulty faced is that the water is expensive and as such, they are not able to bear the cost of water. One of the domestic water users said that she always tries to use water in an efficient way as the cost of the water is considered very high. They pay the water bills to the water authority. The problems with quality remain the same - saline nature of the water and undesired taste.

Based on the interviews it can be noted that there is insufficient water available during the summers when many are forced to make use of the water from the desalinated lake. The vast majority of end-users suggest that the quality of water with its saline nature could improve. There seems to be a disagreement regarding the affordability of water, farmers seem to be able to afford water in many cases, perhaps because some of them are also well-owners and/or can afford water more easily due to their income, while domestic users seem to find that the price is very high, perhaps due to their relatively low income.

Collaboration with other stakeholders and possible conflicts

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As for the present synergies or conflicts between the different stakeholders of the region, the survey participants expressed the absence of coordination or dialogue between the stakeholders such as the Ministry of Water and the Miyahuna Company with end-users about rationalizing water resources using or water community management. They also mentioned that there are few water-related awareness-raising programmes in their city.

The farmers, in particular, said that there are synergies/conflicts between different types of stakeholders e.g. producers, regulators, utilities, end-users. The competencies between the different stakeholders are not completely defined and there is rather low active participation in water management. The farmers are open to the idea of cooperating with stakeholders of the same water basin to better share and manage resources.

According to the female domestic water users, there are synergies/conflicts between different types of stakeholders e.g. producers, regulators, utilities, end-users. They suggested that the competencies between the different stakeholders are not completely defined and that there is low active participation in water management.

Based on the interviews, while competencies between the stakeholders are not completely defined, there is a clear interest from the participants to collaborate and actively participate in water management.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

In general, the survey participants said that they strive to join effective programs in water resources management.

According to the farmers, the social benefits of the G-Tool will consist in the provision of good quality and sufficient quantity of water and managing water resources efficiently of societies and to distribute the water in a fair way, while maintaining the water basin. They think awareness and science are required to ensure the fair participation of all stakeholders in water management. They are interested in participating in the G-Tool design process through sharing farmers' concerns and the use of this tool will motivate them to improve the cultivation of their farms.

The domestic water users who took the survey expect the GTool to ensure the quality and provide a sufficient quantity of water. Some of them are interested in participating in the design process of the GTool and what motivates them to be involved is to learn and increase their awareness about the state of water resources in the Azraq region.

There is a general interest in the GTool co-creation process and in cooperating with other stakeholders.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

The survey participants would like to obtain sufficient information about the status of water in Azraq and the impact of climate change on water quality and quantity. Besides, they would like to monitor

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the water quality periodically. They have shown great willingness to use "GTool" because it is a smart and innovative tool.

The most important information the farmers would like to get from the G-Tool is the future of the “water situation” in Azraq.

The most important information the domestic water users would like to get from G-Tool is water supply, water quality and remote sensing regarding the amount of water in the Azraq Basin. At present they do not make use of any tools for monitoring the water consumption and they check the water filter every six months.

Based on the interviews, end-users would like to obtain information on water management in the region and information on the quality and quantity of water.

Thematic 4: Involving the stakeholders into communities of practices

Even though the concept of Communities of Practice was difficult for the end-users to understand, they agreed that the stakeholders should talk, have face to face meetings and discuss the issues related to the water status in the region. The survey participants expressed their willingness to participate actively within the "working group" by bringing together users of the same water resource into a unique discussion circle to discuss tomorrow’s solutions. 70% of the survey participants/interviewees preferred to have meetings 4-6 times in a year, while 20% preferred it once a month and the remaining 10% want the meetings to take place twice a year. They also inclined towards having these meetings in physical face-to-face format and to discuss various open topics related to water resource in the Azraq region.

Farmers think it is necessary to talk about water resources and they would prefer to have online meetings with open debate. As for the mode of conducting the meetings, the farmers think it is necessary to talk about water resources.

The group of females consider that the working group is useful to them by knowing the quality of good water and water consumption and rationalizing water consumption. Rules to follow to ensure fair participation of all stakeholders select experienced people and decision-makers. She thinks it is necessary to talk about water resources 2-3 times per month, also she would prefer meetings to be face-to-face and the debate to be open.

The interviewed household water user Regarding the work of the G-Tool, she was open to the idea of cooperating with stakeholders of the same water basin to better share and manage together this important resource. She said that there are different gains she wants to see for her and the society as of achieving the supply of water needed, maintain the water basin and achieve equity in water share. The concept of “community of practice” was difficult to understand and therefore each one presented different visions with respect to the usefulness of the concept. She had the opinion that stakeholders should talk, meet face to face and discuss issues related to the water status in the area.

The interviewees are not aware of the concept of CoPs but they are open to the idea of cooperating and creating a community and they prefer to meet regularly and prefer physical rather than online meetings.

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4.3.2. Water Producers

4.3.2.1. Water Producers – actors and organisations in Azraq

Private well-owners

Al-Musafer desalination plant (treating groundwater and selling it for drinking purposes)

4.3.2.2. Interview summary and initial analysis

One private water producer – a private well-owner (male) was interviewed.

Thematic 1: definition of stakeholders' preliminary roles and expectations

Quantity, Quality and Cost of Groundwater

The water producer interviewed is also a farmer and he said he mainly cultivates olive, pomegranate, palms and others, for agricultural purpose he mainly makes use of groundwater and he has a licensed borehole. His groundwater usage is less than 500.000m3 and more than 90% of water comes from groundwater sources compared to surface water as there are no sources of surface water. He said that he had access to the amount of water that is required for his activities and to measure his water consumption he makes use of a water meter. As for his farms, he uses the sprinkle irrigation method all year round.

Even though he has a licensed borewell and has sufficient water for his activities he said he strives to use the water efficiently and not to overuse it and does follow the optimal water allocation and engages in intelligent water use. He said he makes use of the weather station to monitor how much water is needed and how much is used for irrigation and/or other purposes.

He affirmed that he does not face any obstacles in obtaining the water or finds any issues with water. He added that he finds the cost of water reasonable and can afford it and he pay the water bills to the water authority and that the amount of water is regulated.

Interestingly the producer said that the water is moderately saline at 1300p/p and there is enough quantity of water available but the quality of water is poor and he faces issues due to the saline and sulphurous nature of water.

Collaboration with other stakeholders and possible conflicts

The producer stated that there is no coordination between different actors for a common resource but there exists a dialogue between the stakeholders to better manage the water resource. He also said that there is a system of collaboration and it is hierarchical. He also added that he is involved in water management at the territorial level but adds that there can be more involved than the present.

The interviewed water producer has a licensed borewell in the region and strives to use the water efficiently. The interviewee suggests that there are issues with the water quality. Furthermore, it also becomes clear that even though there is no coordination, there exists a dialogue that occurs only when there is a crisis or conflict.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

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The water producer said that he saw the gain of GTool in achieving sustainability of water, getting water at a good price and maintaining the water basin. He also suggested that he would be interested to participate in the design process of the GTool and said that he believes that it is necessary to be involved in decisions on water sustainability.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

The water producer said that he uses flow meters and checks the water quality monthly.

Thematic 4: Involving the stakeholders into communities of practices

The producer suggested that he would like to have the following information from GTool: information related to irrigation, and modern methods of reducing water wastage.

4.3.3. Water Suppliers/utilities

4.3.3.1. Water Suppliers/utilities – actors and organisations in Azraq

Ministry of Water and Irrigation (represented by Water Authority of Jordan)

The Ministry of Water and Irrigation (MWI) is the official body responsible for the overall monitoring of the water sector, water supply and the wastewater system. It is responsible for their related projects, planning and management, the formulation of national water strategies and policies, research and development, information systems and procurement of financial resources. Its role also includes the provision of centralized water related data, and the standardization and consolidation of data.

The MWI was established in 1992 under a bylaw issued by the executive branch of the Government under the Jordanian Constitution. The establishment of the MWI came in response to Jordan's recognition of the need for a more integrated approach to national water management.

The MWI embraces the two most important entities dealing with water in Jordan:

- The Water Authority of Jordan (WAJ): in charge of water & wastewater systems.
- The Jordan Valley Authority (JVA): responsible for the socio-economic development of the Jordan Rift Valley, including water development and the distribution of irrigation water.

Area of private wells managed by the Ministry (Water utilities)

Water suppliers (private sector)

4.3.3.2. Interview summary and initial analysis

Interviews were conducted with three water suppliers (one female and two males).

Thematic 1: definition of stakeholders' preliminary roles and expectations

Quantity, Quality and Cost of Groundwater

Water suppliers (private sector) said that they were obtaining groundwater through a legal and regulated supply from the Ministry of Water. One of the interviewees owns a private water treatment station and sells potable and non-potable water using quantities less than (1 million m^3) annually and

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pays fees and taxes annually. Revenue is variable according to supply and demand. The interviewee also stated that this product reaches all members of the Azraq community. This water supplier makes periodic water quality checks more than 24 times annually but does not monitor the water level of her well nor the sustainable production in the long-term. Another interviewee pays fees and taxes annually and performs periodic water quality checks annually but is not monitoring the water level in the well nor the sustainability in the long-term. The third interviewee monitors water quality annually but does not monitor long-term sustainability. All three interviewees complained about high salinity and high sulphur concentration in the water, turbidity, and water level decreases annually, especially in the summer.

Once again, the interview results of water suppliers suggest that there are issues with water quality – referring to high salinity and high sulphur concentration.

Collaboration with other stakeholders and possible conflicts

The participants expressed the absence of coordination or dialogue between the stakeholders such as the Ministry of Water with end-users about rationalizing water resources using or water community management. They also mentioned that there are few water awareness programmes in their city.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The interviewees strive towards joining effective programmes in water resource management, so they have shown great willingness to use "GTool" because it is a smart and innovative tool.

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

They hope to obtain sufficient information from the GTool about the state of water availability and the impact of climate change on water quality and quantity. Besides, they would like to monitor the water quality periodically.

Thematic 4: Involving the stakeholders into communities of practices

The interviewees expressed their willingness to participate actively in the CoPs by bringing together users of the same water resource into a unique discussion to discuss tomorrow's solutions. They preferred joining face-to-face meetings 4-6 times annually to discuss various open topics related to the water resources in Azraq city. They would like to have exchanges between the participants and create connections between stakeholders and end-users.

The water suppliers expressed interest in the GTool and are interested to participate in the CoPs.

4.3.4. Water Regulators

4.3.4.1. Water Regulators – actors and organisations in Azraq

Ministry of Water and Irrigation (represented by Water Authority of Jordan)

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Please see the description for MWI in the section above 4.3.3.1 Water Suppliers/utilities – actors and organisations in Azraq.

4.3.4.2. Interview summary and initial analysis

One regulator (male) was interviewed.

Thematic 1: definition of stakeholders' preliminary roles and expectations

The interviewee suggested that groundwater in Azraq has been used since the 1960s as the main and is the only source of water, used by several sectors for different purposes: domestic (24%), industrial (1.5%), agriculture (60%), environmental use (1.5%) and became a source for drinking water for the capital Amman as well as the Azraq area itself. Irrigated agriculture is the major consumer of water in the basin with an estimated abstraction volume of 28 MCM of water per year nearly the equivalent of the basin's safe yield. The flow of groundwater starts from south Syria towards Jordan from high to lower elevations towards Azraq. He suggested that topographically, the basin is concave with the Azraq oasis as a large fertile mudflat in the central and lowest part of the basin. The depth of groundwater varies from a few meters in the centre of the Azraq oasis to 400 m and it is recharged mainly from the Jabal Al Arab (also known as Jabal Al Duruz) recharge area in the north of the basin. The average precipitation for the basin is 87 mm/year, occurring between January and March because of that, the Azraq basin's safe yield is 24 MCM per year. The interviewee suggested that the government tried to control abstraction by introducing well metering in most wells. Also, it activated several laws, but the control remained weak, and the water table still goes deep causing an increase in salinity and degradation of water quality. Finally, most of the water used is groundwater, 60% goes to agriculture and 20 m^3 is available per capita and conflicts still persist with the absence of coordination among all stakeholders.

The interview sheds light on the existing problems regarding water monitoring: the government tried to regulate water abstraction and introduced well metering, however the implementation of these regulations remained weak.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The interviewee said that most of the time he communicates with all other stakeholders and provides his experience to everyone. He thinks that the GOTHAM project, through the GTool, will provide real solutions for all, give smart tools to monitor water use and water reality in Azraq.

4.3.5. Intermediary Organisations

4.3.5.1. Intermediary Organisations – actors and organisations in Azraq

Charitable organisations and NGOs

AL Azraq is a small village located at the very heart of an extensive transboundary, renewable groundwater basin in the northern part of the Eastern Desert of Jordan. Once referred to as « a glimpse of heaven » owing to its luxurious marshes, today it constitutes « little more than a truck stop » in an impoverished, sandy environment. Having witnessed radical ecological and socio-economic changes due to over-extraction of water from the basin and the Refugee movement through the years, it is now

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classified as a « poverty pocket » in dire need of development conducted. Later this led to the establishment of the **Charitable societies** in Azraq, most of them are aimed to providing assistance to the poor and the needy, Interaction with the local community, fortify the women in the financial field in order to help herself and her family, economic empowerment, and providing essential humanitarian assistance to Syrian refugees as well as vulnerable Jordanian households while promoting more sustainable solutions to meet the challenges.

Such charitable societies and NGOs include:

- *Al Aoun Charitable Society and Rabe'e Al-shomare*
- *Al- Irfan Charitable Society*
- *Cooperative Association Women of Alazraq (NGO)*

Nature reserves in Azraq

There are at least seven nature reserves in Jordan, two of them located in Jordan's eastern desert near the town of Azraq. In 1966, the organization that would later start Jordan's nature reserves, the Royal Society for the Conservation of Nature (RSCN), was founded.

The Royal Society for the Conservation of Nature (RSCN)

RSCN's first efforts involved bringing back severely endangered species. In 1973, RSCN was given the right to issue hunting licenses, giving RSCN an upper hand in preventing extinction. The first step was the founding of Jordan's first nature reserve, Shaumari Wildlife Reserve.

Shaumari Reserve

Located in al-Azraq, approximately 100 km east of Amman, It is a regionally important reserve created by the Royal Society for the Conservation of Nature as a breeding centre for endangered or locally extinct wildlife. The 22-square-kilometre reserve is a thriving protected environment for some of the most threatened species of animals in the Middle East. Some of the species include Arabian oryx, Somali ostriches, Persian onagers (an Asian wild ass from Iran) and gazelles.

Azraq Wetland Reserve

Azraq Wetland Reserve is RSCN's only wetlands reserve. The reserve, once a popular stopover for millions of migratory birds going from Africa to Eurasia, is now severely depleted due to over-pumping to support Jordan's growing population. In 1978, the reserve was established as an effort to conserve the oasis. Between 1981 and 1993, water levels decreased sharply, concluding with the drying up of the springs in 1992. Azraq today only makes up 0.04% of its former size. Water levels are maintained by RSCN in order to save indigenous fish species such as the Azraq Kill-fish and to keep the site a tourist destination. Efforts have been partially successful; some birds have returned and kill-fish have increased in numbers, but attempts to increase the water mass by 10% of the original size have been unsuccessful. Water pumping and lack of manpower and wetland experience keep water levels at a low.

4.3.5.2. Interview summary and initial analysis

Interviews took place with three representatives (three females) of charitable organisations and two discussions with representatives from two nature reserves (two males).

Thematic 1: definition of stakeholders' preliminary roles and expectations

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All the representatives of the charitable organisations confirmed that the measures aimed at monitoring groundwater abstraction and reducing over-abstraction limits were not respected and the number of illegal wells increased due to the weak monitoring of actual use on the ground. The mismanagement of groundwater usage by both the government, through its lack of control, and private users, caused the deterioration of water quality and quantity. The lowering of the water table in the basin encouraged deeper well drilling and new wells, contributing even further to the degradation and over-abstraction of the resource while increasing salinity and degradation of water quality. The representative said that they look forward to the tool proposed by the GOTHAM project, like a magic wand to solve the problem, and they said that they are willing to help.

One of the interviewees said that the main source of water in the Reserves is the Groundwater wells, these wells are controlled by the WAJ (Water Authority of Jordan), yet Azraq still endures many water problems that have led to many conflicts between all stakeholders (residents, farmers, and Service operators) some of the main problems include the lack of quantity (insufficient amount of water) and deterioration of water quality, the rise of water cost and the presence of violating wells and the deterioration of the water table.

The interviews with intermediary organisations also present the problem of lack of groundwater use monitoring, lack of law enforcement related to this and high water consumption by illegal wells owners, as well as a deterioration of water quality related to these issues.

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The interviewee welcomed the idea of the GOTHAM project, said that he is interested in cooperating and is willing to transfer his expertise and gain new experiences that will improve the water situation. He also emphasized that he would like to participate in monthly face-to-face meetings with all members of society.

4.3.6. Interviews - conclusions

Thematic 1: definition of stakeholders' preliminary roles and expectations

More than half of the end-users said that the water is not sufficient for their usage especially during the summers and that the water is highly saline and sulphuric and they make use of artesian wells. The farmers make use of drip irrigation methods. There is a general disagreement regarding the cost of the water where a group of stakeholders like farmers agree that they can afford the price of water while on other hand the domestic users seem to find the price of water to be expensive. Although the stakeholders' competencies are not fully established, there is a strong desire among the participants to cooperate and actively engage in water management. The water producer interviewed said that more than 90% of the water comes from groundwater sources and he makes use of sprinkle irrigation method while affirming that there are currently no problems faced by him and the water is affordable while pointing that the water is only moderately saline in nature. The producer also agreed that there lacks coordination between different actors even though there exists a dialogue. The three suppliers are obtaining water from legal sources and the revenue from water is variable as per the supply and demand. All of the three suppliers agreed and added to the high salinity and sulphuric nature of the

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water and also agreed that there is a lack of coordination or dialogue between the different stakeholder groups.

Interestingly, the water regulators said that the Azraq oasis is on a large high fertile mudflat and the depth of the groundwater varies. The government tried metering in most wells but were unable to strictly implement it leading to the water table going deep leading to high salinity and degradation of water quality while agreeing that there exist conflicts and an absence of coordination between the stakeholders of the basin. The intermediary organisations agreed on the issue of weak law enforcement, the problematic of illegal wells, and degradation of the quality of water in the region due to these issues. One of the representatives suggested that there are many conflicts between the stakeholders in the region.

	End-users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Perceived water accessibility (available water for use)	End-users in general: Insufficient Farmers: Sufficient	Sufficient	Insufficient (In summer)	-	Insufficient
Perceived affordability of water (price)	Farmers: Affordable Domestic Users: Expensive	Affordable	-	-	Rise in cost
Perceived water quality	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
Perceived cooperation with stakeholders	No cooperation	No cooperation	No cooperation	No cooperation	No cooperation

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

Among the end-users there is a general interest in the GTool co-creation proves and in cooperating with other stakeholders and they think the GTool's social benefits will consist in the provision of good quality and sufficient quantity of water and managing the water resources efficiently of water the producer also agreed to the benefits of the GTool in achieving sustainability of water and is interested in the participation of the co-creation of the tool. The suppliers commented that the tool is smart and they showed great willingness to use the GTool. The regulator was the only one who interacted and communicated with other stakeholders of the basin and he thinks that the GTool will provide a smart tool to monitor water use and water reality in the basin. The organisation also agreed to the cooperation process of the GTool.

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	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Willingness to cooperate	Yes	Yes	Yes	Yes	Yes

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

End-users would like to get more information about the state of water in Azraq and the effect of climate change on the quality and quantity of water, as well as track water quality regularly. End-users (farmers and domestic users) would also like to obtain information from the GTool regarding the future of the water situation in the basin. The producer only said that he uses the flow meters and checks the water quality monthly. Meanwhile, water suppliers said they hope to obtain sufficient information from the GTool such as the availability of water and they would like to monitor water quality periodically.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in obtaining information from GTool	Yes	-	Yes	-	-

Thematic 4: Involving the stakeholders into communities of practices

While most stakeholders are unfamiliar with the idea in Communities of Practices, they are enthusiastic about collaboration and attending meetings. End-users agreed to engage actively, with the majority preferring meetings every 2-3 months. Farmers believe that talking about water resources is important, and they prefer online meetings with open discussions. In general, end-users plan to engage and have meetings every 2-3 months to learn about the basin's water quality, quantity, and supply. Other stakeholder groups also showed interest, for example the interviewed producer is interested in learning more about irrigation and new water conservation techniques.

	End users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in participating in the CoP	Yes	Yes	Yes	Yes	Yes

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5. Conclusions and next steps

The matrix below provides an overview on the three case studies' interview results divided per thematic and representing the different stakeholder groups' point of views.

While in Campo de Dalías (Spain) it is mostly perceived that water is accessible and available to end-users, in Iaat Baalbeck-Hermel (Lebanon) and Azraq basin (Jordan) end-users seem to be facing more obstacles in obtaining water and/or are facing issues with water, such as water shortages, infringements on the water network, etc.

In terms of affordability, in Campo de Dalías there is more or less a consensus that water is affordable to end-users. Again, there a common trend in the two latter case studies regarding the pricing of water. End-users (often urban users) who rely on public or private water suppliers suggest that the price for groundwater is too high to be able to afford it. The situation for farmers seems to be somewhat better in both cases, possibly because many farmers own wells (as well as having as potentially having a different income), as such they are not facing the same issues that household users are facing in terms of affordability of water.

Furthermore, in both case studies one of the biggest issues is related to illegal wells and an associated lack of monitoring of water extraction. In Iaat Baalbeck-Hermel, in the case study area, there were about 200 wells drilled illegally, the owners of which do not pay fees nor taxes for the extraction of water and there is also very limited water consumption monitoring by the well-owners (and thus potential overconsumption). While laws and regulations exist, there is a lack of law enforcement. Similarly, in the Azraq basin, illegal wells affect the basin negatively, as it has been established that users abstract via illegal wells almost one and a half times more than what legal wells are licensed. Accordingly, farmers have tended to increase groundwater abstraction via illegal wells to avoid paying the water price. Law enforcement remains weak, despite some initiatives to boost water use monitoring by the regulators.

In terms of water quality, in all three case studies there are issues with water quality, based on the interviews. In Campo de Dalías some of the interviewees suggested that there are some issues with the water quality due to exploitation, but there are no major issues currently according to most of the interviewees. In Iaat Baalbeck-Hermel, there are major issues, there is pollution related to the malfunction of the Waste Water Treatment Plant (WWTP) and problems such as sewage leakage, and industrial and rainwater that carries pollutants. In the Azraq basin, stakeholders also consider the water quality to be insufficient, referring to its highly saline and sulphuric nature.

Regarding the thematic of cooperation, there are generally mixed views, in the case of Campo de Dalías Iaat Baalbeck-Hermel, in both cases there seem to be some level of cooperation in place, but there is also conflict between different stakeholders, so cooperation could be improved in general. Meanwhile, the views in Azraq basin were more negative, with most stakeholders suggesting that there some level of dialogue between the stakeholders, but no cooperation as such in place between the different types of stakeholders. Some of them referred to existing conflicts and an absence of coordination between the different stakeholders in the basin.

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Thematic 1: definition of stakeholders' preliminary roles and expectations

		End-users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Perceived water accessibility (available water for use)	**Iaat Baalbeck-Hermel**	Mostly sufficient (in contrast with the words "drought or thirst")	Insufficient	Insufficient (shortage)	Insufficient	Insufficient
	Campo de Dalías	Sufficient	Sufficient	Insufficient, (depends on rainfall)	Sufficient (because of desalination plant)	Sufficient
	Azraq basin	Farmers- Sufficient End-users: Insufficient	Sufficient	Insufficient (In summer)	-	Insufficient
Perceived affordability of water (price)	**Iaat Baalbeck-Hermel**	Price too high	Price too high	Affordable	-	Price too high
	Campo de Dalías	Affordable	-	-		
	Azraq basin	Farmers: Affordable Domestic User: Expensive	Affordable	-	-	Rise in cost
Perceived water quality	**Iaat Baalbeck-Hermel**	Insufficient	Insufficient	Sufficient	Insufficient	Sufficient
	Campo de Dalías	Sufficient but can improve	Depends on the time of year,	Depends on the time of year,	Sufficient	Sufficient (because of desalination plant)

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			mostly good	mostly good		
	Azraq basin	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
Perceived cooperation with stakeholders	**Iaat Baalbeck-Hermel**	Cooperation	Lack of cooperation	Lack of cooperation	Cooperation	Conflict
	Campo de Dalías	Cooperation but can improve	Lack of cooperation	Mixed views	Lack of cooperation	Cooperation
	Azraq basin	Lack of cooperation	Lack of cooperation	Lack of cooperation	Lack cooperation	Lack of cooperation

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process.

The large majority of stakeholders interviewed in Iaat Baalbeck-Hermel agree to cooperate, have a great interest in the GTool and are highly interested in participating in the design process of GTool. Some of the most important drivers that motivate them to participate include exchange of experience, good management of water and conflict resolution, fairwater distribution, addressing the issue of water waste, etc.

The idea of collaboration and the development of the GTool to help share and administer water resources was well received by stakeholders in Campo de Dalías, however not all interviews touched upon this subject in detail due to lack of time.

In the Azraq basin, there is generally interest towards the GTool and in cooperating with other stakeholders and most stakeholders believe that the GTools social benefits will consist in the provision of good quality and sufficient quantity of water and managing the water resources efficiently.

		End-users	**Water producers**	**Water suppliers**	**Water regulators**	**Intermediary organisations**
Willingness to cooperate	**Iaat Baalbeck-Hermel**	Yes	Yes	Yes	Yes	Yes
	Campo de Dalías	-	-	-	-	Yes

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	Azraq basin	Yes	Yes	Yes	Yes	Yes

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

In Iaat Baalbeck-Hermel, there was an interest in smart tools, even through currently the use of smart tools is limited. Some of the information required from GTool included information on monthly water table level in the well to manage it in the best way, rationalizing water consumption, water allocation for each crop, quantity of produced water and distribution geographically, estimating groundwater reserves, water availability, precipitation, temperature, humidity, irrigation timing, the quantity of water for irrigation available, water quality, daily water quantity available in the well, the quantity of water available in the well and sustainability, direct analysis of water quality, soil humidity, estimate groundwater reserves in the aquifers, the current state of the availability of water and how it will be in the future given the current information, the threshold required to reach sustainability, economically feasible crops under the current reality, the best management for the available water regarding extraction and distribution; making available accurate data and statistics that is reliable, etc.

In Campo de Dalías stakeholders suggested that they would like in general to create a coalition that would include numerous scientific and educational institutes as well as various basin stakeholders. No details were provided no the specific capabilities regarding GTool.

In the Azraq basin, there was an interest towards smart tools. End-users for example would like to obtain more information about the state of water in Azraq and the effect of climate change on the quality and quantity of water, as well as track water quality regularly. End-users (farmers and domestic users) would also like to obtain information from the GTool regarding the future of the water situation in the basin, and information on water quality. Meanwhile, water suppliers said they hope to obtain sufficient information from the GTool such as the availability of water and they would like to monitor water quality periodically.

		End-users	**Water producers**	**Water suppliers**	**Water regulators**	**Intermediary organisations**
Interest in obtaining information from GTool	**Iaat Baalbeck-Hermel**	Yes	Yes	Yes	Yes	Yes
	Campo de Dalías	Yes	-	-	Yes	Yes
	Azraq basin	Yes	-	Yes	-	-

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Thematic 4: Involving the stakeholders into communities of practices

In Iaat Baalbeck-Hermel, even though most stakeholders were not very familiar with the concept of CoPs as such, all stakeholder groups were very interested in trying CoPs and trying to support better water management. There was a preference towards physical meetings, as opposed to online meetings. Some stakeholder groups (e.g. regulators) are highly interested in CoPs and see them as a tool to resolve conflicts and raise awareness about the importance to preserve water in the region. Intermediary organisations were also highly interested as well and considered that it is important to establish guidelines to ensure that all parties participate fairly in the water management process.

In Campo de Dalías, stakeholders had a basic understanding of how the Communities of Practices would work for their benefit and accept the tool to support a fair and transparent distribution of water.

In the Azraq basin, while most stakeholders are unfamiliar with the idea in Communities of Practices, they are enthusiastic about collaboration and attending meetings. End-users, farmers in particular, believe that talking about water resources is important, and they prefer online meetings with open discussions. Other stakeholder groups also showed interest, for example the interviewed producer is interested in learning more about irrigation and new water conservation techniques.

		End-users	Water producers	Water suppliers	Water regulators	Intermediary organisations
Interest in obtaining information from GTool	**Iaat Baalbeck-Hermel**	Yes	Yes	Yes	Yes	Yes
	Campo de Dalías	Yes	Yes	-	Yes	Yes
	Azraq basin	Yes	Yes	Yes	Yes	Yes

The stakeholder mapping, as well as the conclusions from the interviews will be used for further project activities, especially for future engagement with the identified stakeholders of the three case-study areas, for the activities of the Communities of Practices (CoPs) and the related co-creation workshops planned under GOTHAM. The Communities of Practices will support cooperation between actors of the same basin, around the co-creation and use of the GTool. As such, these stakeholder-oriented activities support the overarching objective of GOTHAM: the development of a user-driven Groundwater Governance Framework (GGF) that could be applied in all Mediterranean countries.

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7. Annex – Interview guidelines

GOTHAM – Interview Guidelines for stakeholder relevant to effective groundwater governance

7.1. General information

Interviewing GOTHAM partner	
Name of the person interviewed	
Function, institution	
Date	
Place	

7.2. Methodology and aim of the interviews

The interview guideline consists of 2 sections – Part A which is an individualised interview guideline per stakeholder group and Part B which is a generical interview guideline and that has 3 subsections.

The aim of the first section "Part A"– an individual interview that is conducted per stakeholder type, thus differs for each stakeholder group addressed – addresses the thematic of *"thematic 1: Definition of stakeholders' preliminary roles and expectations".* The aim of this section is to understand the roles of the different stakeholders within the ecosystem and understand more about their use of groundwater and what issues the different stakeholders face related to the management and/or to the use of water. As such, questions are related to the *quantity*, *quality* and *the cost* of water. Such analysis will enable to understand whether there are issues related to the quality of the water, whether the end-users in the region have sufficient access to water, and issues around cost of water – for example whether the use of groundwater can be afforded by the end-users. All these questions will help to understand the state of the art and uncover whether there are problems related to the way the groundwater is managed in the area and if there are internal conflicts between the different stakeholders groups. The interview will allow to understand the water resources management landscape in the region from the point of view of relevant actors. The questions in this section aim to understand stakeholders' view on the current water resources management system, whether they are satisfied with it or envisage changes, what issues they see, and to understand more in-depth whether different actors engage in dialogue in order to better manage water or whether there are conflicts/ lack of discussion.

Following the individual interviews with the various stakeholder types, Part B is a generic interview – to be filled out by all stakeholder types. It consists of 3 thematic areas. Following, an introduction of GOTHAM project and GTool shall be conducted by the interviewers in order to give an overview and familiarise the interviewees with the main goals of the project. Accordingly, *"Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool Design Process"* aims to uncover how the stakeholders can be involved in the process of GTool design*; "Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop"* aims to uncover what the interviewees' interests are in terms of the project and the tool*"; "Thematic 4: Involving the stakeholders into communities of practices"* aims to explore

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whether the interviewees are interested to get involved in the communities of practices.

Note that these guidelines are a supporting document. Conversation and trust with stakeholders is what matters most to the success of GOTHAM. Feel free to conduct the interview in the way to find the most appropriate, with regards to your experience and expertise.

At the beginning of each interview, GOTHAM and the GTool and should be presented and explained by the interviewer:

- ***Brief explanation of GOTHAM: Triggering cooperation between stakeholders of the same water basin to better share and manage resources***
- ***The aim of GTool and its capabilities and use ("GTool aims at supporting people's sharing the water resources in a fair and equitable way. etc.")***
- ***Expected impacts for the (relevant) case study***
- ***Explanation of why and how the (given) stakeholders can get involved in the process and what exactly will be needed from them (We believe the tool would be more useful if final users help us design its features." etc.)***

Who: GOTHAM is a European Collaborative project carried on by several partners around the Mediterranean basin.
What: It proposes to create a tool, called GTool, which supports collaborative management of water resources. The application uses several indicators to tell each users how much water they can get, in order to manage sustainably the resource.
Why: Ground water resources around the Mediterranean basin are threatened by pollutions and overconsumption. We believe it can be shared in a fairer and more efficient manner, in order to be preserved, whilst serving everybody's interest.
Where: Activities will take place in three countries: in Spain, in Lebanon and in Jordan
When: The project started in 2020 and will finish in 2023
How: The tool will be an IT solution. It is not created yet. To create it, we want to work hand in hand with you, to make sure it really matches your needs. The Gtool does not have the possibility to create more water, but the capacity to help people work together to better manage the resource and share it in a fairer and more efficient manner.

By answering the following question, you support the development of the GTool. Do you consent?

7.2.1. Individual interview per stakeholder type

Thematic 1: definition of stakeholders' preliminary roles and expectations

Stakeholders #1 – End-users (Farmers, Industries, Final/Urban users)

1. Please provide a short explanation of your activities
2. What do you use groundwater for and how do you acquire it?
3. Please provide information on the quantity of the groundwater that you use:
    a. How much water do you need (approx.) annually for the purposes of your activity?
    b. What percentage (approx.) of your water use comes from groundwater versus surface water?
    c. Do you have access to the amount of water that you require for the purposes of your

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activities or is there a shortage compared to your needs?

d. Do you follow/monitor your water consumption? If so, how?

e. Do you strive to use water in an efficient manner and not to overuse e.g. do you follow optimal water allocation recommendations/ do you engage in intelligent water use (for farmers/industry) – monitoring how much water is needed/necessary and how much is used for irrigation or other purposes?

f. Do you face any obstacles in obtaining the water or issues with water (regulations etc.)?

g. If so, could you please explain what the source of the problem is (e.g. conflict between different stakeholders/ mismanaged governance/shortage of resources/someone responsible for the issue etc.)?

4. Cost of groundwater use

   a. Can you afford the water that you need?

   b. Do you consider the cost of water to be affordable/too high/too low?

   c. Who do you pay to in order to use the water?

   d. Who do you pay the water to?

   e. Is the amount of water you use regulated?

5. Please provide information on the quality of the groundwater that you use:

   a. Please give us your view on the quality of groundwater in the area/region in general

   b. Do you consider that the quality of the groundwater is sufficient for the purpose of your use specifically (or better quality is required for what you use it for)?

   c. Do you face any particular issues related to the quality of the water?

   d. If so, could you please explain what the source of the problem is (e.g. someone responsible for the issue, natural conditions etc.)?

6. Do you collaborate with other stakeholders e.g. water producers, utilities, regulators intermediary organisations? Are there any conflicts?

   a. Do actors coordinate the use of this common resource – water? Is there a dialogue between different types of stakeholders – end-users such as farmers, water utilities, water regulators etc. - in order to better manage water resources? Any examples for community management of water?

   b. Are there synergies/conflicts between different type of stakeholders e.g. producers, regulators, utilities, end-users?

   c. Is the system hierarchical or rather collaborative? Who has (the most) influence?

7. How do you see your own role in the water resources management process? How would you like it to be in the future?

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Stakeholders #2 – Water producers (e.g. managers of water treatment plants)

1. Please provide an explanation of your activities concerning the production of water – and please explain whether your activities concern only surface water or groundwater as well.
2. Please provide information on water producers in the region
    a. Do you pay for the use of the water sources (e.g. concession fee to the government)? If so, what is the fee?
    b. Do you coordinate how much water is produced by you with other actors? Do you monitor whether the quantity that you produce is feasible in the long-run /whether there is over or underproduction?
    c. Could you please explain your revenue model and mechanism of costs/payments/taxes e.g. from who you get your revenues?
    d. Who are the main water producer actors in the region? Are these actors from the public sector/private sector/public-private partnership?
3. Quantity, Cost and Quality of water
    a. How much water is produced by you (annually?)
    b. Is there sufficient water produced for the end-users of "X" region/area? Is it accessible and affordable to end-users?
    c. What percentage (approx.) of water use comes from groundwater versus surface water?
    d. Who do you sell the water too?
    e. Are there any issues with the quantity of water produced (e.g. overexploitation of resources)? If so, could you please explain what the source of the problem is?
    f. Are there any issues with the quality of the water produced? If so, could you please explain what the source of the problem is?
4. Do you collaborate with other stakeholders e.g. water utilities, water regulators, end-users and intermediary organisations? And other water producers, if any? Are there any conflicts?
    a. Do actors coordinate the use of this common resource – water? Is there a dialogue between different types of stakeholders – end-users such as farmers, water utilities, water regulators etc. - in order to better manage water resources? Any examples for community management of water?
    b. Are there synergies/conflicts between different type of stakeholders e.g. producers, regulators, utilities, end-users?
    c. Is the system hierarchical or rather collaborative? Who has (the most) influence?
5. How do you see your own role in the water resources management process? How would you like it to be in the future?

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Stakeholders #3 – Water utilities (actors that supply/allocate/distribute water)

1. Please provide an explanation of your activities concerning the distribution of water to the population/end-users etc. - and please explain whether your activities concern only surface water or groundwater as well.
2. Please provide information on water utilities in the region
    a. Who are the main water utilities in the region? Are these actors from the public sector/private sector/public-private partnership?
    b. Do you pay any fees/taxes to the government or other actors?
    c. Could you please explain your revenue model and mechanism of costs/payments/taxes e.g. from who you get your revenues?
3. Quantity, Cost and Quality of water use
    a. How much water do you distribute (annually?)
    b. Is there sufficient water produced for the end-users of "X" region/area? Is it accessible and affordable to end-users?
    c. What percentage (approx.) of water use comes from groundwater versus surface water?
    d. Who is charged for the use of water (end-users?)?
    e. Are there any issues with the quantity of water produced (e.g. overexploitation of resources)? If so, could you please explain what the source of the problem is?
    f. Are there any issues with the quality of the water produced? If so, could you please explain what the source of the problem is?
4. How do you collaborate with other stakeholders e.g. water producers, water regulators, end-users and intermediary organisations? And other water utilities, if any? Are there any conflicts?
    a. Do actors coordinate the use of this common resource – water? Is there a dialogue between different types of stakeholders – end-users such as farmers, water utilities, water regulators etc. - in order to better manage water resources? Any examples for community management of water?
    b. Are there synergies/conflicts between different type of stakeholders e.g. producers, regulators, utilities, end-users?
    c. Is the system hierarchical or rather collaborative? Who has (the most) influence?
5. How do you see your own role in the water resources management process? How would you like it to be in the future?

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Stakeholders #4 – Water regulators

1. Please provide an explanation of your activities
2. Please provide information on water regulation in the region
    a. Who/ what organisations are responsible in the region for water regulation?
    b. How is the pumping of groundwater regulated?
    c. Can you please provide information on the overall water balance, i.e. what proportion of the water consumption is used for 1 Agriculture, 2 Industry, 3 Potable water, 4 other
    d. Previous question – but for the use groundwater only
    e. What is the principal objective of water regulation in your region e.g. quality protection of water?
    f. What use of water are effectively allowed or forbidden? Indicate quotas if relevant.
    g. Is there water that is not regulated at all?
    h. Are there contradictions between the public policy and property rights (IPR) or environmental regulation related to the use of water?
    i. Are there regulations against pollution?
3. Quantity, Cost and Quality of water use
    a. How much water (cubic meters) is available in the region per capita per year?
    b. Do you consider that there is sufficient water produced for the end-users of "X" region/area? Is it accessible and affordable to end-users?
    c. What percentage (approx.) of water use comes from groundwater versus surface water?
    d. Who is charged for the use of water (end-users?)?
    e. Is the use of groundwater affordable to the population/end-users ? What % of the population can afford groundwater?
    f. Are there any issues with the quantity of water produced (e.g. overexploitation of resources)? If so, could you please explain what the source of the problem is?
    g. Are there any issues with the quality of the water produced? If so, could you please explain what the source of the problem is?
4. How do you collaborate with other stakeholders e.g. water producers, water utilities, end-users and intermediary organisations? Are there any conflicts?
    a. Do actors coordinate the use of this common resource – water? Is there a dialogue between different types of stakeholders – end-users such as farmers, water utilities, water regulators etc. - in order to better manage water resources? Any examples for community management of water?
    b. Are there synergies/conflicts between different type of stakeholders e.g. producers,

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regulators, utilities, end-users?

c. Is the system hierarchical or rather collaborative? Who has (the most) influence?

5. How do you see your own role in the water resources management process? How would you like it to be in the future?

Stakeholders #5 – Intermediary organizations (associations, NGOs, international organisation)

1. Please provide an explanation of your activities
2. Please provide information on water regulation in the region
    a. Who/ what organisations are responsible in the region for water regulation? Do they fill their role?
    b. How is the pumping of groundwater regulated? Is the regulatory framework respected?
    c. What is the principal objective of water regulation in your region e.g. quality protection of water? Is it met?
    d. What use of water are effectively allowed or forbidden? Indicate quotas if relevant. Are these quotas respected?
    e. Is there any use of water that is not regulated at all?
    f. Are there contradictions between the public policy and property rights (IPR) or environmental regulation related to the use of water?
    g. Are there regulations against pollution? Are they respected?
3. Please provide information about the beneficiaries of the intermediary organisation
    a. Who are they? Where are they located? What is their main occupation?
    b. Do hey have issues regarding water availability (quantity)? If yes, please explain?
    c. Are they satisfied with water quality? Please explain
4. Quantity, Cost and Quality of water use
    a. How much water (cubic meters) is available in the region per capita per year?
    b. Do you consider that there is sufficient water produced for the end-users of “X” region/area? Is it accessible and affordable to end-users?
    c. What percentage (approx.) of water use comes from groundwater versus surface water?
    d. Who is charged for the use of water (end-users?)?
    e. Is the use of water affordable to the population/end-users (what %)?
    f. Are there any issues with the quantity of water produced (e.g. overexploitation of

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resources)? If so, could you please explain what the source of the problem is?

g. Are there any issues with the quality of the water produced? If so, could you please explain what the source of the problem is?

5. How do you collaborate with other stakeholders e.g. water producers, water utilities, end-users and intermediary organisations? Are there any conflicts?

   a. Do actors coordinate the use of this common resource – water? Is there a dialogue between different types of stakeholders – end-users such as farmers, water utilities, water regulators etc. - in order to better manage water resources? Any examples for community management of water?

   b. Are there synergies/conflicts between different type of stakeholders e.g. producers, regulators, utilities, end-users?

   c. Is the system hierarchical or rather collaborative? Who has (the most) influence?

6. How do you see your own role in the water resources management process? How would you like it to be in the future?

7.2.2. Generic interview – to be filled out by all stakeholder types

Thematic 2: Identification of stakeholders' main drivers and the elements that can be used to effectively engage them in the GTool co-creation process

1. Are you open to the idea of cooperating with stakeholders of the same water basin to better share and manage resources?
2. What gain do you see for (1) yourself and (2) for the society through the use of GTool?
3. Would you be interested in participating in the design process of the GTool? If so, how do you see your role/ contribution within the design process?
4. What would encourage you to participate? What would you consider as your drivers for participation?

Thematic 3: Pre-identifying stakeholders' needs regarding GTool capabilities and preparation of the first co-creation workshop

1. Do you use smart tools to monitor your water use? Please explain?
2. What are your activities regarding water quality control, such if they make lab test, frequency of test, results…
3. If not, why? Is there no tool available? Do you have trouble in obtaining them? Are there other issues that you are facing (access to electricity, internet…)?
4. What functionalities are you currently missing in your activities and that you would like to have from GTool?

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Thematic 4: Involving the stakeholders into communities of practices

Brief explanation of the "Community of Practices" concept: bringing together users of the same water resource into a unique discussion circle to discuss tomorrow's solutions

1. How do you perceive communities of practices? How could it be useful for you?
2. What rules should be set in order to ensure a fair participation of all stakeholders?
3. How often do you think it is necessary to talk about water resources?
4. What mean of communication do you prefer? Physical meetings? Online? Discussion thread (e.g. WhatsApp?)
5. Would you prefer to have open topic or on the contrary would you prefer to discuss pre-defined issues?

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