



# AWESOME

WATER-ECOSYSTEM-FOOD

## WEFE NEXUS MENTAL MODEL

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## LIST OF ACRONYMS

### Abbreviations

EC:	European Commission
ES:	Ecosystem Services
GA:	Grant Agreement
MAWG:	Multi-Actor Working Group
Mx:	Month number
NBI:	Nile Basin Initiative
SIA:	Systems Innovation Approach
WEFE:	Water Energy Food Ecosystems
WP:	Work Package

## EXECUTIVE SUMMARY

The Deliverable 6.2 is a detailed report that describes the road towards and the first phase of the Multi-Actor Working Groups (MAWGs) held from M9 to M21 in the micro and meso level following the case study description and analysis as well as stakeholders' engagement held during the first eight months of the project period which resulted in the submission of the D6.1. It provides a description of the MAWGs convened the summer of 2021 as Task 6.2 (M 9 – 42) that engaged a dedicated group of key actors in collaborative exercises and the resulting concept maps, describing the key drivers of change, the problems, causes, gaps and needs related to the Nile River Basin Water Energy Food Ecosystems (WEFE). For each MAWG, engaged in mental mapping sessions facilitated by the AUEB team (at meso level), and an external facilitator (at micro level). Sophisticated versions of the mental maps, combining the results from the WEFE sectors. The resultant maps were validated through rounds of one-on-one interviews with WEFE sector experts and were then shown to the participants in order to obtain comments, additions and suggestions. The mental maps presented and analyzed in this deliverable contributes to the development of other AWESOME WPs and tasks including:

- Evaluation and validation of outputs from WP3, WP4, WP5
- Input in WP2: i) Ecosystem Services (ES) identification finalized (after D6.1), ii) ES participatory prioritization to be used in D2.5 on ES valuation, iii) linkage among catalogue of international policies with ES (part of Task 2.5), iv) elicitation of key drivers, v) co-creation of future scenarios as part of the open-source energy model (D2.4, M20), of WP3 on the role of uncertainty in the macro-economic modelling (Task 3.1, M7-42) and of WP4 on meso scale modelling (D4.3, M36 and D4.4, M40).

The findings that arise on the water sector from the meso and micro level mental maps are the high variability of flow and flooding issues, dams' impacts on aquatic biodiversity, dams' impacts on sediments and evaporation, climate change, inefficient utilization of water, opportunities for cooperative management of dams. In the energy sector arise the interconnectivity between basin countries, opportunity for combinations, initiatives and energy security. In the food sector the promotion of irrigated agriculture, increased water demand, watershed development, internal conflicts, impacts from the pandemics, availability of inputs such as seeds and fertilizers, and exports increase. In the ecosystems are the rich and diverse ecosystem types, the ecosystem services, the threats and the need for integrated watershed approach and participatory planning.

The key drivers of WEFE changes are climate change, ecosystem services, food security, hydropower dams, policy and management practices and synergistic approaches. The system's key challenges are climate change, policy and management practice, water scarcity, stress on ecosystems, political conflict and increasing energy prices. While opportunities appear in synergistic approaches, technology, renewable energy, exploration of innovative management approaches and investments tied to sustainable WEFE practices

The main drivers and opportunities highlighted by the mental model are indicative of the relevance and the importance of the work being undertaken by the AWESOME project. In particular, three of

the projects main outputs (*the WEF Nexus decision support system, the hydroponics and aquaponics technology, and the training and capacity development programmes*) reflect identified drivers and opportunities in the form of *Policy and management practices* and *Synergistic approaches*, and *Capacity Development and Training* respectively.

## 1. INTRODUCTION

Throughout the project the Multi Actor Working Groups (MAWGs) facilitate the interaction between AWESOME research process and representative key stakeholders whose perspective is necessary. The objective is to ground the project's research in a real-world situation and increase the potential for practical application of the projects results. The stakeholder engagement methodology of AWESOME utilizes the MAWGs as a state-of-the-art participatory method to maximize the opportunities for co-creation and co-learning, with emphasis on knowledge exchange, cross-fertilization of ideas, adopting a three-level approach, namely macro-, meso- and micro- levels. The macro level is the regional one (Mediterranean and North-East Africa), the meso level refers to the Nile River Basin scale and the micro level is represented by the demo site in Egypt. The MAWGs following AWESOME's three-level approach are developed on two levels:

- micro level: engaging a dedicated group of key actors at the local level
- meso level: engaging a dedicated group of key actors who are domain experts at the river basin scale

The MAWGs described in this deliverable seek to:

- to map the WEF sectors drawing on data from the face-to-face workshops and interviews
- to prioritize the ES on the River Basin level affected by WEF changes
- to identify problems, causes, gaps and needs in terms of policy initiatives, WEF management

Building on the results from the initial stakeholder analysis reported in D6.1 and the collected input from the first MAWG, this report extends the preliminary stakeholders analysis, describes the concept behind the concept and mental maps in stakeholder engagement, provides the methodology for the co-designation of the WEF mental maps with stakeholders, their visualization and key findings.

This deliverable presents an update on the overall methodology followed on stakeholder engagement and its extension regarding D6.1, on MAWGs' objectives, target scale, timing and their link with the project's needs, on micro and meso level concept and mental maps production. It describes the methodology for the convening of the MAWGS, the steps for the development of the WEF nexus maps. The deliverable goes on to describe the background of the micro level MAWG, associated mental maps along from the face-to-face discussion and the semi-structured interviews on the four WEF sectors and key results and findings. The same information is presented on the background of the meso level MAWG presenting the resulting four concept maps, the final mental map and key results and findings on the four WEF sectors. Finally, the deliverable discusses the resultant mental models, and provides some final remarks before outlining the next steps in relation to the stakeholder engagement process.

## 2. METHODOLOGY

The aim of the mental modeling workshops conducted by the MAWGs was to introduce to stakeholders the nomenclature of the AWESOME, and by using the best available scientific information (such as Nile Basin Initiative reports) to frame the structured discussions according to the WEF Nexus idea and direct them to offer as much evidence as possible in order to take a broad look at the four sectors of WEF Nexus. The actions, issues, solutions, indicators as well as drivers of Nexus change were visualized during workshops on the map which represented the systemic interactions based on stakeholders' evidence and information on the case study area at the micro and the meso level.

The multi-actor approach is followed to analyse the WEF sectors interdependences, synergies and feedbacks in a Systems Innovation Approach (SIA), taking into consideration the three spatial scales of AWESOME model, namely the micro (case study level), meso (river basin level) and macro (Mediterranean level). The SIA implies that micro and meso/macro stakeholders are directly involved in the formulation, application and validation of models to their own problem context. SIA is widely used for problem analysis in a diverse range of application from public policy, energy transition, logistics etc<sup>1</sup>. The last two decades it is widely used by non-governmental organizations as well as international institutions such as United Nations, Organization for Economic Co-Operation and Development (OECD), the Inter-American Development Bank (IDB) in policy analysis and technological development and innovation in developed and developing countries. As a problem-driven approach considers stakeholders as problem-owners who interact with the problem analysts in order to create mental models and mind maps clarifying the problem and defining pathways that the problem is linked to management and policies as well as potential technological solutions.

The first two MAWG workshops, one on the micro level and one on the meso/macro level, were organized in the second half of 2021 and aimed at developing raw mind maps for the four WEF sectors. Details of the process are described in the following sections of this chapter.

### 2.1 STAKEHOLDER ENGAGEMENT IN AWESOME

This chapter provides the methodology for the stakeholder identification, mapping and analysis part of which was included within the D6.1. It also extends the initial stakeholder list following the revisions that took place after AWESOME partners collected feedback.

#### 2.1.1 ROLE OF STAKEHOLDERS

Stakeholders play a crucial role in the AWESOME project and are necessary for the identification, prioritization and mapping of the WEF subsectors, drivers, barriers and constraints. They contribute to the AWESOME project in the following ways:

- a) They provide information as local actors on the micro level and scientific expertise as executive actors on the meso level. Both are critical for the modelling of the WEF Nexus on



the basin level in order to develop a model that enhances our understanding of the interlinkages between WEFE sectors.

- b) They validate AWESOME projects initial finding on ES identification as well as outputs from WP2, 3, 4 and 5 participating in the research process
- c) They become beneficiaries of the training service that will take place after M26 aiming at skills gap assessment and capacity development with local workers training and liaison with financiers and investors.

In that way, stakeholders are engaged in AWESOME by participating in the MAWGs where they share their perspectives on the drivers of WEFE change and ES on micro and meso level; they provide detailed information and knowledge for the meso model development as well as feedback and mapping validation helping to develop technological solutions aligned with sustainable agriculture.

### 2.1.2 STAKEHOLDER ANALYSIS

#### **Step 1: Definition of purpose and conditions**

The identification of stakeholders begins with defining the purpose of engaging the stakeholders in order to establish the main objectives of the stakeholder engagement. In addition, it is important to identify the conditions the stakeholder engagement will be required to conform to.

##### *Purpose a. Co-production with stakeholders*

The first purpose is to ensure relevance of the research and to develop a real-world multi-scale case study. This is why it is crucial to engage stakeholders from the onset of the project and collaborate with them asking critical information to support the modelling on the meso level as well as to characterize all opportunities and constraints for implementation of technological solutions on the micro level.

##### *Purpose b. Uptake of the projects' outputs*

The second purpose is to maximize the projects impact by assessing the gap in terms of local workers skills and to build capacity in order to ensure that technological solutions will be applied on the micro level. The MAWGs will act as training ground to ensure the uptake. At the same time, it is necessary to ensure the scaling-up of the solutions on the wider river basin level (meso).

##### *Condition a. Work within the three-level framework of AWESOME research*

The meso level refers to the river basin scale, where the strategic planning needs to take place based on realistic projections in order to be useful for decision making. That meso level is informed by the experiment and innovations developed on the micro level. WP6, following WP4 meso modelling, focuses on three main countries crossed by the Nile River: Egypt, Ethiopia and Sudan. The stakeholders of the meso level MAWGs are engaged with the purpose of giving a detailed intra-basin analysis in AWESOME mental maps.

The micro level is represented by the demo site where innovative technological solutions are first trailed via experiments and then piloted, with the aim of increasing the productivity of a unit of water in terms of valuable products such as crops and fish. Stakeholders engaged in the micro level

MAWGs serve in linking the case study research with the real-world constraints and opportunities that local people face.

*Condition b. Ensure representativity from all WEFE sectors and subsectors*

AWESOME's main objective is to better understand tradeoffs, synergies and nested interdependencies across the WEFE Nexus components. This cannot be achieved without ensuring explicitly the representativity of all sectors and subsectors in each MAWG. For this reason, several organizations were identified from the: i) Water sector, broken down in water supply, water quality, water affairs, ii) Energy sector broken down in subsectors that affect more water use, such as hydropower, solar energy, wind energy, desalination iii) Food sector broken down in traditional agriculture, food security, hydroponics, and aquaculture, iv) Ecosystem sector broken down in ecosystems. Two extra sectors were chosen in the framework of the pandemic crisis: v) the Public health sector broken down in clinical medicine and other human health and finally the vi) Social sector and vii) others. The above categories were cross-referenced in a matrix in order to produce an initial database.

**Step 2: Preliminary scan of actor network in relationship with the case study experiment**

In order to achieve that step, the local partners (Zon Gardens) were engaged and together with WP6 team scanned information to identify organizations involved and affected by WEFE changes in the area as well as policy and research experts active in the Nile River basin. Project reports, policy documents and strategies were scanned (such as Nile Basin Initiative's documents) and a collaborative process of research and discussion with field experts has started, with the aim to ensure feedback on the identified stakeholders, but also their positioning in terms of their interactions within the WEFE Nexus. The online tool Miro (<https://miro.com/>) was used for the visualization of the stakeholders positioning and the actual mapping. That process took place in parallel with the technical description of the case study (soilless agriculture experiment) developed by RWTH. The methodology of the step 2 are described in the MS4 on convening the MAWGs that was delivered by WP6 team in M13 and in D6.1 on Case study description delivered in M14.

72 Stakeholders were identified at that initial stage, who were split in a short and a long list depending on their usefulness for engagement (see ANNEX A). 15 belong to the water sector, and out of them 9 represent the water supply subsector, 2 the water quality, and 4 the water affairs subsector. 12 belong to the energy sector and out of them 1 represent the hydropower subsector, 3 the solar energy, 1 the wind energy, 2 the desalination subsector and 5 are energy authorities and directorates. 28 stakeholders belong to the food sector, with 17 of them representing the traditional agriculture subsector, 6 the food security, 2 the hydroponics, and 3 the aquaculture subsector. 11 stakeholders belong to the ecosystems sector, with 6 of them to be occupied with management aspects and environment generally while 5 of them to represent the conservation subsector. 3 stakeholders belong to the public health sector, 2 to the social sector and particularly the sustainable livelihood and 1 stakeholder is classified in the "other" category as is considered to be concerned with humanitarian assistance and resilience building, although it is linked with nutrition and food security.

Taking into account that this is a work in progress any divergence noticed by the reader regarding the total number of the stakeholders between D6.1 and D6.2 is due to refinement of the initial list by the AWESOME team. The same is true for the Step 3a where the initial positioning of stakeholders

in terms of influence and potential interest in the project has been revised following feedback and validation exercises with project scientists from other WPs and identified sector experts from the research network.

### Step 3a: Identification of initial list of stakeholders' interests and influence

At that step a preliminary estimation was crucial regarding the stakeholders understanding of the WEFE Nexus in Nile, their potential conflicting interests and interactions as well as their influence. This analysis was conducted in order to understand their usefulness and set that as a criterion in order to decide the level of their engagement and scale relative (micro or meso/macro). The influence/interest matrix presented in Table 1 was used in order to classify stakeholders and four categories that were mapped with the use of Miro tool (<https://miro.com/>). The stakeholders listed in ANNEX A were plotted on a graph where *Influence* was represented in x-axes and *Interest* in y-axes. The mapping allowed the research team to see where each actor stands when evaluated against the same two key criteria, and to compare them to one another:

- i) Influence: how much influence they have. (here it is important to understand what actors fall within this sphere of influence (e.g. the research community, the locals, the SMEs etc)
- ii) Interest: how likely they are to engage in activities or initiatives relevant to the WEFE Nexus

The analysis of stakeholders based on this matrix allows the identification of stakeholders to whom the work is most relevant and who are most likely to be engaged in the research process. While it is advantageous to utilize the MAWG forum as an opportunity to engage influential decision-makers and solicit their buy-in from an early stage; the examination of 'Interest' also allows for the identification of those stakeholders who will invest time and effort into supporting the research process<sup>15, 16</sup>.

The table 1 below explains how the usefulness of each stakeholder is assessed in AWESOME.

**Table 1** – Levels of stakeholders' engagement based on influence and interest.

Influence / Interest relationship	Level of engagement	AWESOME engagement
High interest / High influence	Manage closely (high involvement, tap into stakeholders expertise)	MAWGs Data collection (interviews)
High interest / Low influence	Keep informed (one-way communication, presentation of research results)	MAWGs Diffusion of projects outputs

High influence Low interest	Keep satisfied (acting together with stakeholders based on shared goals)	MAWGs Training Capacity building
Low influence Low interest	Monitor (one-way communication with minimum effort)	Diffusion of projects outputs

Figure 1 below presents a sample from the stakeholder mapping illustrating influence on the vertical axis and interest on the horizontal. The resultant mapping produced a grouping of stakeholders under four quadrants:

- Quadrant 1 - Low Interest/Low Influence: 13 stakeholders
- Quadrant 2 - Low Interest/High Influence: 12 stakeholders
- Quadrant 3 - High Interest/Low Influence: 30 stakeholders
- Quadrant 4 - High Interest/High Influence: 16 stakeholders



**Figure 1** –Sample from stakeholders mapping in Miro.

The mapping was undertaken via an iterative process /a series of exercises, whereby the initial plotting based on input from project scientists and local partners, was further revised by field experts. The stakeholders within quadrant 4 constitute the core group of stakeholders within the context of the WEF Nexus in the case of the AWESOME project and will serve as the basis of the Multi-Actor Working Group (MAWG) formation. In addition to these core stakeholders, consideration was also given to the inclusion of stakeholders at the upper limits of quadrants 2 and 3 in order to develop the shortlist of stakeholders from which the MAWG participants are selected and invited.

### **Step 3b: Extended identification of stakeholders**

Taking into account that the identification and mapping is a work-in-progress and based on the deficiencies and limitations recognized in the 1<sup>st</sup> Workshop that was realized on the micro level, the team extended the list of stakeholders in order to ensure:

- wider representativity of Sudan and Ethiopia in order to receive more balanced critical information for the meso level model, which was considered crucial for meeting the Condition a. “Follow the three-level nature of AWESOME research”
- wider representativity of the ecosystems sector as well as some energy subsectors such as wind and desalination

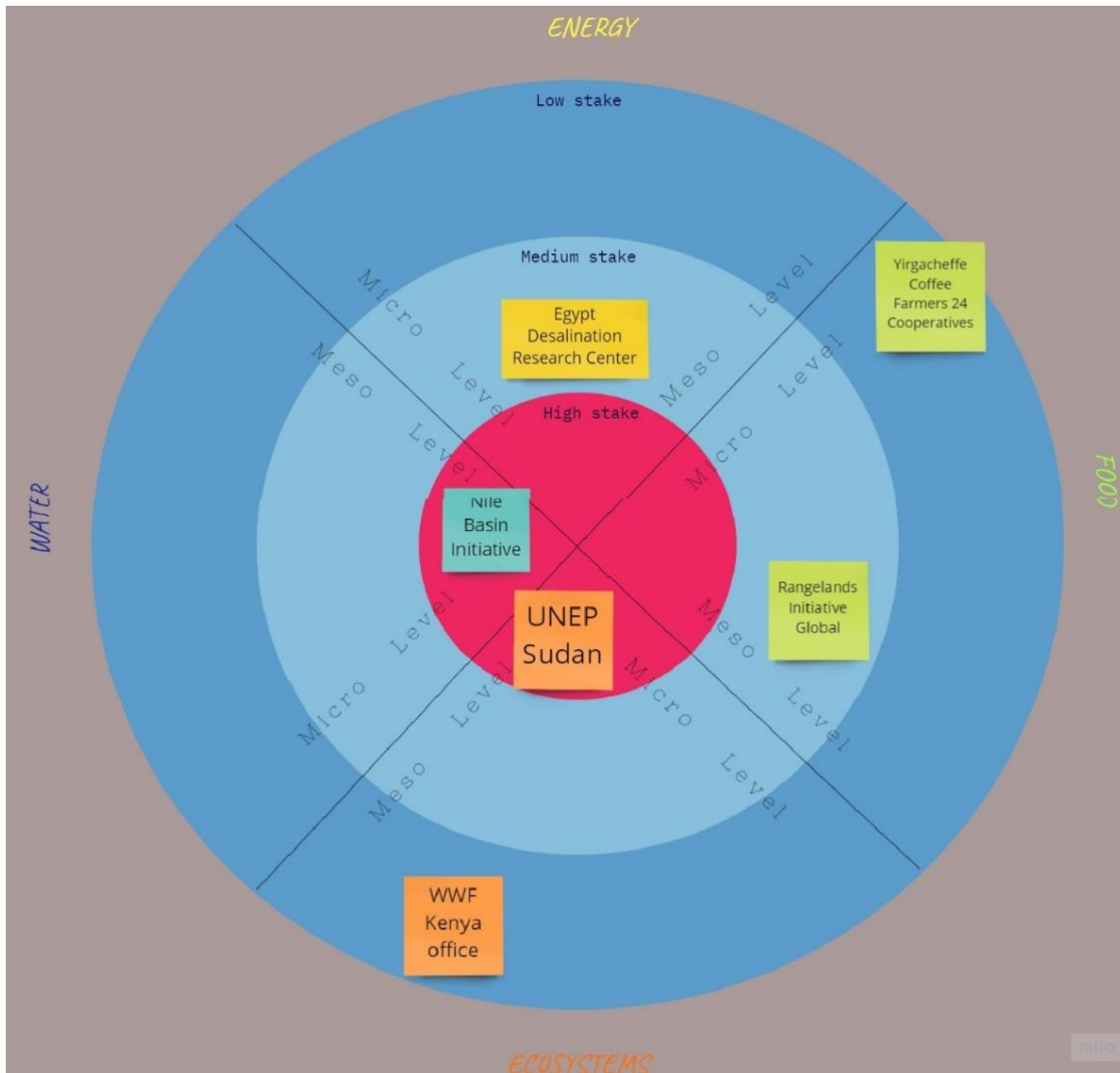
Toward that end, 18 more stakeholders were identified and mapped. 4 out of them belong in the water sector, 2 belong in the energy sector, 9 belong to the food sector and 3 in the ecosystems.

The detailed list, which is presented in the ANNEX B operates as the main pool for selecting stakeholders to convene the meso level workshops. Repeating the exercise described in Step 3a the new map produced the following groups of stakeholders under the same four quadrants:

- Quadrant 1 - Low Interest/Low Influence: 1 stakeholder
- Quadrant 2 - Low Interest/High Influence: 14 stakeholders
- Quadrant 3 - High Interest/Low Influence: 1 stakeholder
- Quadrant 4 - High Interest/High Influence: 3 stakeholders

### **Step 4: Analysis of stakeholders**

This step involves the categorization of all the 90 stakeholders into low, medium and high stakes based on their influence and interest. The influence is assessed either by their position in authority organization or based on the local partner input (Zon Gardens); while their interest is assessed based on their responsiveness and their active participation in the WEF activities in the region (publications, data collection, ongoing projects, policy input etc.). The overall goal of that step is to ensure that only actors with medium and high stakes who have both interest and high or medium influence are involved actively in MAWGs. The figure 2 represents the visual categorization of stakeholders according to their stakes while grouped according to the four WEF sectors and by scale (micro – meso) based on their activity and expertise.



**Figure 2** – Chart of stakeholder categorization.

**Step 5: Selection of stakeholders**

For that reason, for the WEF Mapping Workshop that was convened on the micro level, the team reviewed the long list of the 72 stakeholders (at micro level) and selected 19 who were invited to participate in a presential workshop that took place on the 5<sup>th</sup> July 2021, in Kempinski Hotel in Cairo. The selection was based on the steps described above analyzing these key actors and their relationships. The final shortlist is presented in the ANNEX A.

For the WEF Mapping Workshop that was convened on the meso level, the team reviewed the extended list of the 72 stakeholders to include 18 more; before the selection process based on the steps above resulted in the invitation of 22 stakeholders to participate in the online workshop that took place on the 22<sup>nd</sup> September 2021. 4 of them were part of the preliminary list and the rest 18 were part of the extended list.

While the final shortlist of stakeholders forms the basis of selection for MAWG participation, this does not rule out the potential to incorporate additional partners in the event that knowledge gaps are identified through the course of the MAWG or further key recommendations for input are made by the MAWG members themselves.

## 2.2 MULTI ACTOR WORKING GROUPS

This chapter provides a general overview of the MAWG planning for the whole duration of AWESOME project. It presents general picture of the objectives of each workshop, their level in terms of micro and meso scale, the expected timeline and the link with the project needs following the GA.

### 2.2.1 MAWG OBJECTIVES

Following the stakeholder selection at micro and meso levels, the project convened two MAWGs; one at a local scale in Egypt (micro), and another at the river-basin scale (meso). The main objectives from the MAWGs are:

*a. WEF Nexus Mapping*

AWESOME's main objective is to better understand tradeoffs, synergies and nested interdependencies across the WEF Nexus components. As a first step, stakeholders are introduced the nomenclature of the project and the idea of WEF and then data on the status quo are gathered such as actions, issues, solutions, indicators as well as drivers of Nexus change based on stakeholders' views during the MAWGs and visualized on the map. This will improve the understanding of the Nexus with the lens of the stakeholders on the study area across the three scales, domains and disciplines.

*b. Ecosystem Services identification*

One of the project's objectives is to explore the diffusion of innovative technological solutions for increasing agricultural productions, while reducing water and energy consumption as well as negative impacts on ES. For that reason, it is necessary to have, beyond literature review, a more realistic representation of the processes and policies influencing river basin dynamics in terms of land use, water and energy demands, and ecosystem services. As a continuation of the initial identification of key ES at the meso level, published in D6.1 (chapter 3.5), MAWGs need to validate and extend the initial list as well as prioritize the ES that will then be evaluated using a state-of-the-art economic method by WP2 as part of Task 2.5 (M7-24).

A further objective of the project, based on collaboration of WP2 (MS9, Task 2.5) and WP7 (Task 7.3, M13-42), is to examine the applicable international policies on environmental protections (e.g. Mediterranean Action Plan, European Neighbourhood Policy, Barcelona Convention) which are considered as constraints of the meso level model. MAWGs objective is to deliver a representative list of key ES so that the team examines the potential influences of international policies on river basin dynamics in terms of the ES.

*c. Future scenarios*



AWESOME project will generate future scenarios of the meso and macro scale processes and policies affecting the Nile River basin, by integrating demographic, climate and socio-economic projections. The scenarios will be the output of: WP2 based on open-source energy model (D2.4, M20), of WP3 on the role of uncertainty in the macro-economic modelling (Task 3.1, M7-42) and of WP4 on meso scale modelling (D4.3, M36 and D4.4, M40). Part of the MAWGs' objectives is the communication of the results from the scientific process to the stakeholders as these are directly linked with the actions that are expected to impact them at different future horizons and across the spatial scales.

#### *d. Capacity development*

As the technological uptake of the agricultural solutions is a main objective of AWESOME project, the teams of WP6 and WP7 work towards the maximization of the project's impacts on the micro and meso level. To this end, knowledge promotion and exchange, skills gap analysis to identify capacity deficits, as well as capacity development targeting local small-scale farmers, entrepreneurs, extension workers are crucial in the framework of the MAWGs. Capacity building at micro and meso level along with dissemination of results at the macro level and organization of training module (Task 7.4, M13-42) based on a Summer School will both ensure the uptake of Nexus approaches in the Mediterranean region.

### **2.2.2 MAWG APPROACH AND PLANNING**

The MAWGs were intended to foster a safe and open space, crucial in order to express opinions and conduct constructive discussions, while ensuring that discussions are structured enough to provide the necessary results to produce the mental maps and to provide the necessary input for the project's modellers. Participatory mapping techniques assist the joint examination of the current situation in the river basin as well as in the case study area, the identification of actions and management initiatives (existing and planned), that undermine or contribute to better WEF Nexus management. Transparency and integrity of the team and especially the facilitators are necessary in order to deal with competing interests, to exercise neutrality, to employ conflict resolution and ensure that individuals can focus on identifying the necessary WEF parameters and answering the questions raised. Each of the MAWGs subscribe to the same principles in terms of providing a safe space of interaction, the adoption of participatory facilitation techniques, inclusivity and transparency. However, different approaches were followed within the micro and macro level MAWGs in order to maximise the level of stakeholder engagement and ensure the highest quality of results, while taking into consideration health safety in the context of the COVID-19 pandemic.

For the micro level MAWG, the project took into account the fact that in the case study area (Egypt) the common culture is convening in-person workshops and meetings instead of online ones as well as the existence of potential limitations in internet connectivity or access to technology, the micro level MAWGs conducted a face-to-face meeting. Presential discussions among the participants taking place in the local language ensure the maximum actors' engagement. A duration of 4-5 hours is decided including coffee openings and breaks that offer to opportunity for networking and breaking the ice. Taking into account the political implication in Egypt an external facilitator was

hired for the presential workshops to assist the delivery team (Zon Gardens) in order to ensure neutrality in discussions and safe environment given the political sensitivity of the subject in the region.

In terms of the meso/macro level MAWGs the initial plan for in-person workshops was reassessed in the face of the pandemic, and so the workshops were designed to be held online. Taking into account that these series of workshops refer to participants who are executives and have an international activity, the meso level MAWGs' language was English. The participatory mapping approach was based on the use of the online tool Miro that offers the opportunity of simultaneous use by multiple users as well as asynchronous contribution from stakeholders as they were able to further comment, correct, extend or verify the map after the finalization of the MAWGs. Due to online participation fatigue, the duration of the meso-level workshops was shorter, at 2.5 hours including breaks to ensure the maximum concentration and constructive discussion.

The workshops were designed over the span of the project, each addressing different objectives identified in Section 2.2.1. The table below presents an overview of the various MAWG workshops at micro and meso level.

**Table 2 – MAWGs overview.**

	Year 2 (M13-24)	Year 3 (M25-30)	Year 3 (M31-36)
Micro Level	Drivers of WEFE change (M15) to produce WEFE Nexus Mapping and Mental Models	Ecosystem Services (by M24) to validate the initial finding from WP2 on Ecosystem Services evaluation and receive further input	Capacity Development to assess skills gap with focus on the technological solutions and their operation
	Semi-structured interviews (M18-20) on Agri business to enrich the WEFE Nexus Mapping and Mental Models	Results validation from WPs 2, 3, 4, and 5 with all previously engaged stakeholders as well as governmental institutions	Capacity Development to train local workers with focus on agricultural engineers (construction, maintenance etc.), agricultural labor and financiers and investors
Meso Level	Drivers of WEFE change (M17) to produce WEFE Nexus Mapping and Mental Models	Results validation from WPs 2, 3, 4, and 5 with all previously engaged stakeholders as well as governmental institutions	
	Future scenarios and action (by M25) to present initial scenarios and receive inputs		

## 2.3 MAPPING THE WEF NEXUS

The overall purpose of the two MAWGs was to engage stakeholders in open discussions that identify the aspects, issues, opportunities, management initiatives and potential solutions of WEF based on their own field of expertise or activity (farming, research, energy production etc.). Both MAWGs (micro and meso level) were tasked to conceptualize the WEF nexus within the scope of their respective MAWGs, identifying key issues, drivers, barriers and the interactions between them. In order to achieve this, the project adopted a participatory mental mapping methodology<sup>13</sup>. Mental maps refer to graphical representations of the Water-Energy-Food-Ecosystems sectors. These conceptual models plot core issues (drivers, problems and challenges), barriers, management initiatives, opportunities and their interconnections as these are perceived by the stakeholders at the micro and the meso level.

Such maps have traditionally been used in climate change research as they are particularly useful in presenting a visual representation of complex concepts<sup>14</sup>.

### 2.3.1 MICRO LEVEL MAWG

Key stakeholders from the micro level who convene the MAWGs form the basis for: i) the production of the case study-based mental map of WEF Nexus that will be presented, ii) the elicitation of key drivers, iii) the participatory prioritization of the ES delivered to WP2 for socio-economic evaluation (D2.5, M24) and iv) the co-creation of future scenarios (D2.4, M20).

#### 2.3.1.1 WORKSHOP 1: WEF MAPPING WORKSHOP

The WEF Nexus Workshop on the micro level took place on the 5<sup>th</sup> July 2021, at the Kempinski Nile Hotel with the participation of 5 stakeholders from the following institutions: GIZ, Agriculture research centre, land and water research division, Al Salihya agricultural producer and Export Council. Consent was only given by two of the participants namely GIZ and Agriculture research centre, land and water research division. The representatives of the Export Council were not interested in the discussion, as they are involved in the final products' export process and not the preliminary, decision making and research process.

The MAWGs objectives were: to identify the key WEF issues from the stakeholders perspective, to chart the relationships between these issues and to develop a systemic map of the WEF Nexus from their perspective. In order to achieve them, the workshop's agenda was prepared following the four WEF sectors' structure and was delivered in advance to the attendees (Figure 3).

Agenda		
9:30	30 mins	Welcome/Coffee
10:00	30 mins	Round of introduction
10:30	15 mins	Introduction to AWESOME Project and the WEF Nexus
10:45	10 mins	Break
10:55	45 mins	Mapping 1 - Water
11:40	10 mins	Break
11:50	45 mins	Mapping 2 - Energy
12:35	10 mins	Break
13:05	45 mins	Mapping 3 - Food
13:50	10 mins	Break
14:00	45 mins	Mapping 4 – Ecosystem
14:45	10 mins	Break
14:55	20 mins	Round Up (Next Steps)
15:15		Close

**Figure 3** –Micro level MAWG agenda.

The workshop’s facilitator and partner organization delivered an introductory brief description of the project as well as guidance in order to create an effective mind map. The attendees were then asked to sit in groups and start discussing and creating mind maps for the key points of discussion. Due to the limited participation, only the water and food sectors were discussed and mapped, the reason for which may be the nature of the workshop. As it is not a common culture for the particular target audience, it was noticed that some stakeholders were expecting presentation of results and less input from their side. In light of this, a decision was taken to revise the stakeholder engagement approach and buttress the workshop outputs with a series of semi-structured interviews. The more relaxed set-up of the interviews was chosen precisely to allow focused and in-depth discussions. As for the type of stakeholders, the focus in the interviews was on stakeholders that are more in contact with day-to-day operations, growers and agribusiness professionals. This decision was taken due to the fact that more high-level stakeholders such as government representatives and more ‘downstream’ stakeholders, were not so interested in engaging at this early stage of the project and expressed a desire to focus on outputs (validation) and knowledge dissemination. In addition, with the agri-business stakeholders being the key target group of the project innovations, they were deemed a more receptive group to engage with. These changes were expected to yield a richer output which is depicted in the mind maps. The representatives of the Export Council were less interested in the discussion, as they are involved in the final products’ export process and not the preliminary, decision making and research process.

### 2.3.1.2 SEMI-STRUCTURED INTERVIEWS

During the period M17-19 a series of five semi-structured interviews took place in Cairo between October 20<sup>th</sup> and November 20<sup>th</sup>, organized and conducted by Zon Gardens. Of the interviews - all

with consent of the participants -, 4 were conducted in person, and one was conducted online, due to COVID-related challenges. Each spanned over 3-4 hours, to include time for the introduction of AWESOME, the research being conducted, and building up to the flow of questions mapped out beforehand. Interviews were conducted in Arabic and were not recorded to allow for maximum input from the interviewees. During each interview, stakeholders' input on the challenges was translated into the pre-structured mind-map identifying WEFE challenges and more case-specific data was recorded in notes for further analysis. The interviews' objectives were: to identify the key WEFE issues from the stakeholders perspective adding input in the work started with the 1<sup>st</sup> MAWG, to chart the relationships between these issues and to finalize the systemic map of the WEFE Nexus from the stakeholders' perspective.

Table 3 reports the five stakeholders that interviewed. The stakeholders were chosen in light of their ability to provide relevant, representative, and current insights on WEFE challenges from the perspective of the most affected stakeholder group, agribusiness. Interviewees represent a spectrum of scale of agribusinesses to explore similarities or differences in facing the challenges.

**Table 3** – List of stakeholders at the micro level that were interviewed.

Entity	Title of stakeholder	Size (acres)	Crop Range
Maghrabi Group	Chief Technical Consultant	6000	Fruit trees
AgroStar	Exports Manager/ Owner	1500	Grape Vines
El Dakatra	COO/ Owner	65	Olive trees
Matta Farms	CEO/ Owner	300	Fruit trees
Pico	Greenhouse Operations Manager/ R&D	8500	Fruit trees + banana seedlings + potato tubers

### 2.3.1.3 DEVELOPING THE MENTAL MAPS

The interviews were designed to answer a main question which is identifying WEFE Nexus challenges. Based on the first workshop conducted we created an initial structure for the mind map based on each of the WEFE nexus elements. During each of the interviews notes on the challenges were added to the initial mind map in addition to any further notes on the different elements' relationship or impact on the interviewee specific cases. After each of the interviews a mind map was created using the online software Miro, only highlighting the challenges or opportunities for a simple visual representation of the main goal of the interviews. All additional notes were compiled for further analysis.

After the conclusion of the five interviews, a joint mind map was created starting with the inputs from the first MAWG which then we're complimented with the input from the individual mind maps as well as common observations and trends from the interview notes. Additional validation of interview inputs and research was conducted to finalize the findings and identify certain trends or lack thereof.

### 2.3.2 MESO LEVEL MAWG

The same objectives as with the micro level mapping workshop were targeted at the meso level workshop but with key stakeholders from the meso/macro level forming the basis of the work.

#### 2.3.2.1 WORKSHOP 1: WEFE MAPPING WORKSHOP

The WEFE Nexus Workshop on the meso level took place on the 22<sup>nd</sup> September 2021 online with the participation of 5 stakeholders from the following 4 institutions. They all gave their consent for the recording of the workshop. A further personal interview took place as one of the stakeholders could not make it that day. Participants' sector of expertise, organization and country is listed in Table 4.

**Table 4** – List of stakeholders participating in the meso level MAWG.

SECTORS	COUNTRIES	ORGANIZATION
Water	Sudan	Nile Basin Initiative
	Egypt	Heliopolis University
Energy	Egypt	Egypt Desalination Research Center
Food	Ethiopia	Agri Service Ethiopia (NGO) - Food security, sustainable livelihoods
Ecosystems	Sudan	UNEP, Nairobi Headquarters

The MAWG's objectives were: to identify the key WEFE issues from the meso level perspective, to chart the relationships between these issues and to develop a systemic map of the WEFE Nexus from the stakeholders' perspective. In order to achieve them, the workshop's agenda was prepared following the four WEFE sectors' structure and was delivered in advance to the attendees (Figure 4).



## AGENDA – Multi Actor Working Group

*Day of the meeting: 22<sup>nd</sup> September, 2021*

*Time of the meeting: 08.30 am – 11.30 am (CET)*

*Online tool: MIRO*

08.30 – 08.40	Participants' introduction
08.40 – 09.00	Introduction to the AWESOME Project and the Workshop
09.00 – 09.30	Mapping 1 – Water
09.30 – 10.00	Mapping 2 – Energy
10.00 – 10.10	Break
10.10 – 10.40	Mapping 3 – Food
10.40 – 11.10	Mapping 4 – Ecosystems
11.10 – 11.15	Break
11.15 – 11.30	Round up (Next Steps) & Closing

**Figure 4** –Agenda of meso level MAWG.

The workshop's facilitator (Dr. Ebum Akinsete) delivered an introductory brief description of the project as well as guidance in order to create an effective mind map. AUEB team gave then guidelines how to use the online tool Miro where the mapping would take place and offered technical assistance in case someone was not able to write or use the interactive tool. After framing the discussion with key findings from WP2 climate models, demographic projections as well as findings from Nile Basin Initiative reports, the attendees were then asked questions in order to start discussing and creating mind maps for the key points of discussion.

### 2.3.2.2 DEVELOPING THE MENTAL MAPS

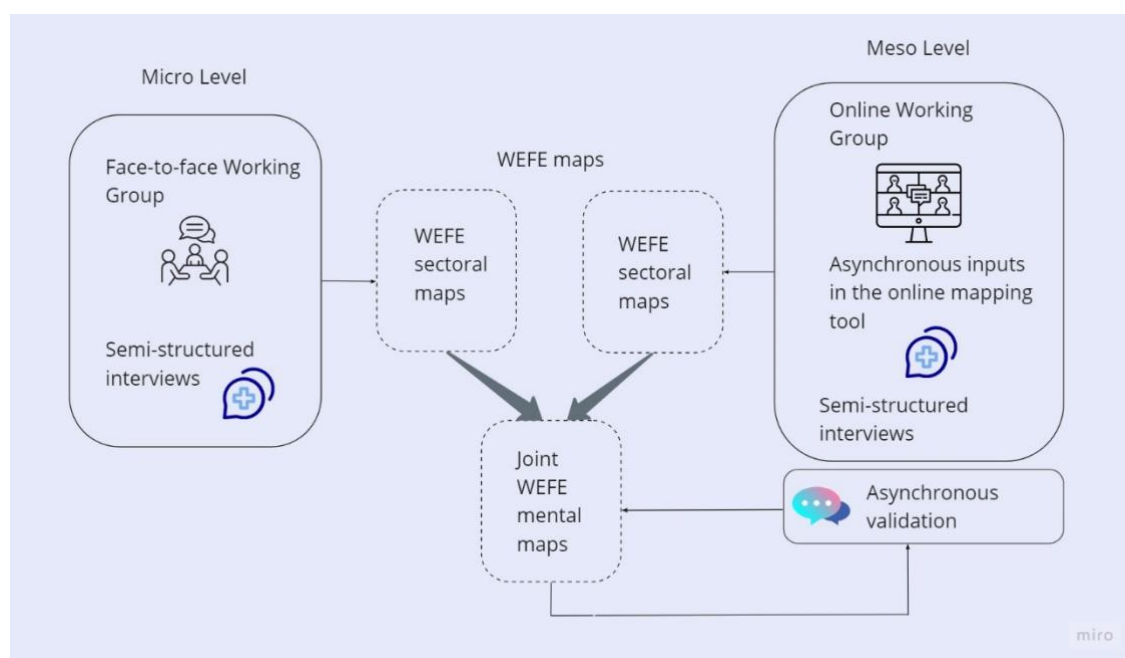
The raw data in the form of mind maps depicting the Water, Energy, Food and Ecosystems were substantially simplified, by “cleaning” variables that appear more than once in different words, by validating some stakeholders' statements (in case of number or statistics as evidence for their opinion) and by removing variables that are not necessary. Variables that appeared as important in

terms of many data or many other variables associated with them received extra marking that highlights their overlap with more than one sector. This work on processing and polishing the mind maps results and adding extra information resulted in more refined conceptual models explaining the problem.

These answer questions such as: what are the main aspects of the Food sector? what are the main aspects of the Water sector? what are the main aspects of the Energy sector? what are the main aspects of the Ecosystems sector? Under what categories these aspects can be grouped? are there further factors affecting these four systems (e.g. environmental, public health)? How to their subsystems overlap? Although an expert or a local actor an answer these questions based on evidence or experience, the answers provide only part of the phenomena. The maps assist in depicting the multiple factors of each phenomenon, which applies certainly for complex interdependent socio-environmental systems such as the case study area at the demo site and the river basin level, with uses that compete for resources such as water, energy, and food.

The strength of these maps lies in the transparency that enables interactive design with the stakeholders, asynchronous inputs after the MAWGs, validation of the final output from their side, and limited data requirement. However, in terms of problem scoping, polishing information and final map production it requires a combination of communication and analytical skills from the delivery project team. These maps are considered as visual representations of complex systemic interactions based on the scientific information and evidence given by AWESOME's leading stakeholders involved in the meso level workshop. Are not intended as objective truths this is why there is likely to be disagreement amongst some readers.

As the teams used the online tool Miro for the mind map AUEB team continued for the simplification process and the mental maps production with the same tool.



**Figure 5** –Micro and meso/macro level MAWGs' interplay.



The maps are intended as valuable tools for approaching the complexities of the WEF interactions, highlighting various components that affect the use of water resources, food, energy resources and ecosystems and finalizing the ES identification carried out as part of D6.1. It is hoped that the maps will add value through:

- i) Showing a bigger picture
- ii) Incorporating local experts' knowledge
- iii) Communicating complex interactions
- iv) Promoting stakeholders engagement in research process

### 2.3.2.3 TOOLS AND SOFTWARE USED

The MAWG took place on Microsoft Teams program that is officially used by AUEB team, while for the mapping was used the online tool Miro (<https://miro.com/app/dashboard/>) during the workshop, the polishing and final map development. For the framing of the discussion a presentation took place with the use of Microsoft Powerpoint (see part of presentation in Figure 6).

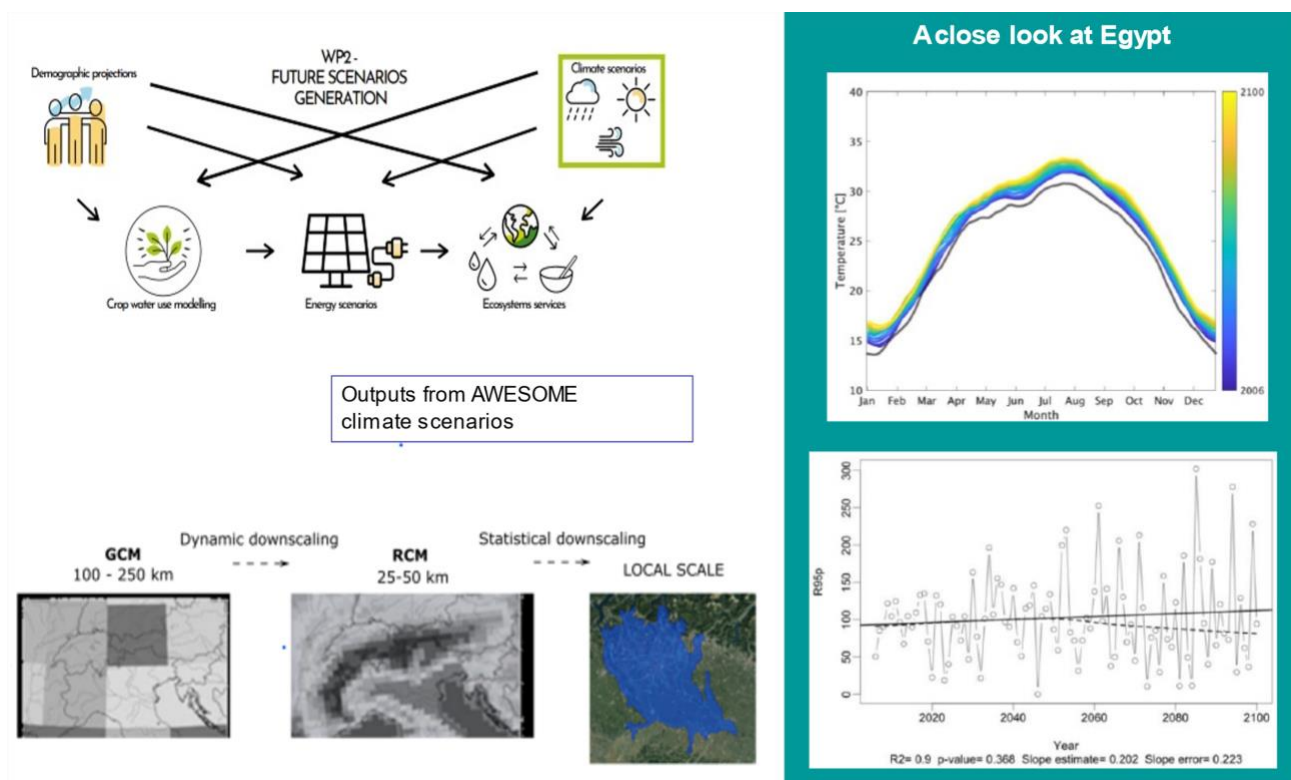


Figure 6 – Powerpoint presentation – meso level MAWG.

### 2.3.3 GENERAL DATA PROTECTION REGULATION

AWESOME follows the European code of conduct for research integrity<sup>2</sup> which is in line also with the Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data<sup>3</sup>. The regulation specifies that personal data must be processed based on certain principles in order to limit the impacts on the persons and ensure data quality and confidentiality. Although AWESOME is only subject to the Directive 95/46/EC it follows also the new EU Regulation 2016/679 that extends the protection of natural persons in terms of their personal data processing<sup>4</sup>.

By the term personal data is meant *“any any information that relates to an **identified or identifiable living individual**. Different pieces of information, which collected together can lead to the identification of a particular person, also constitute personal data. Personal data that has been de-identified, encrypted or **pseudonymised** but can be used to re-identify a person remains personal data and falls within the scope of the GDPR. Personal data that has been rendered **anonymous** in such a way that the individual is not or no longer identifiable is no longer considered personal data. For data to be truly anonymised, the anonymisation must be irreversible”<sup>5</sup>.*

During the MAWGs limited use of personal data was made and it was for the purposed primarily on audio recordings that were kept in order to ensure that data could be processed after the MAWGs for the production of the mental maps and the preparation of the deliverable. The recordings are kept securely and are to be destroyed on completion of the project. In addition the outputs of the workshops and interviews in the form of the mental maps are completely anonymous with no personally identifiable data included. In order to ensure compliance with the above regulations AWESOME team prepared a Workshop Participation Information Sheet, found in ANNEX C, that was distributed before discussions and signed by the participants. This process ensured that the collection and processing of the opinions expressed during the MAWGs were transparent and lawful restricted to use for AWESOME project.

## 3. MULTI-ACTOR WORKING GROUP ON MICRO LEVEL

In this section of the deliverable is described the background of the micro level MAWG, the steps for its development along with the degree of participation, the key results from the face-to-face discussion that took place on the second half of 2021, and the accompanying key results from the semi-structured interviews.

### 3.1 EXECUTIVE SUMMARY

The case study in Cairo (Egypt) is a representative example of an interlinked Water-Energy-Food-Ecosystems area in the Mediterranean region. As analyzed in details in D6.1 (Chapter 4), the factors of the experiment in the lab-scale facility and the initial findings demonstrate the need for sustainable principles to be added to secure Water and Food security. Here comes the WEF Nexus analysis and description of the interlinkages between the three sectors (water, food, and energy) to associate potential synergies and limit trade-offs between the three sectors. The case study area faces expanding

population and accelerating demand call for the consistent need for socio-economic development through sector interactions in a systematic way.

### 3.2 BACKGROUND

Egypt is the most populated Arab country, and the third most populous in the African continent, with 104 million inhabitants as of 2021<sup>6</sup>. Based on WP2 demographic projections, analysed in details in Chapter 2.3 of D2.1<sup>7</sup>, Egypt will face an increase in its population to 1,8 million (under SSP scenario 1), or 2,2 million (under SSP scenario 2) or 2,7 million (under SSP scenario 3) by 2100.

Agriculture, forestry and fishing is the third largest contributor to the Egyptian economy as it witnessed an increase from 11.4% in 2019<sup>8</sup>. While energy is exponentially needed to meet development needs and so Egypt plans to reduce its reliance on oil and natural gases (95%) and shift to induce and produce clean energy<sup>9</sup>. Agricultural sector is first water user, while overexploitation of the aquifer is alarming and water security is targeted by creating renewable water resources. The status of Egypt's canals and drainage networks is deteriorating, posing a serious threat to the country's water resources. Canal and drain networks need to be renewed, and the increase of infringements on them necessitates immediate care. Direct drainage of water into the Nile is a great environmental problem. Thermal effluent, industrial drainage, agricultural drainage and sanitary drainage, contaminates the River Nile, reducing its usage efficiency, and pollution's impact are difficult to keep maintained<sup>8</sup>.

Based on AWESOME's WP2 downscaled climate scenarios, as these are analyzed in Chapter 4.3 of D2.210, Egypt's climate is predicted to be very dry under all considered scenarios, with occasional precipitation events, the amount of which is hard to predict. Particularly in its very dry areas, precipitation is almost always lower than 1mm/d.

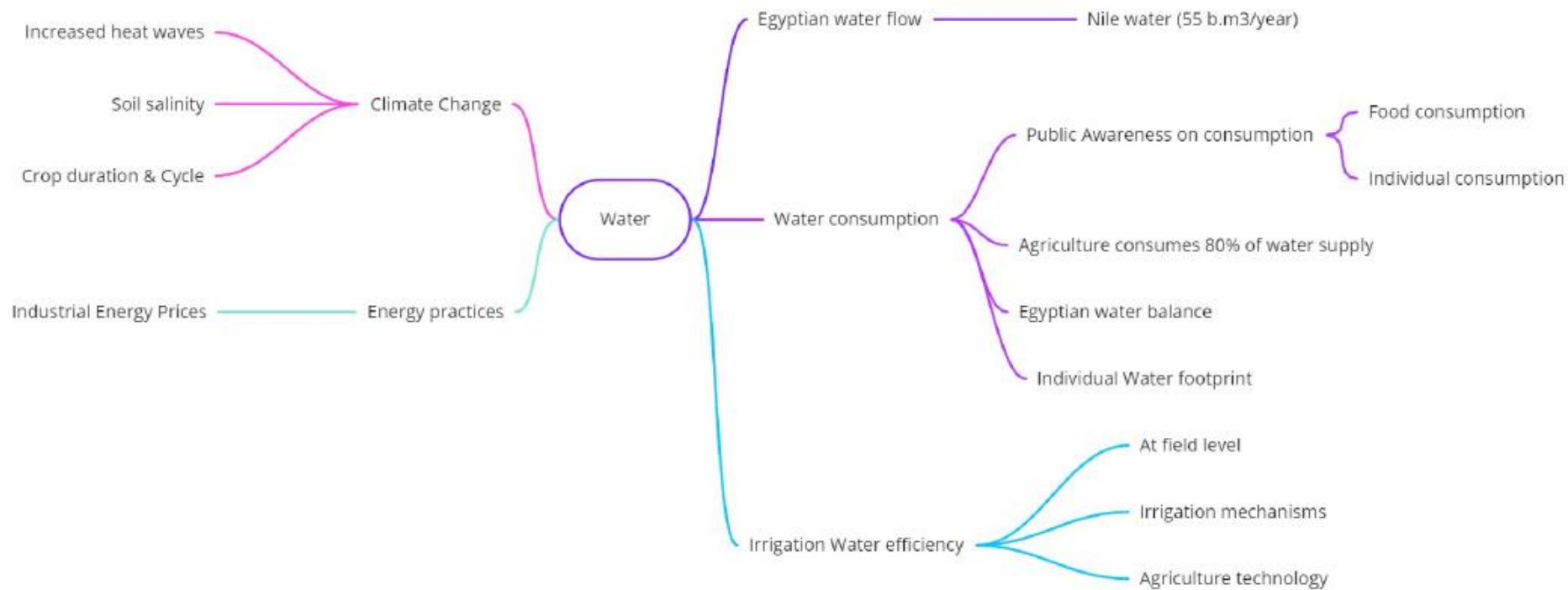
The case study of Cairo, it therefore a representative example of an interlinked Water-Energy-Food-Ecosystems area in the Mediterranean region, well situated to represent other areas in the region. Based on the micro level MAWG the results include the depiction of the aspects that comprise the four WEFE sectors and along with them the key ES for the areas based on stakeholders' perception.

### 3.3 SECTOR BASED WEFE MIND MAPS AT MICRO SCALE

#### 3.3.1 FIRST MAWG WORKSHOP

During the 1<sup>st</sup> MAWG workshop, the low levels of participation detailed in the previous section meant that only the water and food sector were discussed and mapped. Figures 7 and 8 present the sector based mental maps developed during the workshop.

Purple arrays depict the variables and aspects directly related to the water and the food sectors, blue arrays depict variables to technology/ practices/ methods, and pink arrays reflect the relationship among the water and food sector with other environmental variables such as climate change.

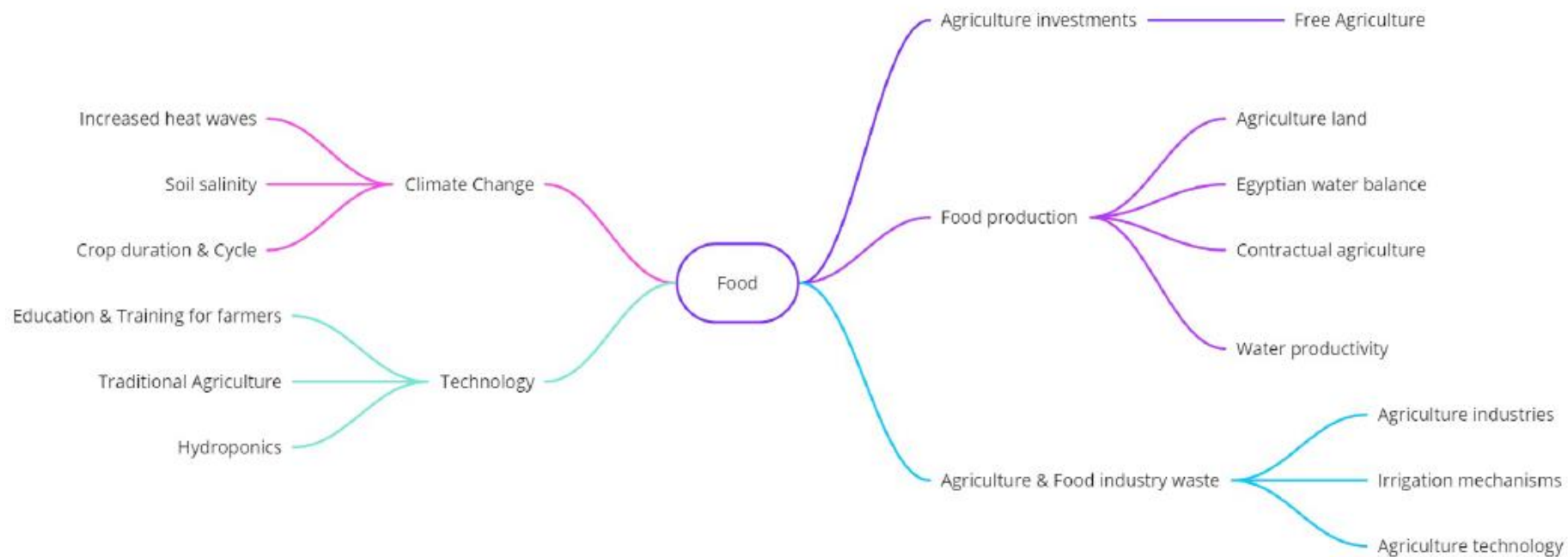


**Figure 7** –Micro level MAWG – Water sector mind map



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**Figure 8** –Micro level MAWG – Food sector mind map.



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### 3.3.2 SEMI-STRUCTURED INTERVIEWS

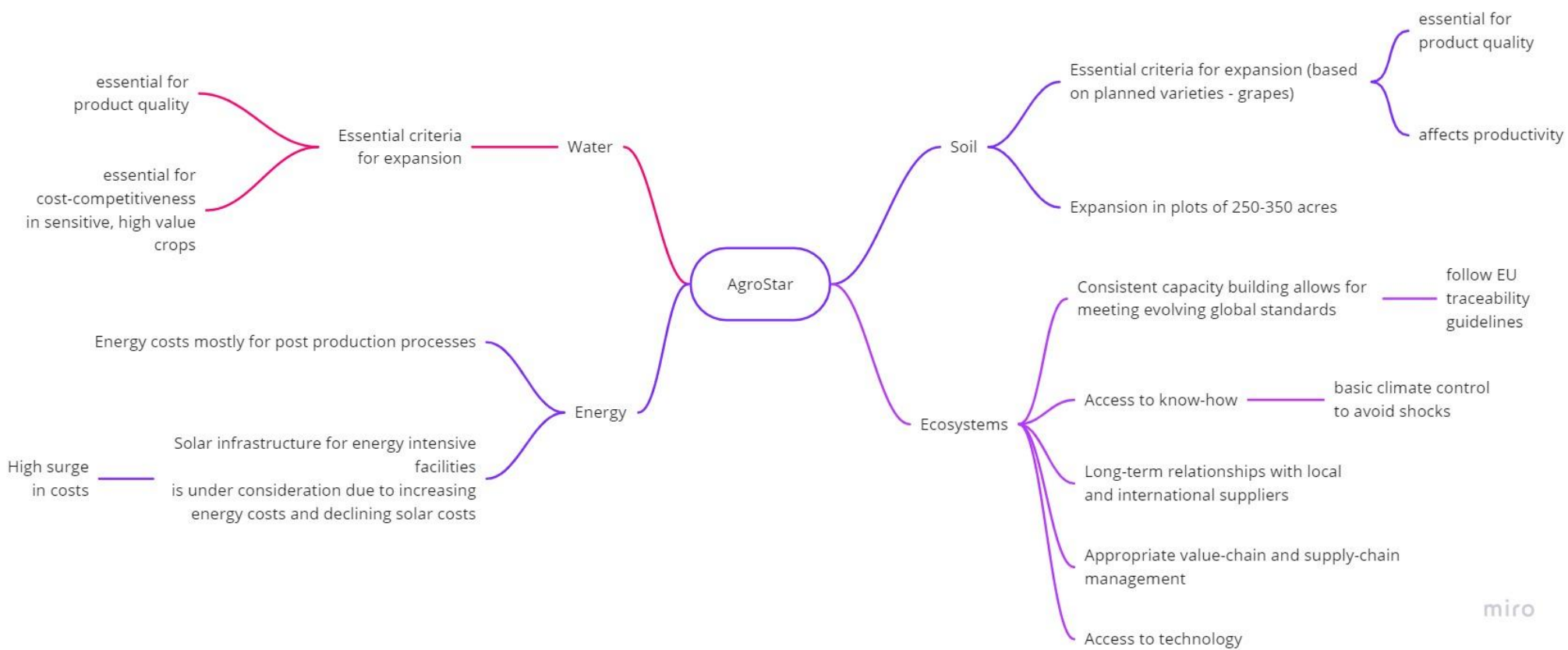
Five semi-structured interviews were conducted with agri-business representatives as described in section 2.3.1.2.

The resulting mind maps are presented in Figures 9, 10, 11, 12 and 13.



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miro

Figure 9 –Agrostar mind map



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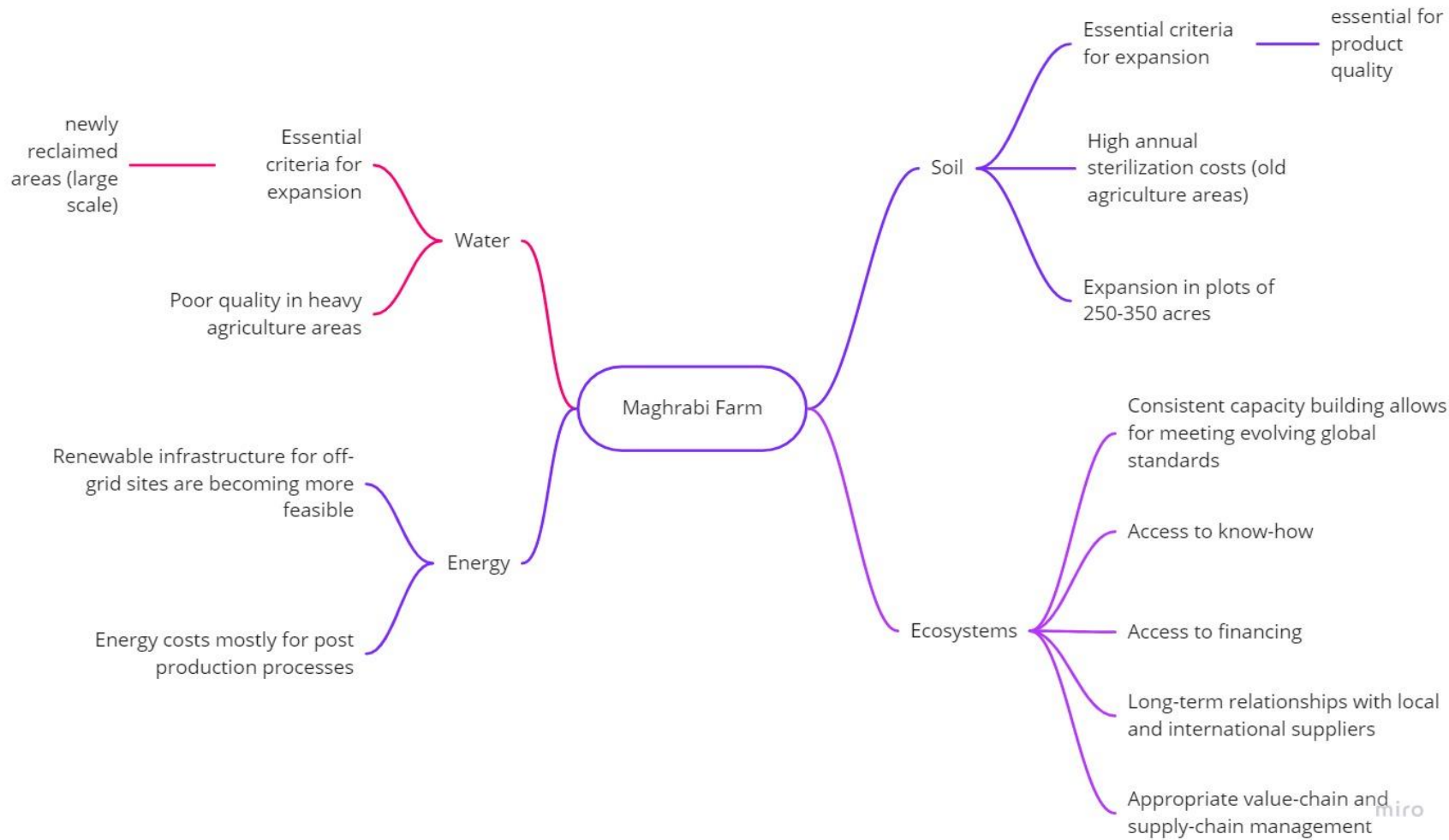


Figure 10 –Maghrabi Farm mind map



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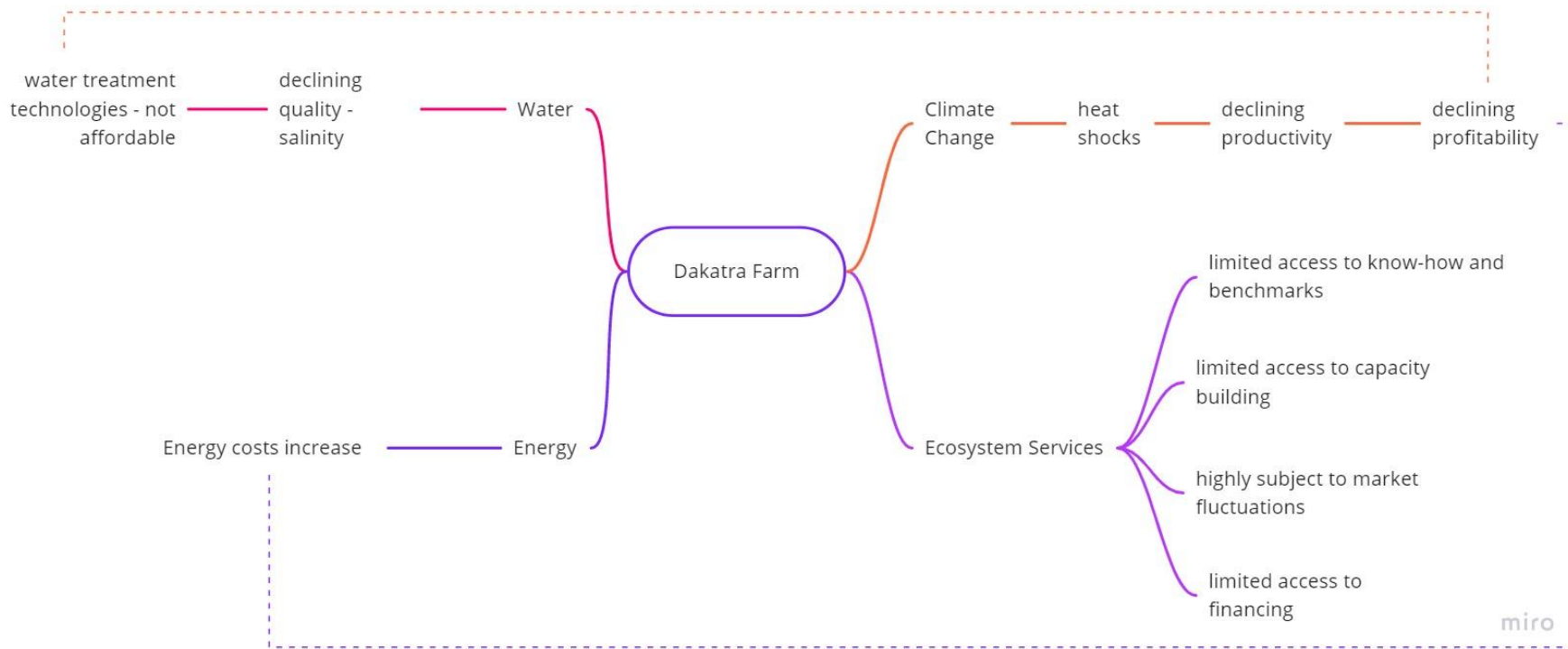
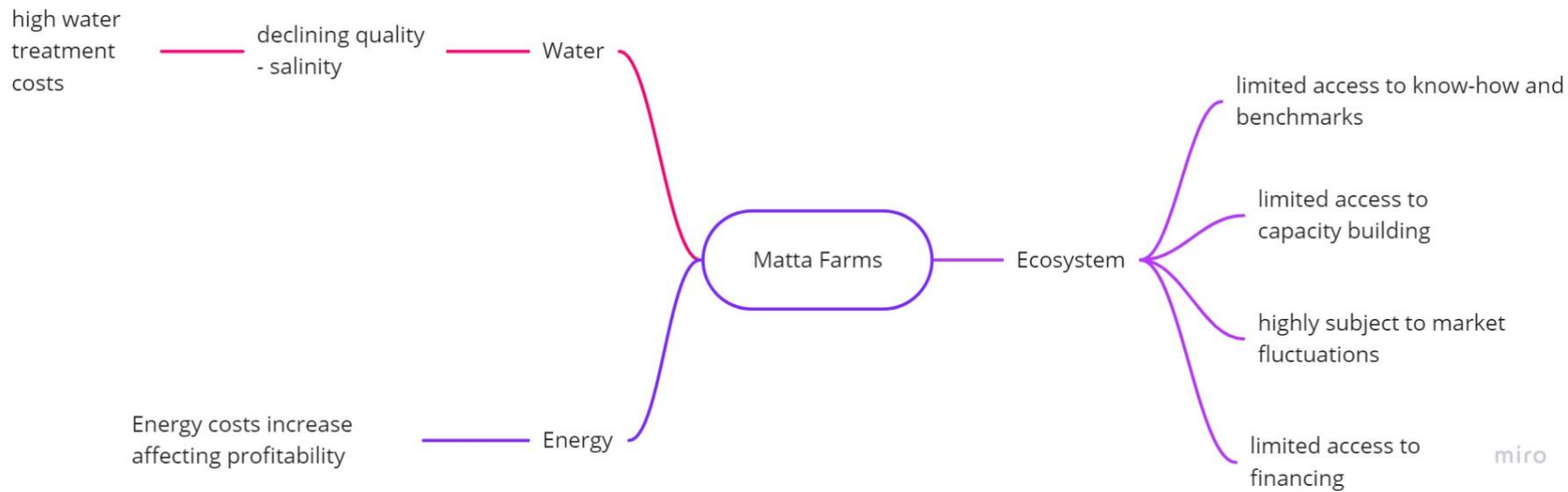


Figure 11 –Dakatra Farm mind map



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**Figure 12** –Matta Farms mind map.



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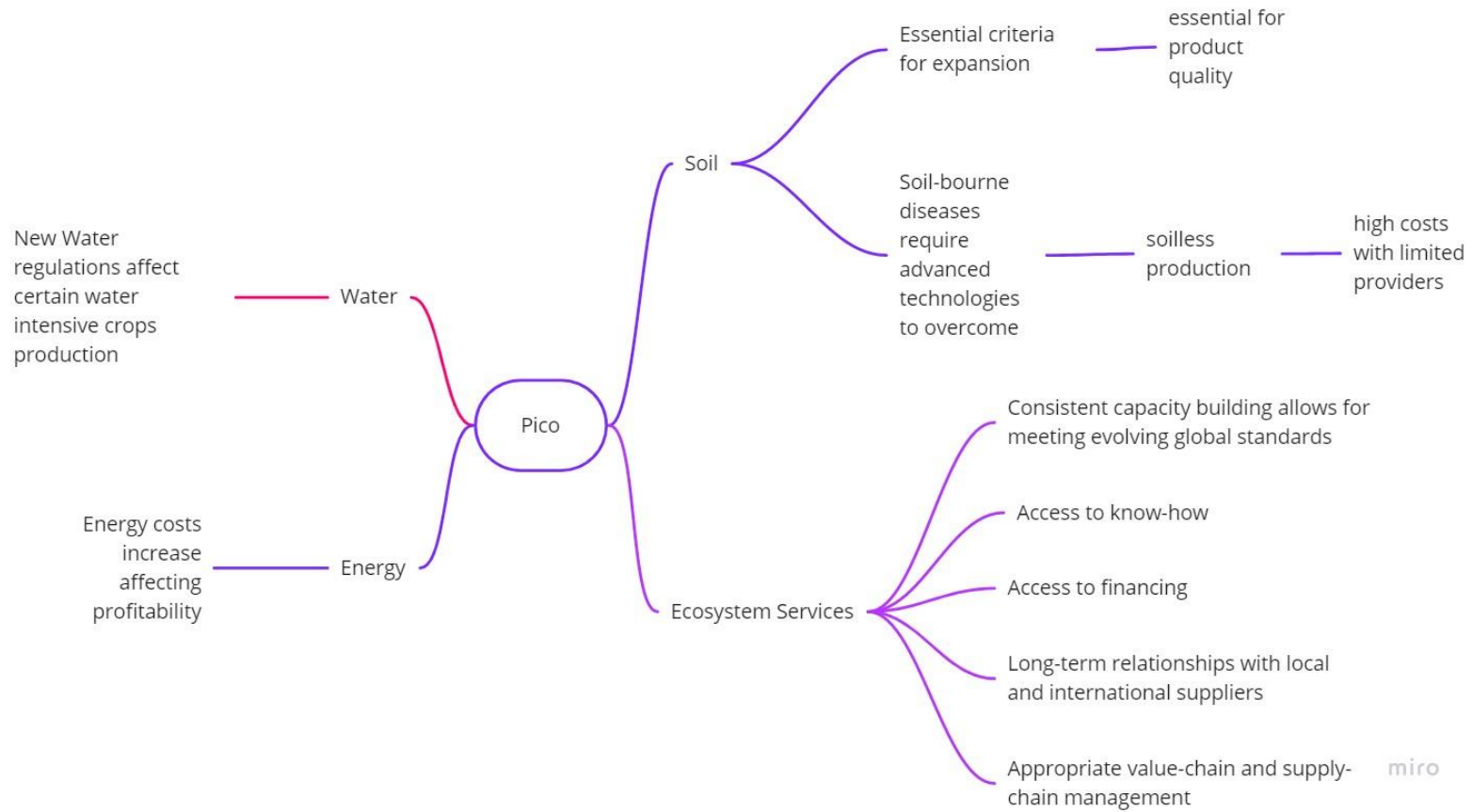


Figure 13 –Pico mind map



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### 3.4 JOINT WEFE MENTAL MODEL AT MICRO SCALE

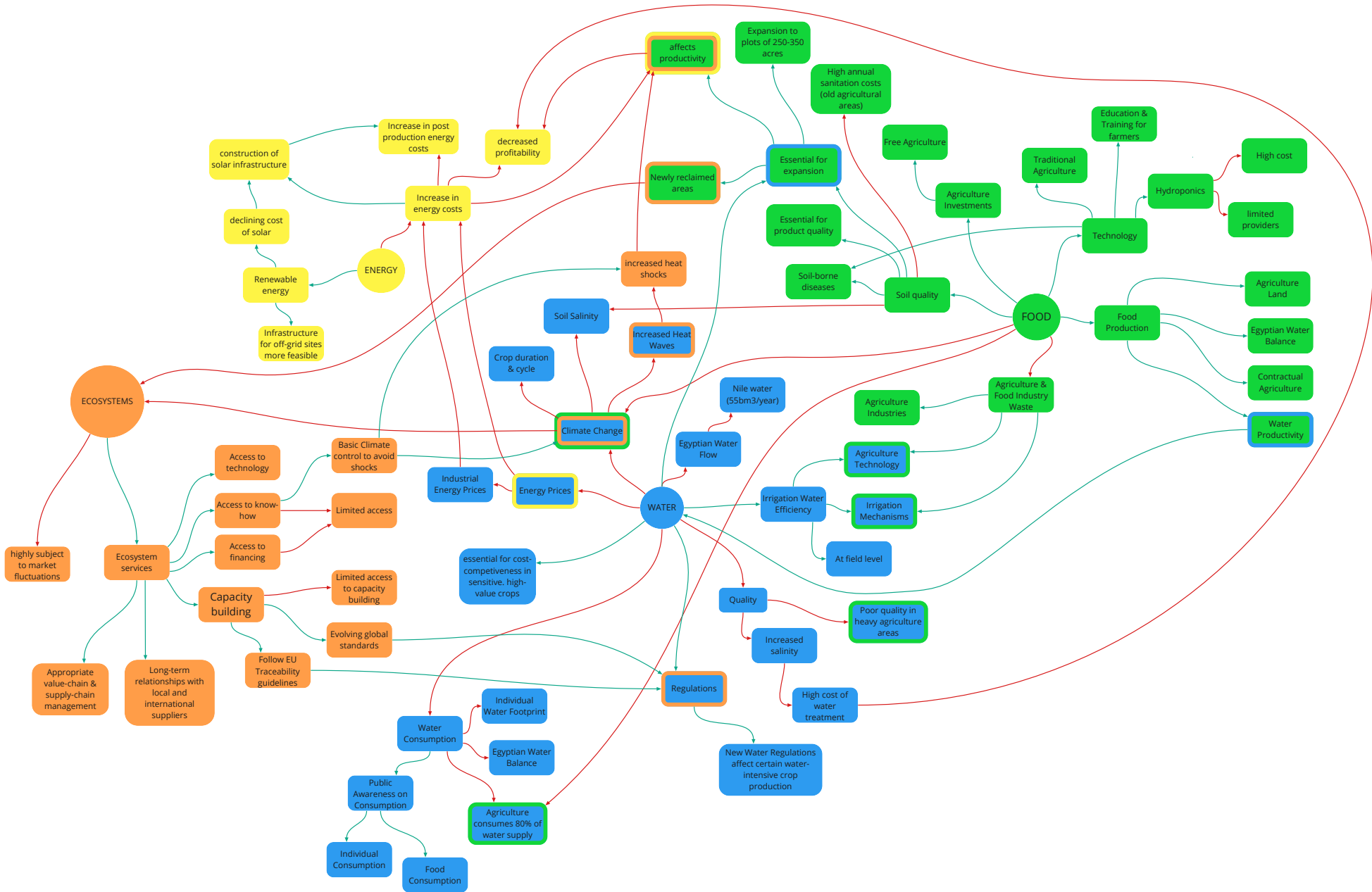
For the visualization of the map four colours are used, each representing one of the four WEFE sectors: blue portrays the water sector, yellow the energy, green the food and orange the ecosystems. Each of the textual elements are represented by nodes of the system; with circles that represent the four WEFE sectors, and rectangles that represent their related parameters (issues, gaps, problems, management initiatives). Certain parameters which are relevant to two or more sectors are depicted with the respective colours of the relevant sectors.

The arrows link different parameters of the systems with the arrow's direction depending on the perceived causality. The weight of all relationships is considered equal; while green arrows implies that a variable is affected positively by another and the red arrow implies a negative impact on the variable. Figure 14 portrays the joint WEFE mental model.



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## 3.5 RESULTS AND FINDINGS

### 3.5.1 FINDINGS ON THE WATER SECTOR

The discussion that took place reflected the following aspects:

*The importance of water supply and division.* Issues related to water productivity from the Nile River, the ground water and wells were discussed as well as suitable methods to divide the resources according to the needs and the quality of the resources. It was agreed participants that there is no focus on the water that is supplied by the water purification units. Regarding the sectors that mostly need the water evidence was provided that 10 billion litres are dedicated for drinking while industry such as cement production (mainly used for cooling) consumes a lot of water, as well as agriculture and tourism. Particularly on agricultural water use the farmers are not allowed to produce high water demanding crops such as sugarcane. Its production is replaced by beetroots which impacts on the other side investors and exporters who trade it as raw material.

*Water footprint and balance.* Aspects of consumers' awareness were discussed, of community mobilization on the basis of WEF. The choice of growing animals in accordance to their usage of water within the process of producing the fodder for chicken and fish as well as the strategic governmental plans for supporting the growth of red meat from large animals were supported by some participants. The need for farmers to strategically choose which crops to grow was discussed as well as the low influence that the water consumers' association has in Egypt.

*Water productivity.* Investment opportunities on flowers or grains were discussed in terms of their water productivity. Evidence was provided both on the consumers perspective based on daily requirements and the investor's perspective. The problems for the small farmers were underlines who can usually afford only growing corn, grains and potatoes.

*Water quality.* Larger scale agribusinesses are able to obtain and expand into new sites with optimal water quality based on their resources, know-how and experience, while small to medium scale growers are forced to adapt to the generally declining water quality in their limited location (mostly heavy and old agriculture areas). This adaptation is often in the form of a more costly production operation, further reducing their profitability.

*Water treatment technologies.* Although water treatment and management technologies are becoming more available and affordable, it is often rendered not feasible or economic for agriculture use – even with larger businesses, due to the high water volume needs and the required infrastructure to serve this operation.

*Water availability.* Last July a new law passed to monitor, control, and improve water usage, especially in light of the growing water shortage. As a result thereof, water quotas for farms depending on rivers/ water streams for irrigation (older heavy agriculture areas, upper Egypt, etc.) have decreased significantly. Farms, who often had access to water 3 out of 7 days a week, currently only access water once a month, driving them to convert to wells for their irrigation. Additionally, growers are encouraged to upgrade their operations/ practice (flooding mostly in those regions) to drip irrigation with expectations of fines for farms in violation – not yet effective -, in an effort to reduce water consumption in general. However, special governmental initiatives facilitate this specific transition for growers through dedicated financing mechanisms. Furthermore, heavy water consumption crops such as rice



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and banana are limited in production areas and expected to convert their irrigation practices to. Drip irrigation as well, within the next 3 years.

### 3.5.2 FINDINGS ON THE ENERGY SECTOR

*Energy consumption in agriculture.* The reason for behavioural changes were discussed where most participants agreed that changes relate mostly to the rising prices rather than awareness

*Cost increase.* Within the Egyptian government's strategy to reduce subsidies in the Energy sector, prices for the agriculture sector has increased by almost 100% since 2015. Although it has temporarily affected growers – especially medium scale growers, produce price inflation has somewhat neutralized this increase. However, it has supported the transition towards renewable energies. Small-scale growers often depend on fossil-fuels – gas - to generate energy. Although their energy needs are significantly less due to the scale of their operation, the energy component within their expenditure has significantly increased in size due to the almost 8 fold increase in gas prices.

*Technology development and economic feasibility.* The development within the solar energy industry has allowed the technology to become more feasible and affordable, rendering a suitable alternative to traditional on-grid energy, while also allowing expanding to newly reclaimed territories with limited infrastructure in place. As the solar and wind energy technologies are further developed, more economic solutions are available in the market. With the rising prices of on-grid energy and the support and facilitation provided by funding agencies for the adoption of renewable energy, growers and agribusiness are able to deploy this more capital intensive but sustainable and more cost-effective solution on the long run.

### 3.5.3 FINDINGS ON THE FOOD SECTOR

*Alternative agriculture.* Discussion on the attempts to reduce dependence on groundwater by promoting modern agriculture such as rooftop that prevents contact with land.

*Trends in traditional agriculture.* The problem of increased production in cultivations such as crops was discussed which cause demand decrease and price fall with losses for the farmers. A farmers' associations would prevent this issue. Some participants correlated this situation with the need to import and accept new technologies.

*Productivity decrease.* As a direct result of the declining quality of soil and water – especially in heavy agriculture areas- production costs are increasing – beyond inflation -, while productivity is declining. Climate change has exacerbated the problem especially the past 2 years, when some crop ranges – especially summer fruits – were heavily affected by heat waves reducing farm outputs by as much as 90% in some locations

*Technical know-how.* There is a clear discrepancy in the access to know-how between small/medium scale growers and large-scale growers. The smaller segment of growers – large agribusinesses with 1000s of acres – often have the financial and human resources to improve their teams' capacity and know-how, as well as access to international experts and consultants to ensure

knowledge transfer of the latest findings and practices. However, in contrast they often lag behind in the adoption of newer technologies, as they are able to withstand and mitigate the effects of rising challenges for longer time periods than smaller size operations.

*Fertilizers.* Over the past months, fertilizer prices have multiplied several times (up to 7x), raising concerns for growers about the upcoming season(s). With an inflation in all operation factors (energy costs, (water costs), labor, seeds) – especially for low productivity crops in the past seasons – sale prices do not render as profitable as prior years. Small to medium scale fruit tree farms are questioning the sustainability of their business and seeking potential solutions that can improve their revenues by utilizing the unused spaces on the farms. This includes growing short-term crops, applying Integrated Vega Aquaculture (the practice of growing fish and utilizing the nutrient rich waste-water in irrigating the farm as a partial substitute for fertilizers), aquaponics, hydroponics. Large-scale agribusinesses, who often have established business relations with their clients are more confident and hopeful that market prices will reflect the increasing costs, as they are global. The actual effect of this price surge might be reflected in the reaction to the upcoming seasons, mostly affecting expansion, rather than current operations.

*Seeds/ seedling.* With limited sources of high-quality seeds and seedlings, growers find it challenging to sustain their quality and productivity, while keeping costs from surging further. Additional challenges of importing seeds, such as delays, and high import tariffs, make it difficult for small and medium-scale growers to compete in producing quality and cost, as large-scale growers tend to have more appropriate supply chain management and rely on their higher purchasing power to secure better deals with suppliers. This has also driven some large-scale agribusinesses to focus on the production of seedlings, such as banana, grapes, as potato spuds production using hydroponics locally, instead of importing them, reducing and the risk of pest transfer (due to growing them in soil traditionally, whereas hydroponics production eliminates this risk completely).

*Agricultural waste.* The aspect of waste management entered the discussion as the most important method to reduce waste along with the need for circular economy initiatives

## 4. MULTI-ACTOR WORKING GROUP ON MESO LEVEL

In this section of the deliverable is described the background of the meso level MAWG, that brought together a number of domain experts, rural and river basin stakeholders and administrations. It also describes the steps for its development along with the degree of participation, the key results from the face-to-face discussion that took place on 22<sup>nd</sup> September 2021, and the accompanying key results from the semi-structured interviews and final results validation.

### 4.1 EXECUTIVE SUMMARY

After focusing on the key drives of WEFE change on the case study level, there is the need to get the broader view of the river basin scale in order to be able to: i) prioritize the Ecosystem Services of



the meso level that will be evaluated by WP2, ii) to link the key drivers of change with the scenarios to be built on the next phase and the actions to be taken by the countries comprising the meso level. As presented in details in D6.1 (Chapter 3) the Nile River flows from Central Africa to the Mediterranean Sea passing from 11 countries and is very important as a shared water basin in Africa with a variability from aridity in its northern areas to tropical rainforests towards eastern and central areas, while it is a representative example of an interlinked Water-Energy-Food-Ecosystems area in the Mediterranean region. The meso level MAWG brought together a number of domain experts, rural and river basin stakeholders from the three countries that are taken into consideration on AWESOME's meso level model: Sudan, Egypt and Ethiopia.

## 4.2 BACKGROUND

The River Nile is the longest in the world, being about 6,650 km long with a river basin of nearly 3,500,000 km<sup>11</sup>. As analyzed in Chapter 2 of D2.2<sup>10</sup>, *“climate change is projected to increase the interannual variability of rainfall, which can cause devastating droughts and floods”*<sup>12</sup>. While in terms of the eastern part of Africa where the meso MAWG is focusing *“are found to be highly vulnerable to changes in climate and climate extremes, and more extreme events such as frequent droughts, floods, and heavy rainstorms are projected in the future”*<sup>12</sup>. In the same AWESOME's WP2 report (Chapter 4), the downscaled climate scenarios for the River Basin is concluded that the concomitance of the predicted warming, the longer-lasting high temperatures, the increasing occurrence of tropical nights, and the high interannual variability of precipitation (very low in some areas) are expected to significantly challenge the agricultural fields and crop productivity in the Nile River Basin. In terms of precipitation, it differs a lot and there is a disagreement among climate models on climate change's impact on the precipitation. D2.2 (Chapter 4) analyzes AWESOME's predictions where precipitation seems to be almost null in the Main Nile sub-basin the entire year and, when present, its values are around 1 mm/d, and to decrease in time in the Blue Nile sub-basin.

Based on WP2 demographic projections, analysed in details in Chapter 2.3 of D2.1<sup>7</sup>, the Mediterranean will face an increase in its population from 300 millions to 950 millions to 2060 under all different scenarios, but from 2060 to 2100 the projections show an increase to that ranges from 1 billion to 1,2 billions, depending on the Shared Socioeconomic Pathways scenario.

Based on the meso level MAWG the results include the depiction of the aspects that comprise the four WEFE sectors and along with them the key ES for the areas based on stakeholders' perception.

## 4.3 SECTOR BASED WEFE MIND MAPS AT MESO SCALE

The WEFE Nexus Workshop on the meso level took place online as described earlier in Section 2.3.2. The resulting mind maps are presented in Figure 15, Figure 16, Figure 17, Figure 18 and Figure 19.

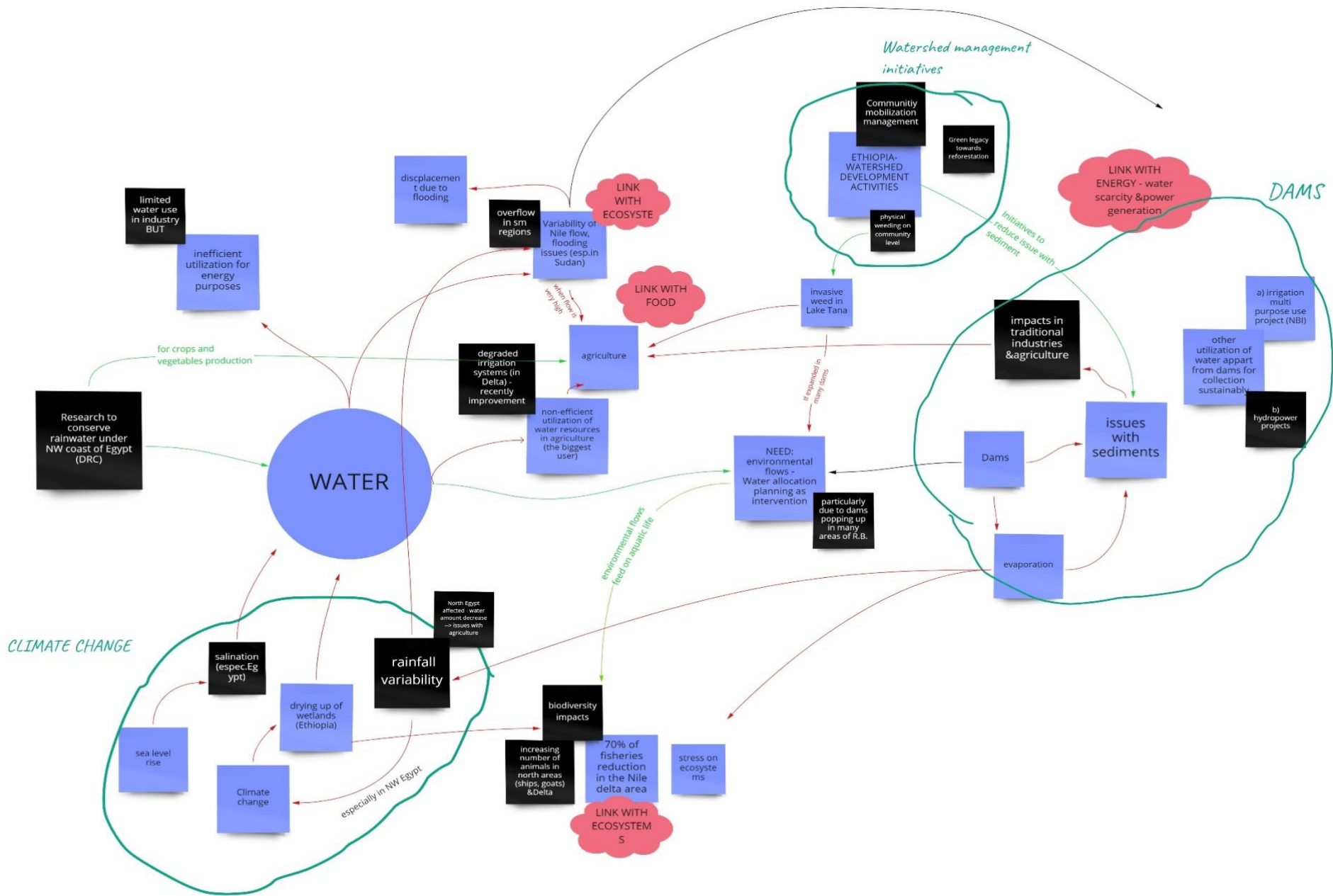


Figure 15 –Water sector mind map



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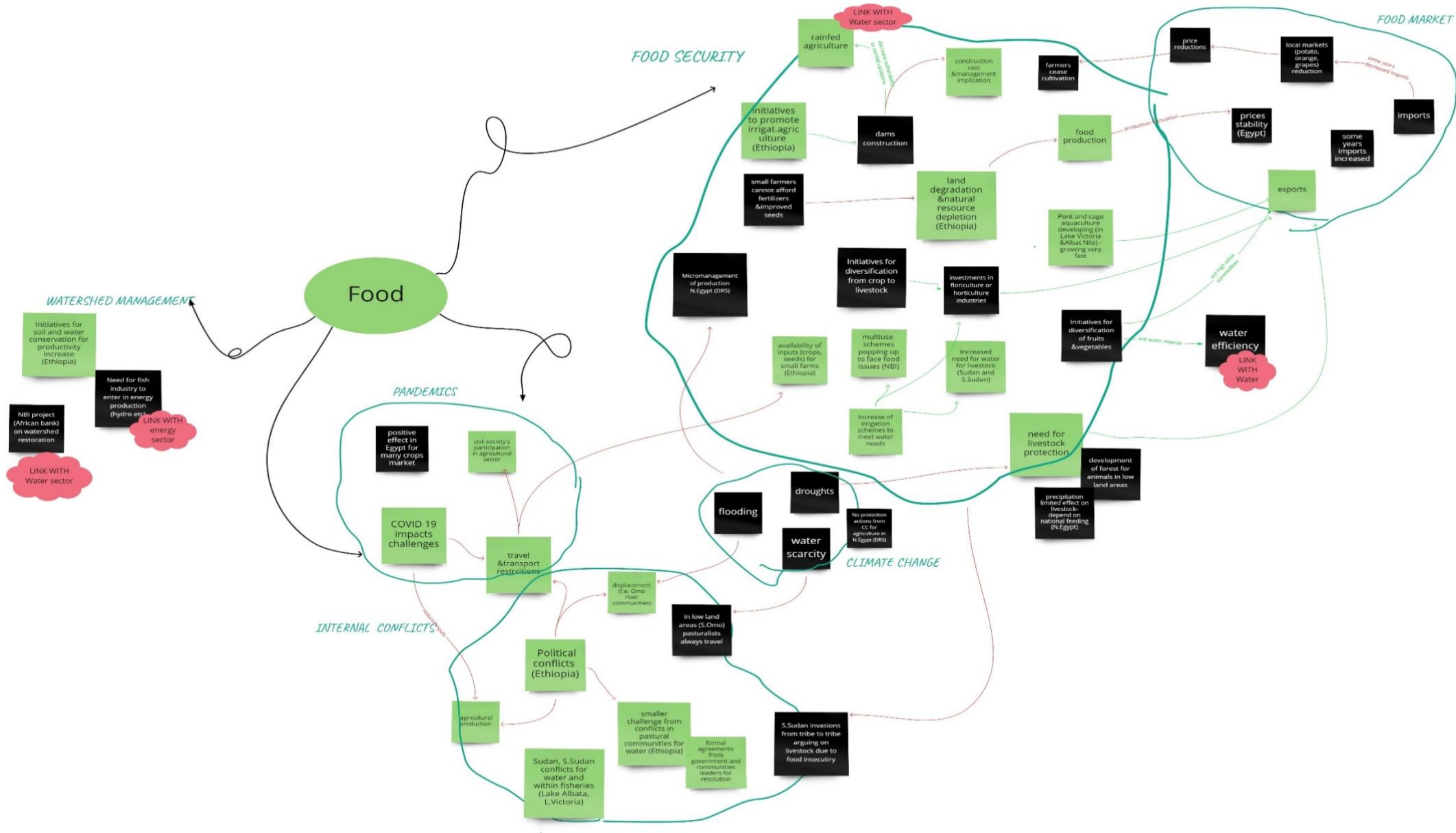


Figure 16 –Food sector mind map



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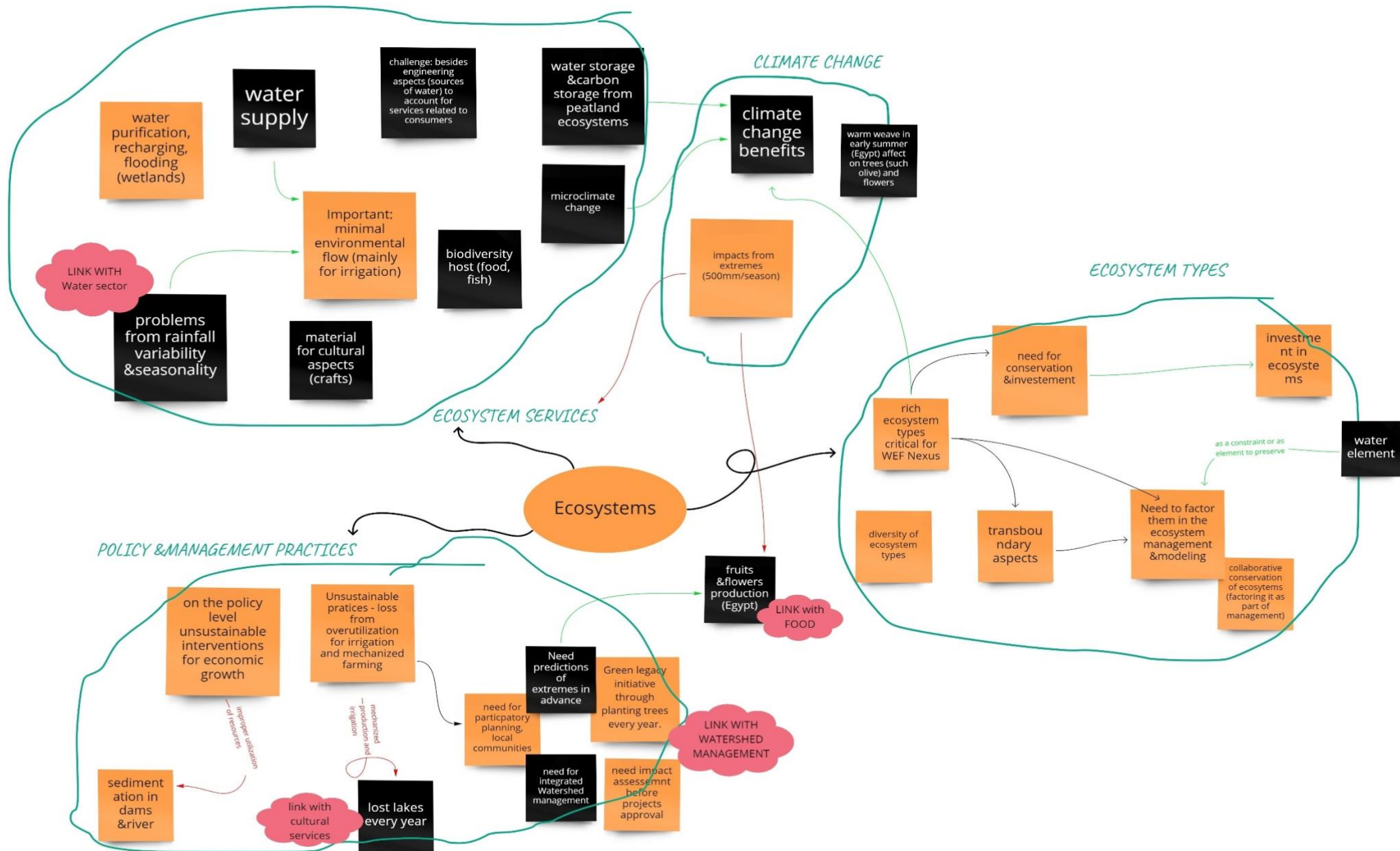


Figure 17 –Ecosystem sector mind map.



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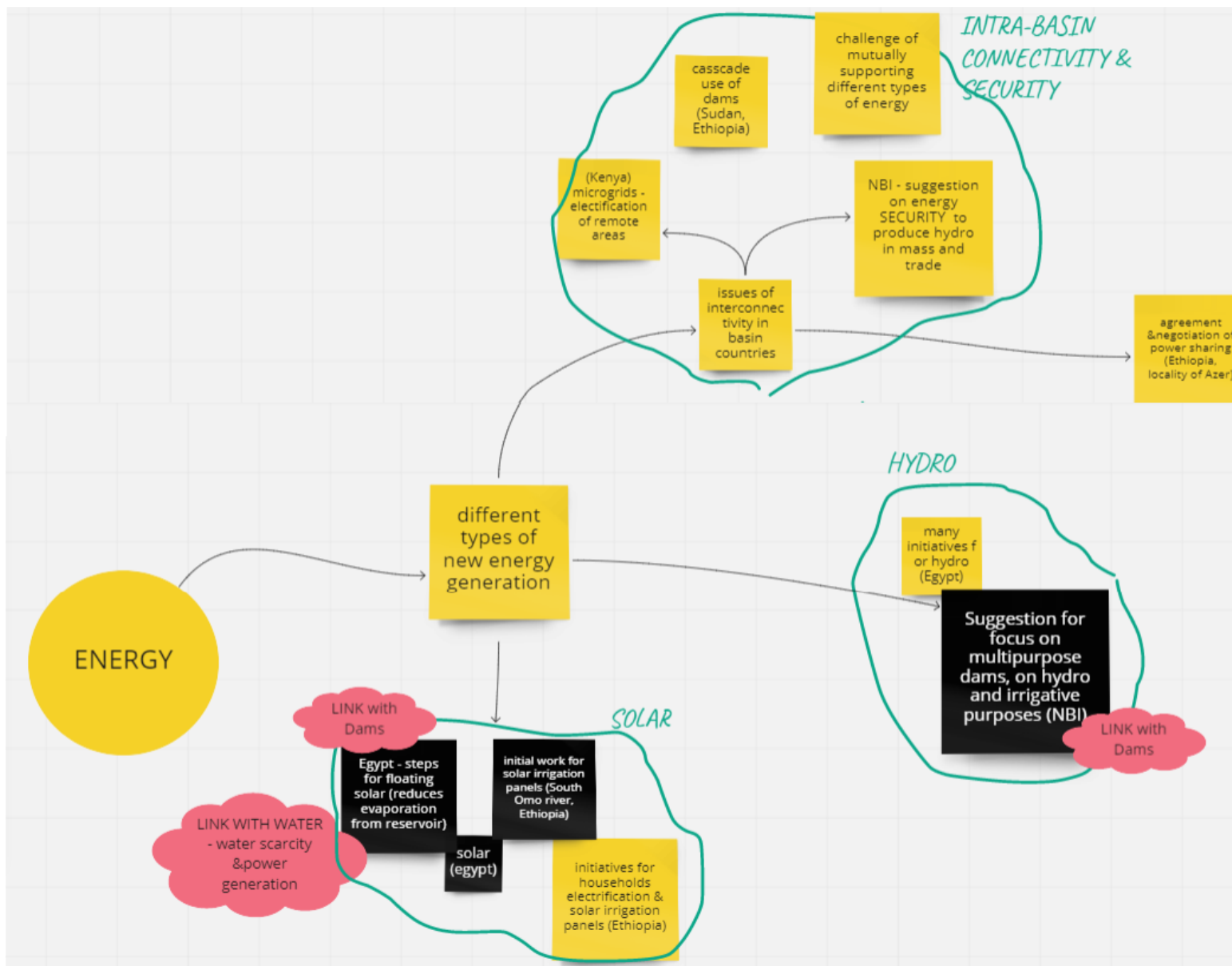


Figure 18 –Energy sector mind map.



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Table 5 provides a list of the basic components of the maps as accompanied by a short description.

**Table 5** – Description of mind maps components.

MIND MAP	
Energy sector frame	A broad overview of the key elements of energy systems, subsystems, forces acting on energy use, environmental or economic drivers
Water sector frame	A broad overview of component parts of the current water systems, main problems faced and initiatives to overpass them on national level
Ecosystems frame	A broad overview of key types of ecosystems and their services, arising conservation needs and interactions with policy
Food sector frame	A broad overview of key parameters affecting productivity of food systems, input availability as well as political and public health challenges impacting supply chain
Climate change	This demonstrates the interaction between some of the climate change influences on each of the WEFE sectors
Watershed management	This outlines some of the impact or benefit of watershed management forces or initiatives on WEFE subsectors
Dams	This outlines a parameter that appeared as important for its linkage among water scarcity, power generation and rainfed agriculture
Food security	This represents an indicator of the food availability and people's ability to access it
Food markets	This demonstrates the pivotal role that regional and local livestock, fish and agricultural markets have on price stability and food security
Ecosystem types	This outlines the basic types of natural ecosystems and its interactions with climate change and watershed management initiatives
Ecosystem services	This gives an overview of the ES impacted by climate change and unsustainable management
Intra-basin connectivity and security	This represents the aspect of connectivity and energy security among the river basin countries
Solar power	This represents one of the energy subsectors
Hydro power	This represents one of the energy subsectors

#### 4.4 JOINT WEFE MENTAL MODEL AT MESO SCALE

130 parameters are contained in the final meso level mental map, while in the WEFE sectoral concept maps are contained 33 parameters in the Water map, 13 parameters in the Energy map, 46 parameters in the Food system map and 30 in the Ecosystems map. In most of the cases these



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parameters visualize opinions, key words, opportunities, statistics or numbers as well as non-descript narratives.

For the visualization of the map four colours are used, each representing one of the four WEFE sectors: Blue portrays the water sector, yellow the energy, green the food and orange the ecosystems. Each of the textual elements are represented by nodes of the system; with circles that represent the four WEFE sectors, and rectangles that represent their related parameters (issues, gaps, problems, management initiatives).

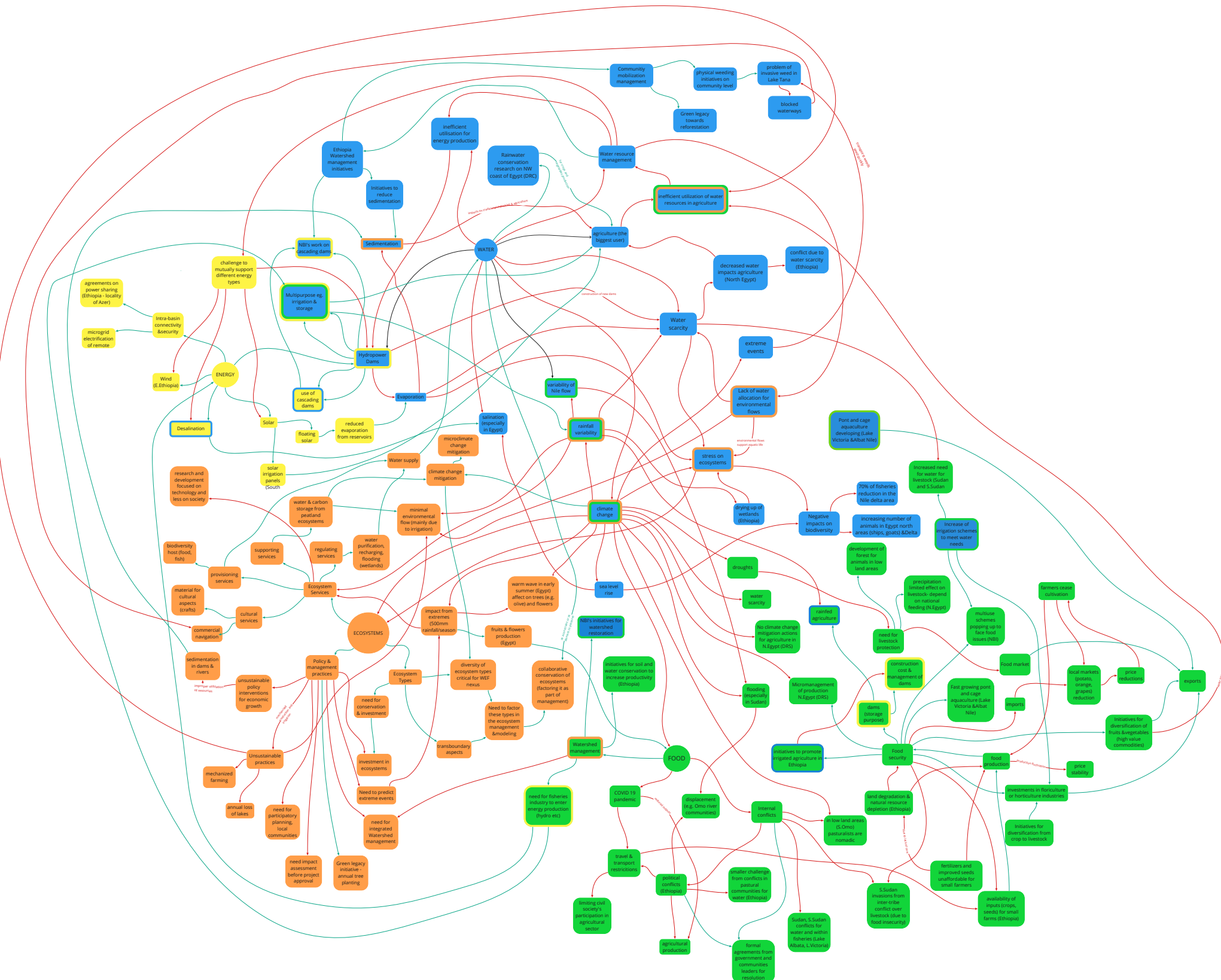
The arrows link different parameters of the systems with the arrow's direction depending on the perceived causality. The weight of all relationships is considered equal; while green arrows implies that a variable is affected positively by another and the red arrow implies a negative impact on the variable. Certain parameters which are relevant to two or more sectors are depicted with the respective colours of the relevant sectors.

AUEB team discussed the different mind maps separately in an attempt to polish the variables, and standardize the principles behind them. The goal was to simplify the maps as much as possible without losing important details and try to convert all descriptive variables into characteristics of a system (e.g. climate change to temperature or lack of cooperation to memberships in cooperatives), and without omitting important qualitative aspects of the WEFE sectors and subsectors interactions. The process was structured by guiding questions such as:

1. What does the sticky note mean?
2. What is direction of the relationship?
3. Is it positive or negative?
4. Is the issue/aspect or system characteristic identified in another variable within the sector or another sector?

In general, the process aimed to:

- Omit sidesteps that were too detailed
- Identify and delete duplications
- Rename or redefine variables to ensure clarity and avoid vague meanings
- Rename variables to connect different sectors.





## 4.5 RESULTS AND FINDINGS

### 4.5.1 FINDINGS ON THE WATER SECTOR

*a. High variability of flow and flooding issues.*

The flooding impacts mainly Sudan, while communities of the whole river basin living close to the river are often dislocated when the river is high.

*b. Dams' impacts on aquatic biodiversity.*

In many river's parts dams are popping up according to environmental flow studies of NBI which impacts aquatic biodiversity especially in the Delta area where fisheries are reduced by 70%. This necessitates an intervention by factoring in the environmental flows.

*c. Dams' impacts on sediments and evaporation.*

Sediment is necessary for agriculture and different parts of the traditional industry which is highly impacted by the use of dams. Water evaporation also

*d. Climate change*

Salination caused by sea level rise, wetlands' drying up due to climate change, and rainfall variability affecting river's flow are the basic impacts from climate change with direct repercussions in the water sector.

*e. Inefficient utilization of water.*

The farming sector suffers from the problem. Particularly in Ethiopia there are management initiatives for watershed development. Part of them aims at water and soil conservation.

*f. Opportunities for cooperative management of dams.*

There is a lot of attention recently on the cascade of the dams, the opportunities for cooperative management as well as the issues on security that arise.

### 4.5.2 FINDINGS ON THE ENERGY SECTOR

*a. Interconnectivity between basin countries.*

There are different types of new generation technologies for renewable energy production especially on solar and hydro. A question is whether the river basin countries can be mutually supportive in terms of energy production. The challenge of developing power sharing among countries is one of the key drivers of NBI's energy security. There are already power sharing agreements in areas of Ethiopia recently.

*b. Opportunity for combinations.*

Floating solar that combines the water scarcity issues with energy generation, that has low investment cost (due to already connection to the grid).

*c. Initiatives.*

There are initiatives taking place in Eastern Ethiopia on wind energy, while solar is less utilized. Further initiatives are taking place for rural households' electrification as well as floating solar irrigation panels on the river South Omo.

*d. Energy security.*

The energy security up to now is focused on investments taking place mainly on hydropower and multipurpose dams. There is a need to extend this to further innovative directions beyond dams.

### 4.5.3 FINDINGS ON THE FOOD SECTOR

*a. Promotion of irrigated agriculture.*

Most farmers are dependent on rainfed agriculture. High value commodities have been introduced in the many river basin countries as investment which have high development potential as are expending (e.g. horticulture)



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*b. Increased water demand*

Many irrigation schemes, such as multi-purpose, in order to meet the increased demand for irrigated agriculture.

*c. Watershed development*

In Ethiopia there are initiatives that have increased productivity of agriculture and try to protect areas from drought (e.g. livestock protection). The Sudan and S.Sudan there is increased issue of limited water availability for livestock as well.

*d. Internal conflicts.*

In Northern Ethiopia Agricultural the conflicts have impacted the agricultural production the last 3 years and are related to the political instability, which includes travel restrictions in many cases as a resolution mechanism. Negotiations and agreements have taken place on diverse administrative levels, most have been initiated by local leaders and followed by the government and are formal. In other areas of the basin there are livestock, and pasture or water conflicts as people move close to water where livestock feeds better. In Lake Victoria take place fisheries conflicts.

*e. Impacts from the pandemics.*

COVID has impacted the travel and in most cases stakeholders talk about negative impacts in agricultural production.

*f. Availability of inputs.*

Especially the small-holder farmers, in areas of Ethiopia, have very limited capacity to afford the required amount for seeds and fertilizers, which impacts the land and is often linked to natural resource depletion.

*g. Exports increase.*

Aquaculture and cage aquaculture

#### 4.5.4 FINDINGS ON THE ECOSYSTEMS SECTOR

*a. Rich and diverse ecosystem types.*

Many types than need conservation and is agreed as a critical part of the WEF Nexus. There is the need to invest in these types not only as sources of water, but on their conservation due to the benefits they offer to the consumers.

*b. Ecosystem services.*

Crop production from irrigated agriculture, livestock maintenance, fish stock, fruits and flowers, water flow, environmental flows, carbon sequestration, sediment retention, microclimate change, habitats, commercial navigation.

*c. Threats*

Issues with water availability and resource availability due to climate change, sedimentation, unwise and improper utilization of water resources especially in cases of mechanized farming.

*d. Need for integrated watershed approach and participatory planning.*

It was discussed as a way to preserve the resources that are based on the ecosystems of the river basin. Many localities are already losing resources. Local administrative communities are able to enter in the management of their regions' resources

## 5. CONCLUSIONS

### 5.1 REFLECTIONS ON THE JOINT WEFE MENTAL MODEL

Although both MAWGs covered the joint issues, drivers of change, problems and gaps among all WEFE sectors, there are some divergences among the micro level and the meso level maps. Some derive from the nature of the WEFE on the two levels. For example most of the word elements/parameters of the micro level maps are related to theme-sector-specific aspects, to national or national economy as driver of system change, while the word elements/parameters of the meso level maps are related to climate, policy decisions and regional economy as drivers of change. The micro level MAWG focused on their very specific issues or concerns which is particularly the agri-business, while the meso level MAWG offered a broader picture of the WEFE interactions. One important observation is the absence of reference to dams within the micro-level discussions, as challenges or changes relevant to the dams were not deemed relevant to the stakeholders, unlike many Nile River basin countries.

#### 5.1.1 DRIVERS

‘Drivers’ represent vital nodes within the system, with the largest number of direct relationships with other nodes (outwards arrows in particular). Changes observed within a driver will have multiple and cascading impacts (be they positive or negative) throughout the WEFE Nexus.

##### ***Climate Change***

With the greatest number of direct relationships in the maps (23), climate change is not only a core driver, but is also identified as a major challenge. As a key driver, climate change was raised by all stakeholders from all of the WEFE sectors and at different scales; from the large corporations with the infrastructure and resources to combat the rising challenge, to small/medium scale growers with limited resources to equip themselves with the necessary mitigation practices. Climate change has a direct impact on a broad range of parameters within the nexus including crop cycles, drought, extreme weather events, rainfall variability, environmental flows, sea level rise, and soil salinity. All of which indirectly have implications for water availability, food production and security, and even geo-political stability.

##### ***Ecosystem Services***

Another major driver identified by the maps (15 direct relationships) relates to ecosystem services. Ecosystem services represent the interface between the environment and the human actors within the WEFE nexus. All WEFE nexus activities can be traced to one of the four main ecosystem services categories; provisioning, regulating, cultural or supporting services. As such, any changes to the status or the function of the ecosystem services, translates into equivalent changes in other areas of the WEFE nexus map. In particular, the ecosystem services play a major role in crop production from irrigated agriculture, livestock maintenance, fish stock, fruits and flowers (provisioning services), in water and environmental flows, carbon sequestration sediment retention and

microclimate change (regulating services), in habitats (supporting services) and commercial navigation (cultural services).

### ***Food Security***

Food security (12 direct relationships) is a driver that while mainly related to the “food” aspect of the WEFE nexus, has a strong impact on the regional economy and stability. A lack of food security not only affects prices, but increases reliance on imports and has a detrimental effect on the local economy. Conversely, food security in the region indicates a healthy local agricultural sector, with a broad variety of produce and serves a key employer for the local workforce. Initiatives to ensure food security have also created several opportunities within the WEFE nexus for technological and social innovations.

### ***Hydropower Dams***

As a major confluence of the WEFE sectors, hydropower dams (11 direct relationships) represent key drivers for change within the system. Their existence (or not) plays a big role in the evolution of all the WEFE sectors in the nexus system. The energy they generate can have transformational impacts for the regions they supply, accelerating agricultural processing, manufacture and industry while boosting the economy and potentially raising the average standard of living for domestic users. At the same time, the water they require can put a strain on local ecosystems, due to evaporation. In addition, it is noted that the utilization of dams for energy generation is currently inefficient. As such, improvements to the current design (the use of cascading or multipurpose dams), utilization and management (power sharing agreements), of hydropower dams, has the potential for greater impact across the WEFE nexus.

### ***Policy and management practices***

Another core driver with 9 direct relationships, relates to policy and management practices. All activities within the WEFE nexus are inherently governed by various policies at different national and regional levels. In addition, transboundary agreements as they relate to power sharing, watershed management, agricultural trade and environmental conservation strongly determine the course of actions within the WEF nexus. Furthermore, even with the best policies in place, poor and inefficient management practices can still result in negative impacts on the WEFE nexus. While policy and management practices, as a main driver for change within the system, however, lack of coordination, poor planning and implementation means that policy and management practices also pose a key challenge.

### ***Synergistic approaches***

A running theme throughout the mental model is the notion of building on synergies to facilitate multipurpose infrastructure and activities. The idea of multipurpose irrigation and storage systems, dual agriculture and aquaculture systems, hydropower and aquaculture, and even hydroponic and aquaponic systems such as those being developed by the AWESOME project, have the potential to bring the various WEFE nexus sectors even closer together; building on synergies while ameliorating trade-offs. These synergistic approaches not only serve as a driver, but also constitute an area of

great opportunity to improve efficiency of natural resource use and management within the WEFE nexus.

### 5.1.2 CHALLENGES

‘Challenges’ represent major stumbling blocks or barriers to the effective and efficient operation of WEF nexus actors and components.

#### ***Climate Change***

Climate change adds challenges to the WEFE nexus of the basin, first by influencing the availability and variability of water resources, and by rendering the agricultural sector more sensitive to the impacts of climate change. Current approaches for food production, which rely on ever-increasing inputs of land, water, and fertilizers, may no longer be suitable under climate change.

#### ***Policy and management practices***

Lack of coordination among policies and institutions, and that has resulted in policy spill-overs and transferring challenges to other sectors. There is, therefore, a need for policy harmonisation, which is the very reason of the WEF nexus approach in resources management<sup>17</sup>. Inadequate governance arrangements lead to overexploitation of water resources. In other cases, restrictive water policies have led to unintended consequences on local farmers, such as the case in Egypt; where the production of multiple crops was restricted through a number of new regulations including bananas and rice which are only to be grown in specific areas and using specific irrigation methods such as drip irrigation (traditionally grown using a flooding method).

#### ***Water Scarcity***

The main challenge is the uneven distribution and the decrease of rainfall towards the north, since the main run-off producing areas are in the Ethiopian highlands and the south west of Sudan, a climate-vulnerable region<sup>18</sup>. This type of physical water scarcity, referred to as “demand-driven” water scarcity, undermines agricultural production that causes changes in the crops that are used in farming and makes more vulnerable population dependant on livestock. Changing climate conditions such as rainfall variability and evaporation partly related to hydropower dams along with lack of water allocation for environmental flows exacerbates the problem. Nile River basin experiences the consequences of unmanaged trade-offs between sectors as water constraints become binding and the demands for food and energy increase<sup>19</sup>. However, it is important to note the severity of the water challenge is very different amongst the different stakeholders. This becomes very clear when we look more in depth at the operational models of small and medium scale growers versus large scale growers. Small to medium scale growers often only own one

location over multiple generations mostly in what we call heavy/old agriculture areas. As the land operates for many years without the proper care and practices it is often stressed and prone to diseases and pests increasing the overall costs. Additionally, as most of agriculture in Egypt relies on ground water or Nile River streams, you can always note that water sources serving those heavy/old agricultural areas to also be strained and with a declining quality, often reflected in high salinity or pollution

### ***Stress on Ecosystems***

Water scarcity, evaporation, wetlands drying up and impacts on environmental flows that support aquatic life put pressure to the already stressed ecosystems affecting human security by reducing water supply, land productivity, and biodiversity; limiting the effectiveness of ecosystem services in the region.

### ***Political Conflict***

Conflicts between local communities (in some cases over water), have a direct impact on the security in the region. The lack of stability coupled the displacement of existing farming and fishing communities leads to a general reduction in food production, further exacerbating issues related to food security. Such conflict is also detrimental to transboundary cooperation, particularly as it concerns power sharing agreements, and sustainable transboundary water resource management.

### ***Increasing Energy Prices***

Rising energy prices, over the past few years has burdened the already increasing production costs. While for small to medium scale growers energy is considered a relatively small component of the operational costs for a larger scale growers energy constitutes a significant expenditure in light of the more complicated post-harvest operations and infrastructure which eventually leads to the rising interest in exploring renewable energy solutions especially for new and remote sites.

## **5.1.3 OPPORTUNITIES**

‘Opportunities’ represent positive activities with potential to grow, or gaps to address existing challenges by the replication and/or adaptation of exiting approaches, or entirely new innovations (technological and social).

### ***Synergistic approaches***

A key opportunity to energy from the study is the gap relating to the development and implementation of synergistic approaches combine multiple complementary activities such as multipurpose irrigation and storage systems, multipurpose dams that serve irrigation, power generation, aquaculture. This can extend further to related activities such as eco-tourism etc.

### ***Technology***

There is a large demand for innovative technologies that will assist in addressing the key WEFE challenges; be it renewable energy, soilless agriculture, or irrigation. Technologies that have the potential to aid the promotion of water management practices that produce more food and energy with less resources. One improvement towards that direction is the use of solar powered pumps as well as hydroponics and aquaponic systems that can also mitigate the trade-offs related to increasing food needs.<sup>27</sup>

### ***Renewable Energy***

With rising energy prices and renewable energy technology becoming more affordable, offgrid solutions from renewable energy sources are becoming increasingly attractive. The adoption of cleaner and renewable energy sources will have positive impacts in water and ensure energy security. The Nile River Basin can take advantage of its abundant clean sources of energy such as solar and wind. The use of renewable sources will be a better option for population that has no access to reliable energy at the present. Increased intra-basin connectivity can benefit the region from water transfer and renewable energy power generation from one part with abundant water resources to the other<sup>20</sup>. Additionally, transition to renewable energies contributes to the reduction of energy sector's water use and can reduce water scarcity.

### ***Exploration of Innovative Management Approaches***

Autonomous and reactive adaptations such as the described diversification in crop mixes and varieties as well as diversification from crop to livestock or community practices to deal with the invasive weed are responses to changes in local and river basin climatic conditions. Proactive interventions, on the other hand, can offer the opportunity for long term adaptation and need the involvement of innovative management approaches through planned policy (e.g. new crop varieties)<sup>21</sup>. The shared natural resources provide an opportunity for development of regional integration for cooperation in resource management. The integration of climate change into regional strategies, policies and plans is an opportunity on climate adaptation<sup>22</sup>.

### ***Investments tied to Sustainable WEFE practices***

With issues related to sustainable practices gaining visibility in the region, under a well-coordinated WEFE Nexus approach there is the opportunity to develop cross-sectoral measures and to explore climate change adaptation and mitigation through greater resource mobilization directed to WEFE infrastructures, to green financing and investment in high commodity values with high potentials for exports such as horticulture and floriculture. It is a proactive intervention that targets both the agricultural system and food security as well as exports and sustainable livelihood. In addition, with policies and initiatives prioritizing new water management initiatives, there are opportunities for both technological and social innovations that address water efficiency (in particular with regards to irrigation). For example, a large initiative was launched in Egypt to restore many of the water infrastructure serving agricultural areas to reduce water waste in addition to complementary regulations to reduce growers water quotas. In general, the perception of key stakeholders on

cooperation priorities reveals that financial cooperation, and transboundary investments in conservation and mechanization are well-received in the region.<sup>23, 24, 26</sup>

### ***Capacity Development and Training***

In all the drivers, challenges, and opportunities listed above, there is also a corresponding need for capacity development and training to support the transition towards sustainable WEFE nexus operation; whether in a bid to leverage the drivers, address the challenges or pursue the opportunities. Promoting research towards the development of multi-purpose agro-systems that can deliver cross-sectoral benefits and not just increased food production or more efficient water management. Mobilize multi-stakeholder dialogues that focus on regional value chains and job creation through WEFE Nexus. In the context of the Nile Basin, capacity building is a “soft” measure that can complement institutional arrangements for water allocation, promotion of technical cooperation and favour political stability as well as promote participatory processes<sup>25</sup>.

## **5.2 REFLECTIONS FOR THE AWESOME PROJECT**

The main drivers and opportunities highlighted by the mental model are indicative of the relevance and the importance of the work being undertaken by the AWESOME project. In particular, three of the projects main outputs (***the WEFE Nexus decision support system, the hydroponics and aquaponics technology, and the training and capacity development programmes***) reflect identified drivers and opportunities in the form of ***Policy & management practices*** and ***Synergistic approaches***, and ***Capacity Development and Training*** respectively.

The parameter of the environmental flows and its importance especially in the water and the energy sector as well as its relationship with the multi-use dams added a new direction in the research particularly for the WP2 models. Further contact with the stakeholders who are experts in that field will be pursued in order to provide feedback POLIMI’s model on the meso level and AUEB’s valuation of ES with detailed studies. The increase of efficiencies for WEFE subsectors that AWESOME investigates can be linked with additional co-benefits related to improved environmental flows, besides the existed direction on improving agricultural production and food security.

AWESOME’s objectives were met on the micro level workshop and interviews in terms of identifying the key WEFE issues, charting the relationships between these issues and completing the systemic map of the WEFE Nexus. Among the key remarks is that governmental and international organizations’ officials although may be very well aware of the high-level trends taking place, might lag behind, when it comes to on-ground trends and changes, versus business, who have a close experience to real challenges. Public academic sector professionals have a high-level understanding of the ecosystem, often lagging behind the latest trends and developments. The large agri-businesses often have a high turnover in employees, coupled with large resources accumulated over years, skewing/ understating representatives’ views of the current challenges faced. A further remark is that experts seems to be more focused on their industries’ development, often unaware



of developments in complementary industries/ fields (highlighting many developmental opportunities and the need for AWESOME).

In terms of AWESOME's objectives on the meso level workshop on identifying the key WEF issues, relationships between these issues and developing the systemic map, these were all met. Among the key remarks is that water is the WEF subsector with the most parameters that overlap with other subsystems parameters with the high variability of flow to be the most prevailing problem. There is still lack of active participation from experts on desalination in the MAWG. Although experts from the meso level are quite aware of issues and developments out of their sectors, it appeared that desalination is quite closed as field. Future step will be the increased involvement of basin experts working on the desalination sector.

This deliverable has described how the WEF mental mapping is developed in AWESOME and the approach to continuous stakeholder analysis and involvement in the project. It includes the results from the first two MAWGs conducted in Egypt and in the Nile Basin level resulting in the first identification of key drivers of WEF change, issues, indicators, prioritized ES to support the future scenarios building and the ES valuation. The report has also provided an overview of the planned MAWGs for the next year and a half, that are interlinked with milestones and Deliverables of the project feeding the research process and the outputs validation. During spring 2022, while preparing the Task 6.3, AUEB will go on to build on the findings of this deliverable to support the policy focus within work being carried out in Task 2.5 on the catalogue of international policies in relation to ES; as well as links with D2.4 on co-creation of future scenarios, and the outputs from WP3, WP4, WP5 that need to be validated. A further intension is a preparation of "digital stories" based on the joint WEF maps to be used by the micro level agri-business actors in order to ensure their understanding of the broader picture and feed their further discussion before the capacity building MAWGs.

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## ANNEX A

### OVERVIEW OF THE LONG LIST OF STAKEHOLDERS (MICRO/MESO LEVEL)

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
1	River Basin authority	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
2	Ministry of Water Resources and Irrigation	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
3	Water resources management authority	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
4	National irrigation institutes/directorates	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
5	National Water Research Center	Egypt	Water	Governmental	National	Inform
6	Global Water Partnership, Egypt	Egypt	Water	Intergovernmental	River basin	Inform
7	Hydrology institutes	Egypt	Water	Research	National	Inform
8	Nile Research Institute	Egypt	Water	Governmental	River basin/national	Inform
9	Groundwater research institutes	Egypt	Water	Research	National	Inform
10	ReNile	Egypt	Water	Business	National	Inform
11	21 Farmers	Egypt	Water	Business	National	Inform
12	Water Affairs	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
13	Ministry of Foreign Affairs	Egypt	Water	Governmental	River basin/national	Consult – Manage closely
14	Ministry of Housing	Egypt	Water	Governmental	National	Inform
15	Nile Basin Initiative	Sudan/Ethiopia/Egypt	Water	Intergovernmental	River basin	Consult – Manage closely
16	The High Dam and Aswan Reservoir General Authority - Ministry of Water Resources and Irrigation	Egypt	Energy	Governmental	River basin	Inform



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#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
17	Electricity Supply Corporations	Egypt	Energy	Non-governmental	National	Involve - Keep satisfied
18	Electricity Supply Authority	Egypt	Energy	Governmental	River basin/national	Involve - Keep satisfied
19	Ministry of Energy	Egypt	Energy	Governmental	River basin/national	Involve - Keep satisfied
20	New and Renewable Energy Authority	Egypt	Energy	Governmental	River basin/national	Involve - Keep satisfied
21	Solar energy developer SOLARIZE	Egypt	Energy	Business	National	Involve - Keep satisfied
22	Solar energy power station	Egypt	Energy	Governmental	National	Involve - Keep satisfied
23	SolarizEgypt	Egypt	Energy	Business	National	Involve - Keep satisfied
24	Wind energy power stations	Egypt	Energy	Governmental	National	Involve - Keep satisfied
25	Desalination stations	Egypt	Energy	Governmental	National	Involve - Keep satisfied
26	International Desalination & Water Treatment Group (IDWT)	Egypt	Energy	Industry	River basin	Collaborate and empower
27	National directorates of energy	Egypt	Energy	Governmental	River basin/ National	Involve - Keep satisfied
28	Ministry of Agriculture & land reclamation (MALR)	Egypt	Food	Governmental	River basin/ National	Consult – Manage closely
29	Food reserve agencies	Sudan/Ethiopia/Egypt	Food	Governmental	National	Inform
30	Agriculture research center	Egypt	Food	Research	River basin/ National	Inform
31	Egyptian Center of Organic Agriculture (EOA)	Egypt	Food	Business	National	Inform
32	Central Laboratory for Agriculture Climate (CLAC)	Egypt	Food	Governmental/ Research	National	Consult – Manage closely

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
33	Desert Research Center	Egypt	Food	Research Center	River basin	Consult– Manage closely
34	Land Reclamation and Developm. Authority	Egypt	Food	Governmental	National	Consult– Manage closely
35	Crops Agency	Egypt	Food	Business	National	Inform
36	Farmers union	Egypt	Food	Interest groups	National	Inform
37	Water consumers union	Egypt	Food	Interest groups	National	Inform
38	Export Development Fund	Egypt	Food	Governmental	National	Consult– Manage closely
39	Egyptian Countryside Development Company	Egypt	Food	Governmental	National	Inform
40	Ministry of International Cooperation	Egypt	Food	Governmental	National	Monitor – Minimum effort
41	El Salhiya for Agricultural Investments	Egypt	Food	Business/Governmental	National	Inform
42	Daltex/Pico	Egypt	Food	Business	National	Inform
43	Sekem	Egypt	Food	Business	National	Inform
44	Sara's Organic Farm	Egypt	Food	Business	National	Inform
45	FAO	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Inform
46	ICARDA, Khartoum office	Sudan	Food	Non profit organization	River basin	Inform
47	Global Alliance for Improved Nutrition	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Inform
48	Community Initiative Facilitation and Assistance (CIFA)	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Monitor – Minimum effort
49	Agency for Cooperation in Development (CAFOD)	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Monitor – Minimum effort
50	Food Security Cluster	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Inform

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
51	Center for Applied Research on the Environment and Sustainability (CARES)	Egypt	Food	Research	River basin	Collaborate and empower
52	Agrimatic	Egypt	Food	Business	National	Inform
53	Akrat	Egypt	Food	Business	National	Inform
54	US Soybean Export Council (USSEC)	Sudan/ Ethiopia/ Egypt	Food	Non profit organization	River basin	Inform
55	Worldfish	Sudan/ Ethiopia/ Egypt	Food	Non profit organization	River basin	Inform
56	Environmental Management Agencies	Egypt	Ecosystems	Governmental	National	Inform
57	Ministry of Environment, Environmental Affairs	Egypt	Ecosystems	Governmental	National	Consult– Manage closely
58	National parks conservation agencies	Sudan/ Ethiopia/ Egypt	Ecosystems	Non-governmental	River basin	Inform
59	Department of fisheries (Ministry)	Egypt	Ecosystems	Governmental	National	Inform
60	Egyptian Meteorological authority	Egypt	Ecosystems	Governmental	River basin	Collaborate and empower
61	Heliopolis University	Egypt	Ecosystems	Academia	River basin	Consult
62	National heritage conservation commission	Sudan/ Ethiopia/ Egypt	Ecosystems	Non-governmental	River basin	Inform
63	WWF Kenya office	Ethiopia	Ecosystems	Intergovernmental	River basin	Inform
64	Desert research institute	Egypt	Ecosystems	Research	River basin	Consult– Manage closely
65	IUCN (International Union for Conservation of Nature)	Sudan/ Ethiopia/ Egypt	Ecosystems	Non-governmental	River basin	Involve - Keep satisfied
66	GIZ - Transboundary	Sudan/ Ethiopia/ Egypt	Ecosystems	Non-governmental	River basin	Inform

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
	water cooperation in the Nile Basin					
6 7	Red Cross Society	Sudan/ Ethiopia/ Egypt	Public health	Non-governmental	River basin	Monitor – Minimum effort
6 8	Ministry of Health	Egypt	Public health	Governmental	National	Monitor – Minimum effort
6 9	Ministry of Social Services /Welfare	Egypt	Public health	Governmental	National	Inform
7 0	Sawiris Foundation	Egypt	Sustaina ble livelihoo d	Non for profit	National	Monitor – Minimum effort
7 1	Ministry of Development and Economic Planning	Egypt	Sustaina ble livelihoo d	Governmental	National	Inform
7 2	World Food Programme	Sudan/ Ethiopia/ Egypt	Other	Non for profit	River basin	Inform

## OVERVIEW OF THE SHORT LIST OF STAKEHOLDERS (MICRO/MESO LEVEL)

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
1	Ministry of Water Resourc es and Irrigatio n	Egypt	Water	Governmental	River basin/natio nal	Consult – Manage closely
2	ReNile	Egypt	Water	Business	National	Inform
3	Nile Basin Initiative	Sudan/Ethiopia/Eg ypt	Water	Intergovernmental	River basin	Consult – Manage closely
4	Solar energy developer SOLARIZE	Egypt	Energy	Business	National	Involve - Keep satisfied



#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
5	Ministry of Agriculture & land reclamation (MALR)	Egypt	Food	Governmental	River basin/ National	Consult – Manage closely
6	Egyptian Center of Organic Agriculture (EOA)	Egypt	Food	Business	National	Inform
7	Central Laboratory for Agriculture Climate (CLAC)	Egypt	Food	Governmental/ Research	National	Consult – Manage closely
8	Desert Research Center	Egypt	Food	Research Center	River basin	Consult– Manage closely
9	Export Development Fund	Egypt	Food	Governmental	National	Consult– Manage closely
10	El Salhiya for Agricultural Investments	Egypt	Food	Business/Governme ntal	National	Inform
11	Daltex/Pico	Egypt	Food	Business	National	Inform
12	Sara's Organic Farm	Egypt	Food	Business	National	Inform
13	FAO	Sudan/ Ethiopia/ Egypt	Food	Intergovernmental	River basin	Inform
14	Center for Applied Research on the Environment and Sustainability (CARES)	Egypt	Food	Research	River basin	Collaborate and empower
15	Agrimatic	Egypt	Food	Business	National	Inform
16	Worldfish	Sudan/ Ethiopia/ Egypt	Food	Non profit organization	River basin	Inform
17	GIZ - Transboundar	Sudan/ Ethiopia/ Egypt	Ecosyste ms	Non-governmental	River basin	Inform

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
	y water cooperation in the Nile Basin					
18	Ministry of Development and Economic Planning	Egypt	Sustainable livelihood	Governmental	National	Inform
19	World Food Programme	Sudan/ Ethiopia/ Egypt	Other	Non for profit	River basin	Inform

## ANNEX B

### OVERVIEW OF THE EXTENDED LIST OF STAKEHOLDERS (MESO LEVEL)

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
1	Egypt Desalination Research Center	Egypt	Water	Governmental	River basin	Consult
2	Environmental Research Institute - National Water Research Center	Egypt	Water	Governmental	River basin	Collaborate and empower
3	International Water Management Institute – East Africa	Ethiopia	Water	Research partnership	River basin	Collaborate and empower
4	WEF Nexus Africa	Ethiopia	Water	Academic network	River basin	Inform
5	Regional Center for Renewable Energy and Energy Efficiency (RCREEE)	Sudan	Energy	Intergovernmental	River basin	Inform
6	Ethiopian Energy Authority	Ethiopia	Energy	Governmental	River basin	Inform

#	Organization/ Institute/ Directorate	Country	Sector	Type	Level	Level envisioned engagement (Inform, Consult, Involve, Collaborate/empower)
7	Egyptian Center of Excellence for Saline Agriculture	Egypt	Food	Research Center	River basin	Collaborate and empower
8	The Global Forum on Agricultural Research and Innovation (GFAR)	Egypt	Food	Research Center	River basin	Collaborate and empower
9	Oromia Agricultural Research Institute	Ethiopia	Food	Research Center	River basin	Inform
10	Yirgacheffe Coffee Farmers 24 Cooperatives	Ethiopia	Food	Cooperative	River basin	Collaborate and empower
11	Ethiopian Institute of Agricultural Research	Ethiopia	Food	Research Center	River basin	Collaborate and empower
12	International Livestock Research Institute (ILRI)	Ethiopia	Food	Research Center	River basin	Collaborate and empower
13	Rangelands Initiative Global	Ethiopia	Food	Non-governmental network	River basin	Inform
14	Climate Change, Agriculture and Food Security (CGIAR)	Ethiopia	Food	Non profit organization	River basin	Consult
15	Agri Service Ethiopia - Food security, sustainable livelihoods	Ethiopia	Food	Non profit organization	River basin	Consult
16	Ministry of Environment, Natural Resources and Physical Development of Sudan	Sudan	Ecosystems	Governmental	River basin	Collaborate and empower
17	UNEP Sudan	Sudan	Ecosystems	Intergovernmental	River basin	Consult
18	African Wildlife Foundation	Ethiopia	Ecosystems	Non profit organization	River basin	Inform

## ANNEX C

### CONSENT FORM



#### PRIMA AWESOME WEF Nexus Workshop Participation Information Sheet

Thank you very much for your interest in taking part in this workshop. Before you proceed, please take time to read the following information carefully.

As part of the AWESOME project, we organize that first Workshop as type of Multi-Actor Working Groups with representative key stakeholders, whose perspective is necessary throughout the whole research process of the project. The Multi-Actor Working Groups represent a way to ground the project's research in a real-world situation and increase the potential for practical application of projects results.

The process involves group discussions in order to gain input from various stakeholders and it is on this basis that you have been invited to participate in this series of workshops. You are under no obligation to take part, but if you do, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

Workshop discussions will be summarised into a mental map, and key quotes may be used within the project deliverable. All personally identifiable data will be anonymised before undergoing qualitative analysis. All documents (including any recordings) will be treated with sensitivity and stored in a restricted access folder until destroyed.

If you require any further [information](#) please contact XXX at the address below:

NAME  
ROLE  
INST  
[Email:](#)  
[Tel:](#)

We thank you once again for your time and valued contribution.

## Workshop Participant Informed Consent Form

I consent to participate in the workshop

I have read and understood the attached information sheet

I have been given opportunity to ask questions

I understand that I am under no obligation to take part in this workshop, and I am free to withdraw at any time

I am happy for direct quotes that may be used in the social accounts report to be attributed to myself

I am happy for the data provided to be used as part of the project deliverables and subsequent dissemination material (e.g. research papers, conference presentations etc.)

I am happy for the discussion during the Workshop to be recorded

Yes	No
Yes	No
Yes	No
Yes	No
Yes	No
Yes	No
Yes	No

Name .....

Signature .....

Date .....