Framing Policy Coherence Toward Improving Climate-Adaptive Water Productivity in Egypt

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Fayrouz Eldabbagh, Noura Abdelwahab, Youssef Brouziyne, Juan Carlos Sanchez Ramirez and Alan Nicol

International Water Management Institute, Cairo, Egypt

Authors

Fayrouz Eldabbagh,, National Researcher - Political Scientist, IWMI, Cairo, Egypt f.eldabbagh@cgiar.org

Noura Abdelwahab, Gender and Social Inclusion Expert, IWMI, Cairo, Egypt n.abdelwahab@cgiar.org

Youssef Brouziyne, Country Representative – Egypt, IWMI, Cairo, Egypt youssef.brouziyne@cgiar.org

Juan Carlos Sanchez Ramirez, Research Group Leader - Water Governance and Political Economy, IWMI, Addis Ababa, Ethiopia J.SanchezRamirez@cgiar.org

Alan Nicol, Principal Researcher, IWMI, Addis Ababa, Ethiopia a.nicol@cgiar.org

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Corresponding author: f.eldabbagh@cgiar.org

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Acronyms

AFD	Agence Française de Développement
AFDB	African Development Bank
AFESD	Arab Fund for Economic and Social Development
ARC	Agricultural Research Center
AWC	Arab Water Council
CAPMAS	Central Agency for Public Mobilization and Statistics
CDA	Community Development Associations
CGIAR	Global Research Partnership for a Food-Secure Future
CSR	Corporate Social Responsibility
DAC	Development Assistance Committee
EBRD	European Bank for Reconstruction and Development
EEAA	Egyptian Environmental Affairs Agency
EIB	European Investment Bank
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field Schools
FLW	Food, Land, And Water
LFRPDA	Lakes and Fish Resources Protection and Development Agency
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IPRS	In-Pond Raceway Culture System
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
JISA	Joint Integrated Sector Approach
KFW	Kreditanstalt für Wiederaufbau
MALR	Ministry of Agriculture and Land Reclamation
MENA	Middle East and North Africa
MOIC	Ministry of International Cooperation
MSMEs	Micro, Small, and Medium Enterprises
MWRI	Ministry of Water Resources and Irrigation
NARSS	National Authority for Remote Sensing and Space Sciences
NL	Government of the Netherlands
NPO	Non-Profit Organization
NPS	National Policies and Strategies Initiative
NSCC	National Strategy for Climate Change
NWFE	The Nexus of Water, Food, and Energy
NWRC	National Water Research Center
NWRP	National Water Resources Plan
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PILA	Policy and Institutional Landscape Analysis
SADS	Sustainable Agricultural Development Strategy
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SLR	Sea Level Rise
SNA	Social Network Analysis

UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WBG	World Bank Group
WF	World Fish
WP	Water Productivity
WUAs	Water Users Associations

Executive Summary

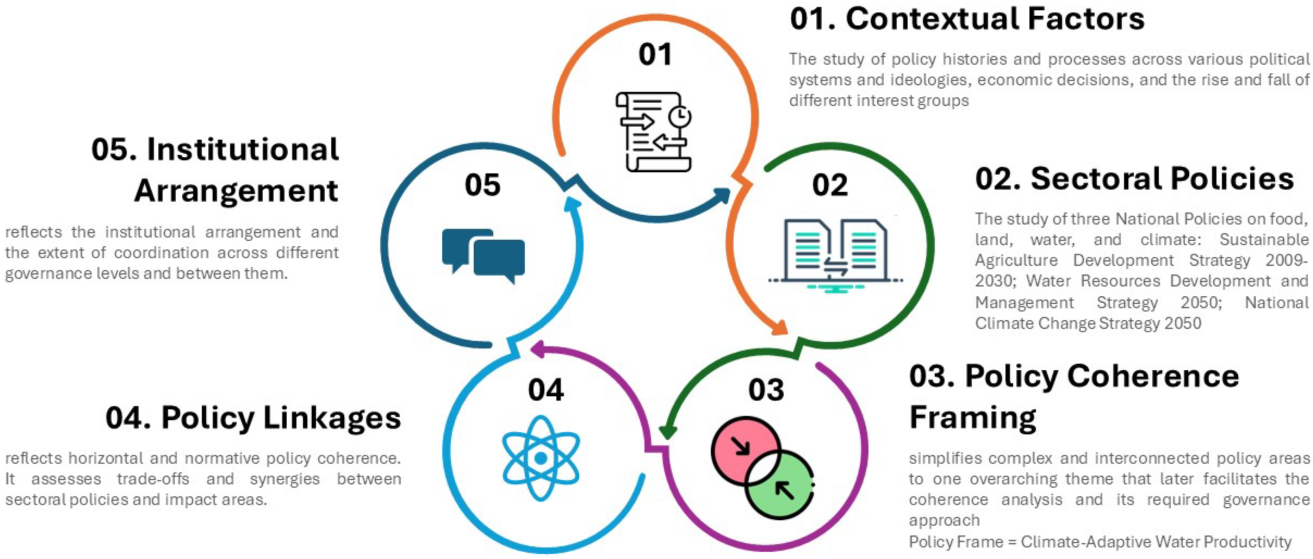
This report evaluates the coherence of national policies related to food, land, and water (FLW) systems in Egypt to develop productive, responsive, and resilient agrifood systems. The OECD has defined "coherence" as a key policy evaluation criterion to capture the interconnectedness between two or more policy areas to maximize the benefits and mitigate negative interactions. Policy coherence comes in various shapes: vertical across sectors, horizontal across institutional levels, and normative across developmental impacts. Thus, this report studies the interactions between FLW systems in public policy to identify their synergies and trade-offs and to analyze the current institutional structure and the power dynamics influencing its governance. It offers actionable recommendations for enhancing cross-coordination mechanisms among various stakeholders, integrating policy processes across different policy arenas, understanding political economy determinants, and identifying expected investments to manage Egypt's scarce water and land resources for improved economic and social prosperity.

Research Methodology

The study of policy coherence of FLW systems follows a five-step process (Figure 1) using the Policy and Institutional Landscape Analysis (PILA) framework created by Nicol, Schutter, and Bhattacharjee in 2024 (to be published). It begins by examining the historical context of FLW public policies to comprehend how various political and economic regimes have shaped the current objectives of Egypt's agrifood national strategies. A review of literature related to policy development revealed five main rationales that shape current policy priorities: 1) population growth and increased food production, 2) balancing water demand with water supply, 3) aligning food and social justice with the government budget, 4) food trade balance, and 5) the effects of climate change on natural resource governance.

Next, this research examines three main national strategies – the Sustainable Agriculture Development Strategy 2009–2030, the Water Resources Development and Management Strategy 2050, and the National Climate Change Strategy 2050. The study argues that these strategies share common objectives forming a holistic policy framework focused on "increasing climate-adaptive water productivity" (CAWP) in its biophysical, economic, and social dimensions to produce more food with less water and land, considering climate change factors. Policy coherence is then assessed by evaluating the policy linkages and institutional arrangements that support this holistic policy frame.

Figure 1: Research Methodology



This research uses several tools to collect data on policy linkages and institutional arrangements. It created two databases. One focused on policies, laws, and programs related to improving climate-adaptive water productivity, and the other looked at institutions managing one or more components of CAWP. The research also incorporates semi-structured interviews and a consultative dialogue held during Cairo Water Week 2023. Additionally, it employs the analysis of power dynamics and social networks to examine public policymaking and implementation related to climate-adaptive water productivity.

Findings

Policy Linkages (Synergies and Trade-Offs)

Policy linkages are analyzed based on synergies and trade-offs that support or hinder improvements in climate-adaptive biophysical, economic, and social water productivity. It reveals both horizontal coherence across sectoral policies and normative coherence across various development impacts.

Increasing Biophysical Water Productivity

Three sectoral policy linkages are associated with improving biophysical water productivity. The first one focuses on the connection between efficient water use/rationalizing water with climate adaptation, the increase in agricultural productivity, and increased water availability for other sectors. Synergies exist between sectoral national policies aimed at upgrading water distribution infrastructure and developing crop varieties to reduce water loss and consumption and thus, increase the water available to farmers and for other sectors, improve land fertility, increase food production, and adapt to dry weather. However, trade-offs arise concerning the impact of modern and smart irrigation on drainage water availability which can constrain fish farm productivity and agricultural expansion in desert areas. Some emerge from reducing water-intensive plants on farmers' livelihoods and land fertility leading to increased illegal cultivation. Trade-offs also occur from the impact of animal husbandry on water management and climate change. The second policy linkage reveals synergies and positive interactions between the development of land and water resources objectives to support higher agricultural growth, by depending on non-conventional water resources and crop consolidation of small-scale fragmented lands. The third policy linkage focuses on water quality, its interaction with food quantity and quality, and its market competitiveness. Despite Egypt's high position in aquaculture production, the sector suffers from low water quality, which negatively impacts food production standards and its market competitiveness.

Increasing Economic Water Productivity

One sectoral policy linkage between national policies focuses on improving the economic water productivity. It includes interactions related to balancing agriculture and food trade between import and export, through market competitiveness, its connections with virtual water import and export, and the improvement in income and employment of agricultural communities. The analysis revealed trade-offs related to the absence of the economic cost of water by adding the cost of the annual depreciation of fixed and operational assets to the cost of agriculture and food trade, thus impacting water value and the profitability of commodities, and enhancing the economic and social status of communities. This research also highlights the policy on increasing the domestication of wheat following the Russian-Ukrainian conflict and its interactions with the increase in water and land consumption at the expense of the cultivation of other crops. As a result, the domestication of wheat leads to social stability, increases self-sufficiency, and reduces the burden on the import budget; however, it comes at the cost of land and water use for other high-value crops. The study also explored synergies related to contract farming and agricultural commodity exchange on trade balance, food self-sufficiency, income, and employment without compromising water and land resources.

Increasing Social Water Productivity

One sectoral policy linkage connects national policies to improve social water productivity. It features the strengthening of an enabling environment by creating employment opportunities and enabling private sector growth with water conservation, food production, and climate adaptation. The analysis highlighted trade-offs associated with the adoption of modern and smart irrigation techniques on employment in traditional farming practices. It also discussed the complexities of fish farm registration between several governmental entities which limits investments, the sustainability of food production, and expansion of export opportunities.

Institutional arrangement (Power Dynamics and Social Networks)

The study identified key criteria of power mobilizing CAWP policy actions, which are knowledge and information, economic capital, social capital, and vertical relationships with policymakers. Knowledge and information enhance education on agricultural production and water conservation practices. Economic capital mobilizes the necessary investment in knowledge, infrastructure, and technological advancements. Social capital – particularly within smallholder farmer networks – facilitates connections with peers and strengthens ties at the community level. Maintaining open and vertical communication between farmers and policymakers maintains policy dialogue and transparency related to water scarcity status and its effects on economic and social prosperity. The findings on institutional arrangements evaluate power dynamics and the extent of horizontal and vertical coherence between sectoral ministries, local directorates, donors and financial institutions, non-profit organizations, and grassroots organizations.

Horizontal Coherence between Sectoral Ministries at the National Level

The analysis highlighted the centrality of the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Agriculture and Land Reclamation (MALR) in leveraging their bureaucratic sectors and resources to influence decision-making related to improving CAWP. However, the role of MALR in policy implementation has been reduced to minimal interference in agricultural operations due to liberal market policies that started in the 1970s and 1980s. The study also revealed the significant role of the Ministry of International Cooperation (MOIC) in fostering coordination among ministries, donors, and financial institutions for promoting financial coherence in addressing CAWP.

High-level and sub-committees between both ministries reflect a horizontal coherence mechanism at the national level. These committees are formed based on the specific needs of each ministry. However, challenges persist in aligning the vision for agricultural expansion with water availability. Furthermore, the aquaculture sector, represented by the Lakes and Fish Resources Protection and Development Agency (LFRPDA), has limited interactions with MWRI and the water national strategies leading to trade-offs that negatively affect the sector.

Moreover, the Central Agency for Public Mobilization and Statistics (CAPMAS) holds a significant betweenness centrality in the CAWP social networks, highlighting its importance in coordinating data for policymaking and resource planning. However, variations exist in the calculations of land data and fisheries productivity per capita among different public entities.

Vertical Coherence between National Research Centers and Extension Services

The affiliated agriculture and Water research centers occupy a powerful position in driving decisions around CAWP, providing technical support and local funding. The collaboration between different research centers with extension services and community associations is confined to pilot projects, hindering the scaling of innovations. Moreover, research innovations are fragmented between centers, which complicates the access to information by knowledge users, such as the research and development component of small- and medium-agrifood businesses.

Horizontal Coherence between Sectoral Ministries at the Local Level

Social network analysis shows the growing social capital of agricultural, irrigation, and drainage directorates and extension services with donors and non-profit organizations implementing CAWP programs. However, the management of these directorates relies heavily on individual traits, rather than robust legal and financial frameworks, impacting policy implementation progress. Nonetheless, weaknesses in public extension services at the local level have been noted, including the absence of an integrated policy on extension services between agriculture and water resources, traditionality of knowledge, slow responsiveness, and low reachability to farmers.

High Engagement of Donors and Financial Institutions in Policies

The World Bank Group, the European Union (EU), the Government of the Netherlands (NL), and the United States Agency for International Development (USAID) are central entities in the network actors supporting financially CAWP programs in Egypt. The analysis also highlights the potential contribution of domestic funding opportunities from national banks and the private sector.

High Engagement of Non-Profit Organizations in Policies

The analysis reveals the significant power and centrality of the Food and Agriculture Organization of the United Nations (FAO) in managing funds, technical resources, and information within the social network. The FAO acts as a key intermediary between various actors, influencing and shaping the flow of resources.

Limited Engagement of Grassroots Organizations in Policies

The study highlights the limited power of cooperatives, Water User Associations (WUAs), Community Development Associations (CDAs), and agrifood entrepreneurs in influencing public policy decisions related to CAWP. Currently, there are many initiatives and programs that aim to improve small and medium-sized agrifood businesses, where they could benefit from other untapped opportunities in digital accessibility and applications for smallholder farmers in machinery exchange. Grassroots movements like cooperatives and WUAs receive technical, knowledge or fund support without clear holistic participation and course of action from their side on a higher level. While WUAs play a crucial role in water management at the local level, their institutional ineffectiveness persists in managing conflicts, mobilizing financial resources, and promoting water accounting mechanisms.

Recommendations

Policy Linkages

The study recommends framing policy coherence between FLW systems and their economic and social impact into measurable outcomes such as improving climate-adaptive water productivity. The policy linkage recommendations are divided into three types: biophysical, economic, and social productivity. To improve biophysical water productivity, the study suggests medium-term objectives focusing on the continuation of the crop consolidation strategy through the agricultural cycle, as well as upscaling and legalizing the agriculture-aquaculture integration. At the same time, existing initiatives on holistic sectoral planning should be further developed, especially those related to horizontal expansion in the desert as a long-term objective. Moreover, the study advises capitalizing on existing water indexes for aquacultural trade commodities and planning for long-term calculation of the economic cost of water to improve economic water productivity. Furthermore, it advocates for creating a one-stop shop for fish farmers and creating incentives for them to adopt water conservation mechanisms.

Institutional arrangement

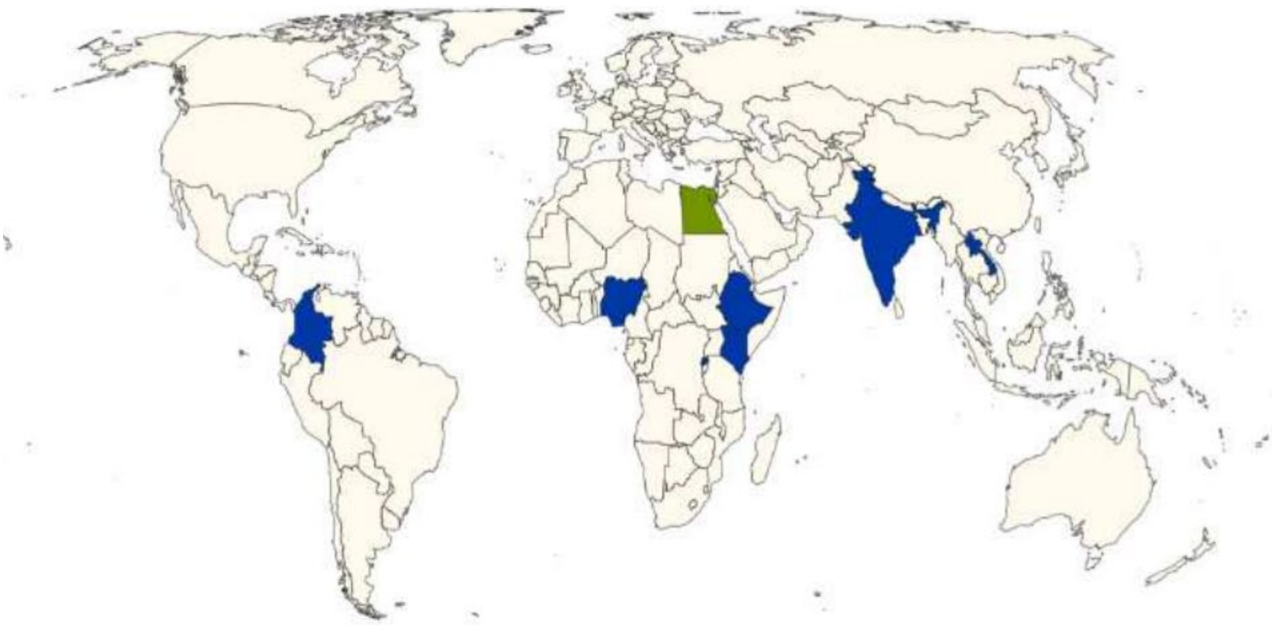
The study suggests enhancing horizontal coherence by replicating The Nexus of Water, Food, and Energy (NWFE) program to other scopes and targets and enhancing financial coherence by aligning donors and development partners with Egypt’s priorities through an interactive database of all past and ongoing programming. It also recommends vertical coherence by enhancing an operational framework for cooperatives and water user associations.

Introduction

Background and Context

National Policies and Strategies (NPS) for Food, Land and Water (FLW) Systems Transformation is an initiative comprising a consortium of CGIAR centers: the International Food Policy Research Institute (IFPRI – lead), the International Water Management Institute (IWMI – co-lead), International Livestock Research Institute (ILRI), Alliance Bioversity International – CIAT and WorldFish. The initiative is active in eight countries across different regions: India and Laos in South and Southeast Asia, Nigeria, Kenya, Ethiopia, and Rwanda in sub-Saharan Africa, Egypt in the Middle East and North Africa (MENA) region, and Colombia in Latin America (Figure 2). The NPS initiative aims to transform the agrifood system by building coherence between national policies on FLW systems, responding to policy demand and crisis, and integrating policy tools from national to field levels.

Figure 2: NPS Targeted 8 Countries



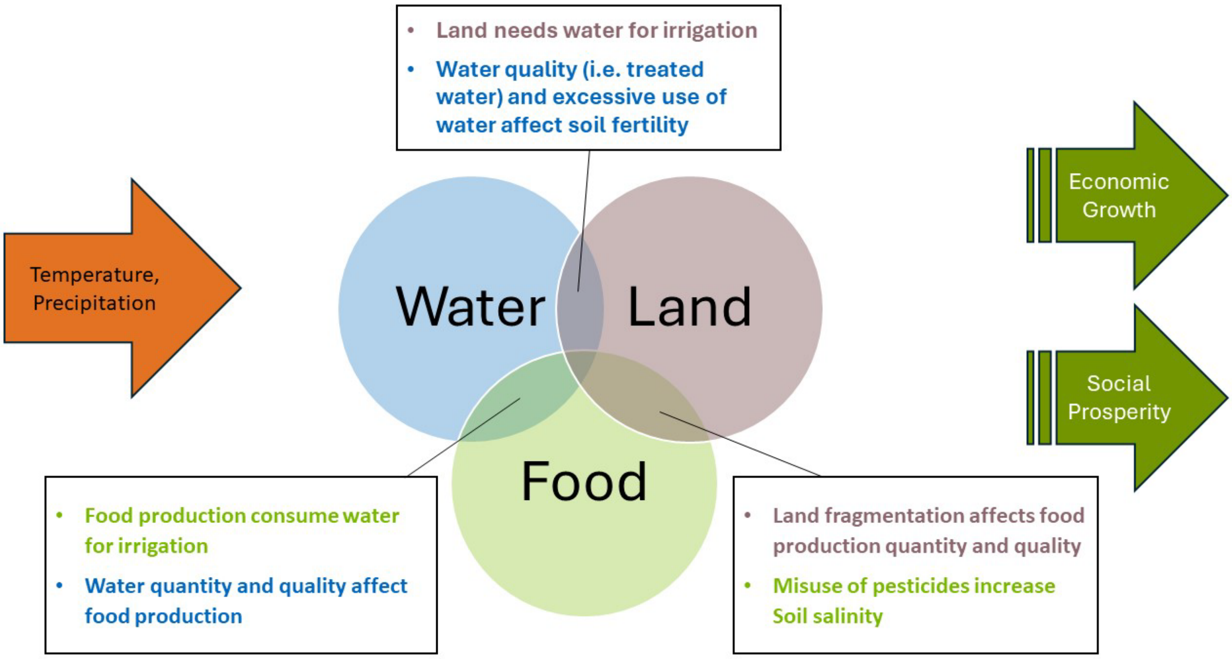
This report analyses building policy coherence in Egypt from two angles — national strategies and laws and institutional arrangement coherence. The objective is to design and implement integrated natural resource governance of land and water under drought and extreme heat to achieve productive, resilient, and responsive agrifood systems. Egypt holds significant importance as an NPS case study. It includes one of the oldest and most complex irrigation systems in the world, in addition to feeling the growing pressure of current economic crises, climate change, and a large population on agrifood systems in the country.

Significance of Policy Coherence between Food, Land, and Water Systems (FLW)

In Egypt, food demand is escalating, with a population now exceeding 100 million, which exerts significant pressure to allocate additional water resources in the agriculture sector to meet growing food demands (CAPMAS 2023d). According to recent figures, agriculture activities, including livestock and fisheries, already account for the largest share of freshwater resources consumption, amounting to 76 percent (CAPMAS 2024d)

The interconnectedness between FLW resources is evident where the use of one resource could generate externalities for others. Inadequate or excessive use of irrigation water contributes to land degradation and diminishes the ability of certain areas to sustain food production (Mahmoud and El-Bably 2019; Mohamed et al. 2019). The misuse of pesticides could increase salt-affected soils, which in turn could affect the quality and quantity of food production in the long-term. The FLW systems are worsened by extremely dry weather, which further consumes the water supply and amplifies the demand for irrigation water in growing summer crops in a context characterized by water scarcity and the decrease in water share per capita (CAPMAS 2022c) (Figure 3). Moreover, Northern Egypt is located in the Mediterranean basin, which is getting warmer 20 percent faster than the global average and contributing to sea-level rise (Jeffries and Campogianni 2021). Seawater thus intrudes into the Northern deltaic groundwaters which consequently affects soils and increases concerns about the long-term sustainability of deltaic lands (Abd-Elaty et al. 2024; El Bedawy 2014).

Figure 3: The Interlinkages between Food, Land, and Water Systems



The ongoing and pressing issue in this field is the fragmentation of institutions and sectoral public policies which hampers the ability to address the interdependencies between FLW systems (Capon et al. 2017; Mohamed 2000; OECD 2016). In this regard, the Organization for Economic Cooperation and Development (OECD) has defined "coherence" as a key policy evaluation criterion to capture the interconnectedness between two or more policy areas to reinforce the synergies (maximizing benefits) and mitigate trade-offs that might impede the development of one sector over the other (KNOMAD et al. 2020; OECD 2016). More specifically, the OECD Water Governance Initiative (WGI) outlined Policy coherence as one of its 12 principles to build an efficient, effective, and more inclusive water governance process (OECD 2015, 2018) (Annex I: Water Governance Principles). Hence, the goal of policy coherence in FLW is to attain simultaneous natural resource security by altering the current institutional arrangement toward effective cross-coordination mechanisms, moving toward integrated policy processes, planning and implementation, through shedding light on political economy determinants, current and expected investments, and pioneering actors (Hoff et al. 2019).

Policy coherence comes in different forms (UNDESA 2023):

- **Vertical** policy coherence between different administrative units at the global, regional, national, city, and community policymaking levels.
- **Horizontal** policy coherence across sectors and between different policy areas.
- **Normative** policy coherence balances each policy across several sustainable development goals, including environmental biodiversity, social inclusion of youth and women, poverty reduction, and employability.

In this study, public policies take the form of national plans, laws, decrees, and programs that define the activities of the government and the allocation of the necessary budgetary and human resources (Nour 2023). They are a set of decisions (choices) made by legislative and executive authorities to solve an existing problem, regulate conflicts, manage resources, or refrain from doing an action (Dye 2017; Hermet et al. 2015).

Objective of the Study

This study examines the building of more coherent strategies and policies in Egypt in the face of growing policy demands and pressures over scarce natural resources as well as overcoming the hurdles of institutional incoherence and siloed policy processes. In addition, Egypt has not yet reported any data on SDG 17.14, which calls on countries to achieve policy coherence in their actions. This study is an attempt to answer the following overarching question:

"How can Egypt's institutions strengthen policy coherence across food, land, and water systems at national and sub-national levels?"

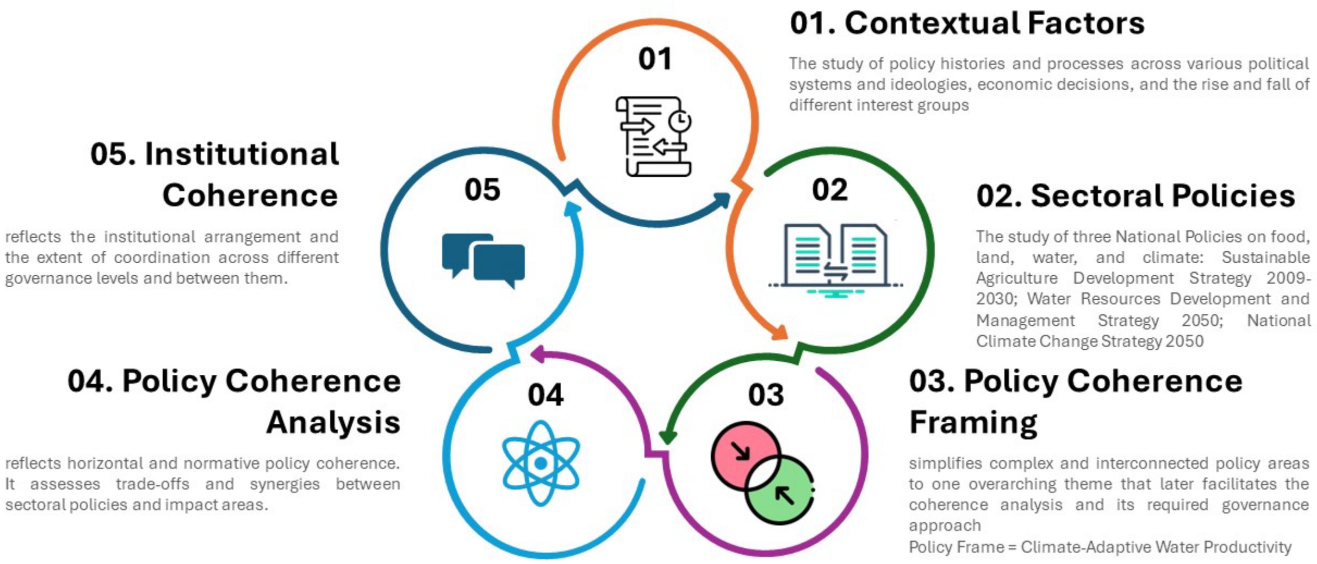
In doing so, it aims to support Egyptian national and sub-national institutions in identifying potential areas of policy coherence and incoherence between agricultural, irrigation, and environmental policies and to provide actionable recommendations among various stakeholders across different policy domains, with the overarching goal of managing Egypt's scarce water resources toward building a more productive, resilient, and responsive agrifood system.

It adopts improving climate adaptive water productivity (CAWP) as a policy frame reflecting the analysis of policy coherence between food, land, water, and climate domains. This will be achieved through a comprehensive review of policies related to the biophysical and economic characteristics of water productivity (WP) and climate adaptation strategies, a series of key informant interviews with relevant stakeholders, an analysis of CAWP social networks, and a final report including significant findings on policy coherence.

Research Methodology Process

The analysis of policy coherence emphasizes the patterns of interaction between policy processes, outlining the actors involved, understanding their roles and positions, their interactions, who makes decisions, who can influence decisions, and who are affected by decisions, and examining their source of funding (Freguin-Gresh 2014; Ostrom 2011). The starting point of this study is the application of the theoretical framework of the Policy and Institutional Landscape Analysis (PILA) (Nicol et al. forthcoming 2024), which provides logical steps to describe the contextual factors in a political economy system that has shaped FLW action arenas, the patterns of interaction, and the extent of change that occurs in policy landscapes as a consequence (Annex II: PILA Framework). The research methodology passes by five phases: 1) contextual factors, 2) sectoral policies, 3) policy coherence framing, 4) policy coherence analysis, and 5) institutional coherence (Figure 4). The analysis will uncover the factors behind policy coherence and policy process transformation and different "windows of opportunities" where it could potentially create synergies and mitigate trade-offs to enable a more productive, resilient, and responsive agrifood system.

Figure 4: Research Methodology Process



Step 1: Contextual Factors

Cover existing and past political and economic systems, the influence of different political ideologies on the flux of the agrifood system in Egypt over the years, and the various interest groups that emerged or disappeared that contributed to the shaping of national and local policies in agriculture, water, and environmental management.

Step 2: Sectoral Policies

Include the study of the three main National Policies on food, land, water, and climate: Sustainable Agriculture Development Strategy 2009–2030, Development and Management of Water Resources Strategy 2050, and National Climate Change Strategy 2050.

Step 3: Policy Frame

Simplifies complex and interconnected policy areas to one overarching theme that later facilitates the coherence analysis and its required governance approach (Candel and Biesbroek 2016). Climate-adaptive water productivity was adopted as a frame for policy coherence that includes three dimensions: biophysical, economic, and social water productivity (Cai et al. 2019; FAO 2022; Molden et al. 2010).

Step 4: Policy Interactions Coherence

Reflects the interlinkages between the three dimensions of climate-adaptive water productivity and three pillars of policy coherence (horizontal, vertical, and normative coherence). It assesses trade-offs and synergies by addressing the interdependencies between different policies and impact areas and identifying measures to mitigate potentially negative effects and optimize synergies. The analysis of policy interactions considers the analysis of other influencing variables such as location and context-specific, timeframe (long- or short-term), governance, and technology (Capon et al. 2017). In addition, it includes the directionality of these interactions, whether unidirectional, bidirectional, asymmetric, circle, or multiple (Capon et al. 2017).

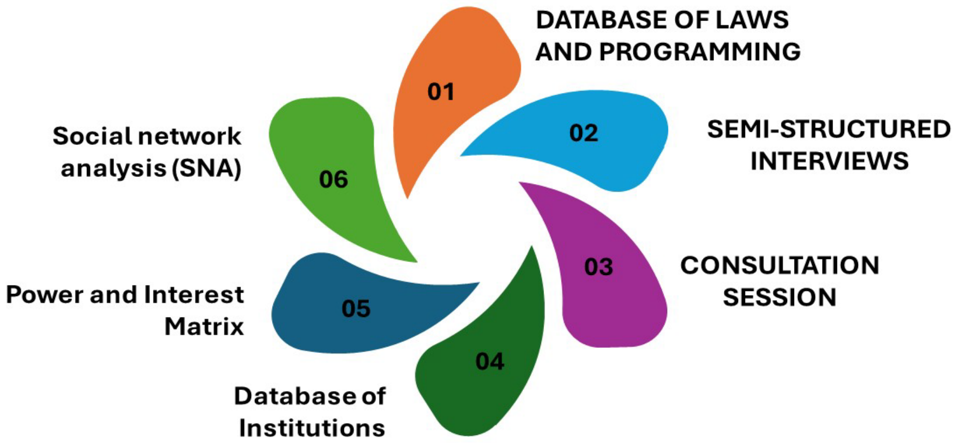
Step 5: Institutional Coherence

Reflects the institutional arrangement of both horizontal and vertical policy coherence. It reflects horizontal coherence through the institutional structure that facilitates regular collaboration among line ministers during various policymaking stages, and mandates that make decisions on trade-offs (UNEP 2022). It also reflects vertical policy coherence through coordination between the global, regional, national, local, and community stakeholders who can affect or are affected by a policy and the alignment of internal and external policies through the involvement of MOIC (UNEP 2022).

Research Tools

The research methodology is structured to qualitatively evaluate the extent to which Egypt has effectively integrated its sectoral policies on FLW systems through two categories: policy interactions and institutional arrangements (Figure 5).

Figure 5: Tools for Measuring Policy Coherence



1. Database of Food, Land, and Water Policies (Laws and Programming)

The analysis relied on the review of 3 national strategies, 17 laws and decrees, and 121 developmental programs on climate-adaptive water productivity from 2016 to 2023.

2. Semi-Structured Interviews

The policy coherence analysis was supported by 20 semi-structured interviews from various organizations representing different categories: ministries, non-profit organizations, research centers, private sector, community-based organizations, and farmers (Table 1). The semi-structured questionnaire was adapted based on the category and scope of activities of each stakeholder.

Table 1: Key Informant Interviews conducted under this study and divided by category

Category	Code	Organization	#
Ministry (decision-maker)	Ministry	Ministry of Water Resources and Irrigation Ministry of Agricultural and Land Reclamation Agricultural directorate Ministry of International Cooperation	5
International and National Non-Profit Organizations	NPO	Care Egypt International Food Policy Research Institute (IFPRI) International Center for Agricultural Research in the Dry Areas (ICARDA) Food and Agriculture Organization (FAO) WorldFish	8
Research Centers	Research	Soil, Water & Environment Research Institute (SWERI) Institute of National Planning	3
Private Sector	Private sector	Mozare3	1
Community Development Associations	CDA	The Integral Development Action of Minia (IDAM) Jesuits' and Brothers' Association	2
Farmers	Farmer	Large farm holders	1
		Total	20

3. Consultation sessions (Cairo Water Week 6th edition)

During the 6th Cairo Water Week, the research team presented preliminary results of building policy coherence across FLW systems. In addition, the session gathered representatives from MWRI, IFPRI, WF, and INP to share their perspectives on improving policy coherence of FLW systems.

4. Database of Food, Land, and Wate Institutions:

The analysis included a database of each institution engaged in improving climate-adaptive water productivity from 2016 to 2023.

5. Power and Interest Matrix

'Power' is defined as the ability to influence, persuade, or coerce others (Hermet et al. 2015; Schiffer and Waale 2008). Many factors affect a stakeholder's relative power from possessing the legal force of coercion, the ability to mobilize economic capital, social capital and networks, infrastructure and technologies, and control of information and expertise, and the extent of their institutionalizations and how strong they maintain vertical relationships with decision-makers (Hermet et al. 2015; Hunjan and Pettit 2011; Schiffer and Waale 2008). 'Interest' is defined as the potential involvement of stakeholders in the inputs or outputs of a policy arena given that the related outcomes address their needs (Brouwer and Brouwers 2017; Retolaza 2022).

6. Social network analysis (SNA)

SNA serves to examine the position and role of each actor within a social network, investigate what socio-economic factors characterize the actors occupying central positions as opposed to those sitting at the margin of the network, and identify the types of opportunities and constraints an actor acquires by the relationships they forge in the network analyzing their extent of power and agency (Borgatti et al. 2009; FAO 2018). The main measures of this centrality are the 'degree of centrality', which counts the number of connections that one actor holds with their counterparts (the level of their social capital), and the 'betweenness centrality', which counts the extent of existence of an institution as a medium between two players and thus, their potential power to influence, impede, distort, accelerate flows of resources passed along in the network in such a way to serve the actors' interests (FAO 2018; Golbeck 2013).

Research Data Limitations

Researchers faced several limitations, including limited published data on relevant ministries' websites, the absence of a database that highlights various developmental programming interventions on food, land, water, and climate, the key stakeholders engaged, the amount of funds, and the evaluation of such interventions. To the same end, data are missing on the outline of the corporate and national non-governmental organizations supporting climate-adaptive water productivity at the governorate or local level.

Report Structure

This report is structured in Six Chapters. Chapter I emphasizes the history of FLW policy in Egypt, the influence of different political ideologies and political systems in shaping the agrifood policies, and the rise and fall of specific socio-economic interest groups. Chapter II highlights the goals and outcomes of the three national strategies, examining their interlinkages that led to framing policy coherence of food, land, water, and climate into improving climate-adaptive water productivity. Chapter III presents the research tools used to analyze the policy interactions, synergies, and trade-offs and the institutional mapping to analyze the power dynamics and the social network of influence in decision-making. Chapter IV presents the policy linkages, synergies, and trade-offs between national strategy objectives across several sectoral policy linkages related to improving climate-adaptive water productivity. Chapter V outlines the institutional arrangement including horizontal and vertical cross-coordination mechanisms and financial coherence between donor-led and national priorities. Chapter VI presents the recommendations to strengthen horizontal and vertical policy coherence to improve climate-adaptive water productivity.

1. Contextual Factors of FLW Policy Coherence

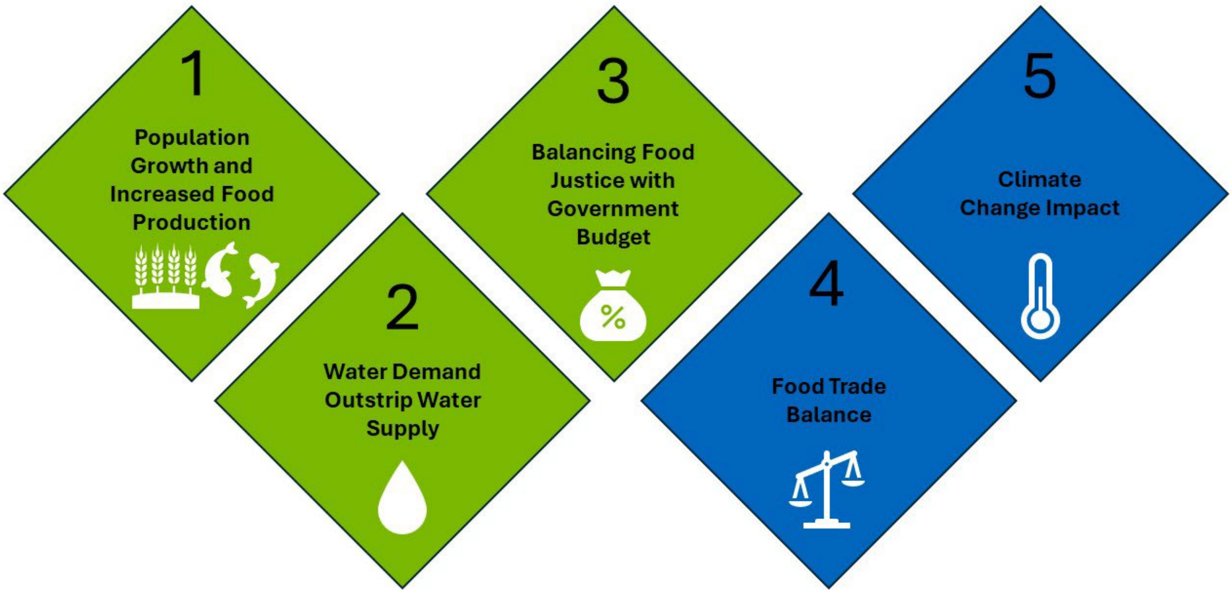
Introduction

Policy coherence of FLW systems is a holistic governance approach to maximize the benefits of natural resource management and minimize negative spillovers from one policy to another while considering their overall effects on the environment, society, and the economy.

This chapter explores the first pathway to analyze policy coherence. It focuses on the historical development of public policymaking of FLW systems in Egypt, and linkages with the political and economic system in place, power resources and structures, and wider political-economic interest groups that emerge or disappear, thereby influencing policy arenas.

By outlining the historical pathways, this chapter identifies five main rationales behind FLW policymaking and their interplay with a state socialist-interventionist and market liberalization policy. Three policy rationales existed across the history of policy development: 1) population growth and increased food production; 2) water demand outstripping water supply; and 3) balancing food and social justice with the government budget. Two other policy rationales emerged which affect current public policymaking in FLW: 1) food trade balance, and 2) the effects of climate change on natural resource governance (Figure 6).

Figure 6: Three rationales of FLW historical policymaking



1.1. Population Growth and Increased Food Production

Policymakers have long been focusing on ensuring the availability of food supply in the market in light of increasing population growth. Therefore, public demand increased over vertical agricultural expansion in old areas (increasing crop yield per *feddan*), horizontal expansion into desert areas, and supporting fish farm productivity.

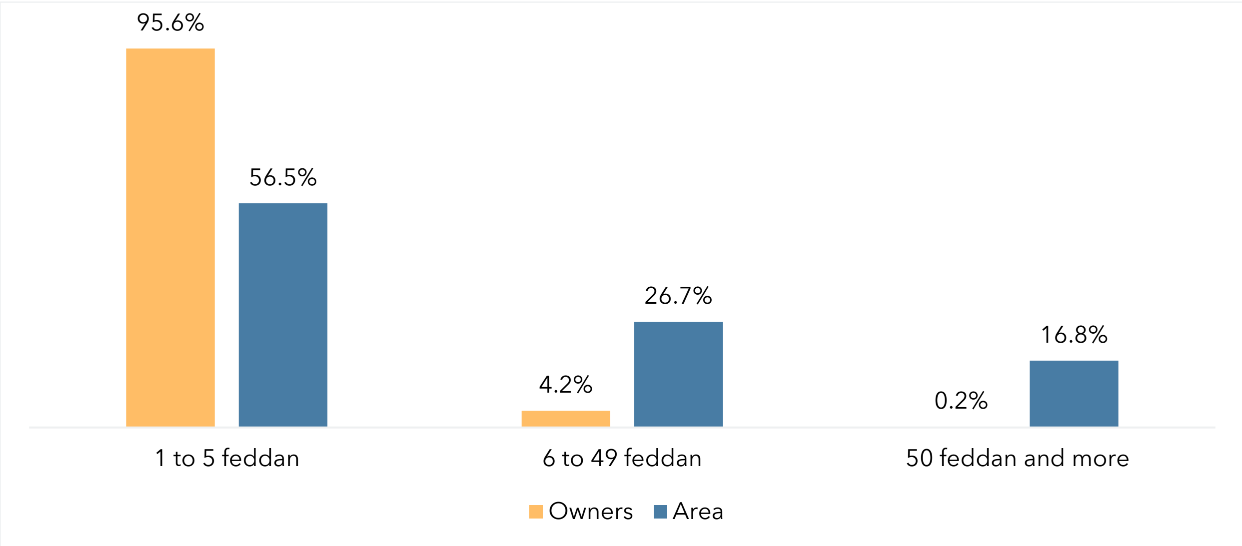
1.1.1. Vertical Agricultural Expansion: Land Reform Laws in the Old Lands

Decree number 178 of 1952 and its consecutive amendments in 1961 and 1969 introduced a socialist land reform law that restricted land ownership to a maximum of 50 *feddan* (51.89 acres) per individual and 100 *feddan* (103.78 acres) per nuclear family (Bush 2007; Ibrahim and Ibrahim 2003).

The implementation of this law resulted in the confiscation of approximately 817,500 *feddans*, equivalent to 12 percent of the arable land, which were then sold at a reduced price to around 342,000 landless farmers (Bush 2007). The underlying motives behind this law were to break the political and economic influence of the wealthiest landowners, secure tenure and agricultural resources for poor farmers, and bridge the unemployment and economic inequality gap (Ibrahim and Ibrahim 2003).

On average, each landless farmer received two to five *feddan* of land. Hence, the owned size of arable land of less than five *feddan* increased from 35.4 percent before the law to 56.5 percent in 2009/2010 and increased small-scale farmers to 95.6 percent (Figure 7) (CAPMAS 2023c; Ibrahim and Ibrahim 2003). This land fragmentation posed a barrier to improving soil management, adopting modern irrigation techniques, achieving higher yield productivity, and implementing a unified marketing strategy. Moreover, small-scale farmers were characterized not only by the land size but also by low income, inefficient use of land and water by the use of traditional patterns of production technologies, weak marketing systems, and the reluctance of new generations from farming activities (Aboulnaga et al. 2017).

Figure 7: Distribution of Land Ownership in Egypt 2009/2010



**The Figure does not include landless farmers, which accounted for 964,863 in 2009/2010*
Source: Authors, based on CAPMAS Statistical Yearbook 2023

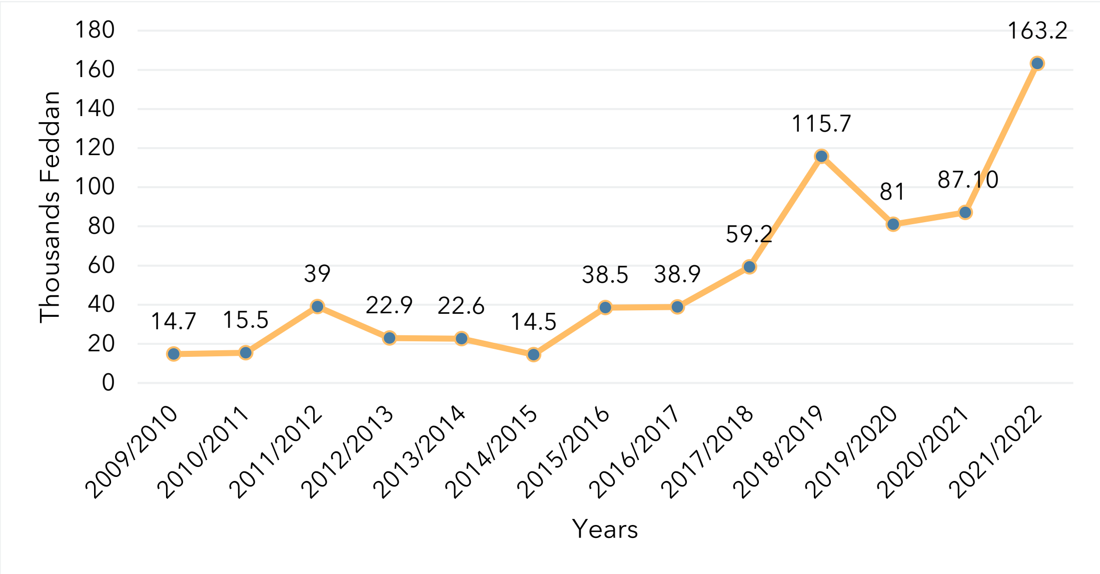
To address these agricultural production and social trade-offs, policymakers introduced a new agrarian liberalized reform law number 96 of 1992. This law, which entered into force in 1997, reversed the previous law and led to the liberalization of land prices between landowners and tenants. This reform represents a significant shift from the tenancy guarantees granted to smallholders under the 1952 socialist agrarian reform (Bush 2007; Ghoneim 2014).

Many international organizations recognized the synergies between market-base land price or rent laws and the efficient use of agricultural lands, reduction of land fragmentation, and better vertical expansion (Bush 2007; Ghoneim 2014). However, this reform has negatively affected the social needs of landless and smallholder farmers. Many landless farmers were evicted from their lands because they were unable to afford the annual rent which jumped to 400 percent compared with pre-1992 prices (Bush 2007). In addition, the constant change of tenants on rented agricultural land had adverse effects on the consistency of farming practices, affecting soil quality and agricultural productivity (Ghoneim 2014).

1.1.2. Horizontal Agricultural Expansion into the Desert Areas

The state increased its investments in land reclamation and farm irrigation projects during the 1970s and 1980s and amplified this further in 2017/2018 (Figure 8) (CAPMAS 2023c, 2024a; Nour 2019). These projects were driven by three main objectives: attracting domestic and foreign investments, increasing the value of agricultural and food exports to offset import costs, and meeting domestic food demands (Ghoneim 2014; Mohamed 2000).

Figure 8: Reclaimed Lands have increased to 163.2 thousand feddan in 2022



Source: Authors, based on CAPMAS Egypt in Figures 2024 and CAPMAS Annual Bulletin of Lands Reclamation, 2022

The agricultural horizontal expansion projects in the deserts required access to large areas of land, various water resources, and advanced production technologies to cultivate high-value crops aimed at exports using less water (Tellioglu and Konandreas 2017). However, these opportunities of land, water, and foreign trade markets were only attainable and affordable to influential Egyptian and foreign investors, who had high financial capacity for applying the latest knowledge, innovations, and intensive technologies (Nour 2019). These large landowners constituted only 0.2 percent of the total, while in parallel, small-scale producers were marginalized from these technological and export opportunities (Bush 2007; CAPMAS 2023c).

1.1.3. Fish Farm Productivity

Egypt is the first producer of farmed fish within the Nile basin countries using drainage water flow. Farmed fish increased its share of the total fisheries production in Egypt, from 16 percent to 56 percent to 78 percent of total fisheries between 1997, 2007 and 2021 (CAPMAS 2024a; Molden et al. 2009). The agricultural strategy has long endorsed fish farming activities, now governed by the LFRPDA. However, the fish farming scope goes beyond the usage of land; it also requires managing water resources and adhering to environmental and health standards. This complexity has long posed a barrier to farm ownership and operation licenses, which involved navigating various governmental regulations. As a result, approximately 60 percent of fish farms operate illegally, which hampers the monitoring of water and fish production quality standards and restricts farmer's access to benefits such as participation in aquaculture cooperatives, access to subsidized inputs, and obtaining credit from banks (Goulding and Kamel 2013; Samy-Kamal 2020).

1.2. Water demands outstripping water supply

During the 1950s and 1960s, water availability from the Nile was largely not a policy issue because there was a surplus of 20 billion cubic meters per year (Nikiel and Eltahir 2021). However, water scarcity started to arise when the quantity of the Nile water supply remained constant while population growth and water demands rapidly increased, leading to a deficit of about 40 billion cubic meters per year by the late 2010s (Hosni et al. 2014; Nikiel and Eltahir 2021). To address the imbalances between water supply and demand, Egypt has implemented five strategies — building and improving the operations and management of water infrastructure, expansion of water reuse, improving crop yield per drop of water, directing drainage water to fish farms, and increasing the import of high-water consuming crops (especially wheat and maize).

1.2.1. Publicly Managed Irrigation Infrastructure

The market economy approach to agriculture did not alter water policies, because the government perceived it as falling under its mandate to upgrade irrigation canals and irrigation systems, minimize water loss, improve navigation paths, control weeds, use groundwater efficiently, and water recover (Cassing et al. 2009).

1.2.2. Expansion of Water Reuse

The state aims to strengthen partnerships with the private sector in some of the value chains to boost the efficiency and sustainability of the performance of infrastructural projects according to the State Policy Ownership issued in 2022 (The Cabinet of Egypt 2022). The State shall approve Design-Build-Operate (D.B.O.) Contracts and performance improvement, related to activities on sewage water treatment plants and reuse, as well as the management, operation, and maintenance of networks.

1.2.3. Water Demand Management for Horizontal Expansion

Agricultural water demand increases to reclaim new lands in the desert to increase agricultural production, expand export capacities, and create employment opportunities in tourism, industries, and services (A. Mohamed 2000). However, land reclamation has been intertwined with major Gulf investments, which fulfil their food needs, thereby raising concerns about the efficient use of available and scarce water for the benefit of other countries (Nour 2019). Thus, many scholars have questioned the fair allocation of water being denied from smallholders for the interests of expansion projects and foreign investments (Bush 2007; Nour 2019).

To regulate water demands in these areas, land reclamation project observers have questioned whether regulations on groundwater discharge, potential groundwater contamination in the short- or long-term, the use of drip irrigation in sandy lands, and the overall water availability in Egypt are sufficient to sustain the proposed expansion of the New Lands (A. Mohamed 2000).

1.2.4. Water Management for Fish Farming

Since the 1980s, irrigation laws have prohibited the use of fresh water in aquaculture, allowing only drainage water or brackish groundwater. The reason behind these regulations is the perception that fish farms consume a significant amount of water and could potentially discharge harmful effluents into the irrigation canals (Goulding and Kamel 2013) (NPO H, pers. comm., 3 October, 2023). However, the use of drainage water also poses potential risks to the quality of fish products, because it contains agricultural effluent and other discharges that could compromise food quality standards. This arrests opportunities to export in the EU markets (Goulding and Kamel 2013) (NPO H, pers. comm., 3 October, 2023).

1.3. Balancing food and social justice with the government budget

In the 1950s, policymakers aimed to reinvigorate agricultural productivity, engage landless and small-scale farmers, and make food accessible and affordable for Egyptian citizens. A socialist interventionist policy was adopted where the government centralized its bureaucracy planning by nationalizing all foreign companies and intervening in all means of production, including access to credits, and agricultural inputs (seeds, chemical fertilizers, pesticides) which were provided at heavily subsidized rates to support smallholders in their agricultural production. Moreover, the government strictly regulated market pricing and imposed the compulsory selling of crops to the government at administered yet cheap prices (Cassing et al. 2009).

However, this policy has had unintended consequences. It has resulted in the inflation of the public sector, which accounted for 75 percent of the Gross Domestic Product (GDP), and increased the budgetary deficit, particularly with the absence of inflows of foreign investment and the cost of the 1967–1973 war (Cassing et al. 2009). Moreover, given the low procurement prices set by the government, farmers were confronted with diminished financial returns, leading to a decline in land productivity and labor migrating to non-agricultural job opportunities.

However, in the 1970s, a new government reversed the precedent policy by adopting a program on economic reform and structural adjustment by the International Financial Institutions to control public sector deficit and curtail agriculture public expenditures, which included the liberalization of agricultural inputs, the end of the state-dictated agrarian rotational cycle, the end of the compulsory supply of agricultural production to the government, and the liberalization of farm gate pricing, except for strategic crops such as wheat (Bush 2007; Cassing et al. 2009; Ghoneim 2014; Goulding and Kamel, 2013).

1.3.1. Control of Agricultural Inputs by the Private Sector

The private sector companies have largely dominated agricultural and aquaculture production inputs which constrained the financial accessibility of small-scale farmers to high-productive seeds, feeds, essential quality inputs, and credit, which put small-scale productivity at risk of vulnerability (Cassing et al. 2009; Nour 2019; Samy-Kamal 2020).

1.3.2. Food Subsidy System

Presently, the wheat subsidy system remains in place as a major cornerstone of food security in Egypt, because it accounts for around one-third of the total calorie intake per capita in the country (Badawy et al. 2022). Although the mandatory supply of crops to the government has been abolished, the procurement policy revolves around the direct purchase of specific food security crops from farmers. The government continues to procure 30 percent of domestic wheat production and the price it sets serves as a benchmark for other buyers to guarantee the availability and affordability of wheat in the market (Ghoneim 2014).

Many economists argue that high subsidies lead to the low economic value of cereals, compared to the amount of water used, which constrains the state's budget and the use of land and water. However, sociologists would argue that it contributes to equal and just access to food for everyone, and it preserves the social contract between the state and its citizens adding to its legitimacy (Cassing et al. 2009; Ghoneim 2014). Hence, what might seem incoherent from an optimal resource management and economic efficiency perspective, can be coherent from a political expediency and social cohesion perspective.

1.3.3. Water Policy

The government supplies water to farmers free of charge or with a very low tariff compared with its real cost because it perceives water as a public good for everyone (El Qausy et al. 2011; Ghoneim 2014; Samy-Kamal 2020). Hence, the agricultural irrigation infrastructure is largely planned and controlled by the state and cannot be an area of privatization (El Qausy et al. 2011; Ghoneim 2014; Samy-Kamal 2020)

Therefore, the government bears the larger part of the cost associated with water conveyance, distribution, and O&M expenses. This has positive implications on the prices of final agricultural products which increases its competitiveness in the market. On the other hand, free-of-charge water may lead to the overuse or the allocation of water to less economically efficient products compared with the water's real value, which consequently affects budget revenues.

These economic liberalization reforms created an institutional void regarding the role and responsibilities of the public and private sectors, including cooperatives (Goulding and Kamel 2013; Tellioglu and Konandreas 2017). In addition, it led to the monopoly of oligarchic elites and crony capitalists over specific economic activities (Bush 2007; Nour 2019; World Bank 2021).

Years later in 2022, the government launched the state ownership policy to determine the sectors and range of economic activities that it will exit, maintain/reduce its investments, or maintain/increase its investments. The government will exit the sectors of aquaculture, horticulture, and field crops, and reduce its involvement in food industries and processing.

1.4. Food Trade Balance

The economic structural program created trade-offs where open markets allowed the gradual substitution of locally produced agricultural food by imports. Ultimately, this resulted in the expansion of agriculture and food imports over exports reaching a negative food trade balance, where export earnings do not cover the vast majority of the cost of import (Cassing et al. 2009; Nour 2019). Yet, food imports remain essential, particularly for cereals and high water-consuming crops, given Egypt's limitations in arable land and water resources. Water demand is expected to increase significantly to support future population and economic growth. Virtual water trade has become a crucial policy to manage water scarcity. In this regard, Egypt has relied on external water resources by importing the equivalent of at least 40 billion cubic meters of virtual water recently (Nikiel and Eltahir 2021).

1.5. Climate Change Impact

In a context characterized by arid and semi-arid weather, climate change has become a dominant discourse in policymaking on the sustainability of food production, and water resources. In 2022, the Government of Egypt submitted its updated version of the Intended Nationally Determined Contribution (INDC) and launched the Climate Change Strategy. These policies aim to better integrate mitigation and adaption to climate change across sectoral policies including agriculture, water resources, and irrigation.

Chapter conclusions

This chapter discussed the five main rationales behind public policymaking of FLW systems. It connected the analysis to the existing political-economic systems, and the type of positive or negative intended or unintended consequences it created. Each policy intervention aimed to produce sufficient and affordable quantities of food, regulate water demands to be consistent with the strained fresh water supply, create more socially inclusive protected citizens against food price shocks and fluctuating macroeconomic indicators, increase agricultural and food exports to cover the value of its imports, and take into consideration the effects of climate change. Each policy intervention created opportunities but also constraints that still persist, impacting the food system landscape in Egypt. These include poor coordination among different stakeholders including governmental agencies, poor integrity and transparency, quality of bureaucracy and institutional effectiveness, weak compliance with global food quality standards, inefficient pricing system, modest logistics, and heavily distorted markets because of the subsidy system.

2. Methodology: Policy Frame of FLW across Sectoral Policies

Introduction

The policy frame is the second methodological step in analyzing policy coherence, recognizing the interlinked nature of different policy sectors and merging them into a unified framework. This frame simplifies the analysis of the synergies and trade-offs between policy interventions toward a unified goal. In addition, it emphasizes the requirement of a particular adjustment of institutional contextual conditions, including jurisdictions, to improve this framework (Candel and Biesbroek 2016).

This chapter explores the present state of demographics, food, land, water, climate, and the economy. It further describes how these current contextual challenges are outlined in the three main national strategies: Sustainable Agriculture Development Strategy 2009–2030; Water Resources Development and Management Strategy 2050; and National Climate Change Strategy 2050. The analysis of the strategic outcomes of the three National Policies on food, land, water, and climate has identified a policy frame of "Increasing Climate-Adaptive Water Productivity".

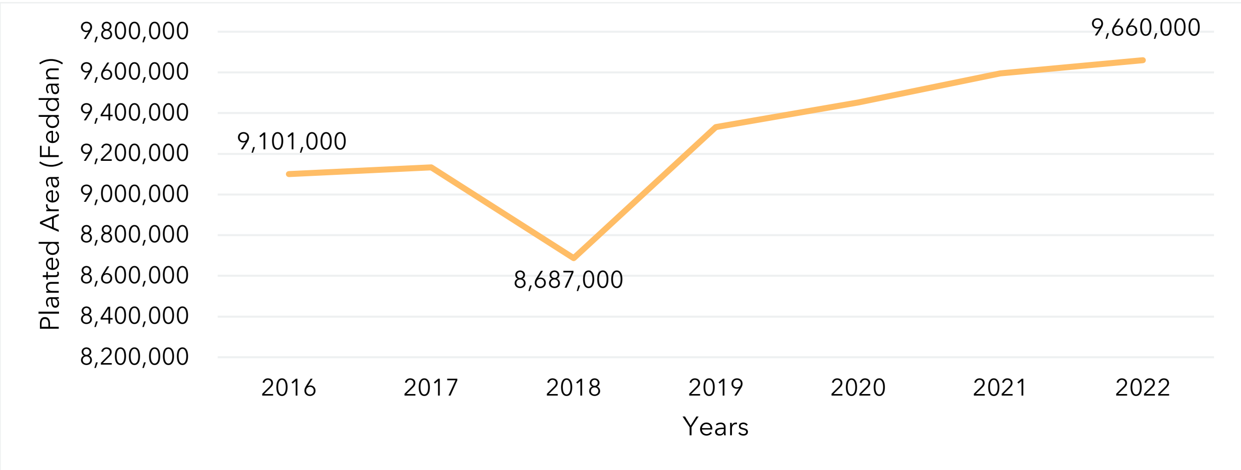
Current Trends in Each Policy Rationale

2.1.1. Population Growth and Increased Food Production

Egypt is the most densely populated country in the MENA region. According to CAPMAS in June 2024, Egypt is home to 106.4 million people; the growth rate has continued to increase from 1.75 in 1947 to 2.34 in the 1960s, till it reached 2.56 in 2017 according to the last census (CAPMAS 2023d).

Over the years, the planted areas have increased from 5.8 million *feddan* in 1974 to 9.6 million *feddan* (9.9 acres) in 2022, by restoring old lands and reclaiming new areas in the deserts (Figure 9) (CAPMAS 2024a).

Figure 9: By 2021, Planted Areas Reached 9.6 million feddan in Egypt



Source: Authors, based on CAPMAS Egypt in Figures 2024

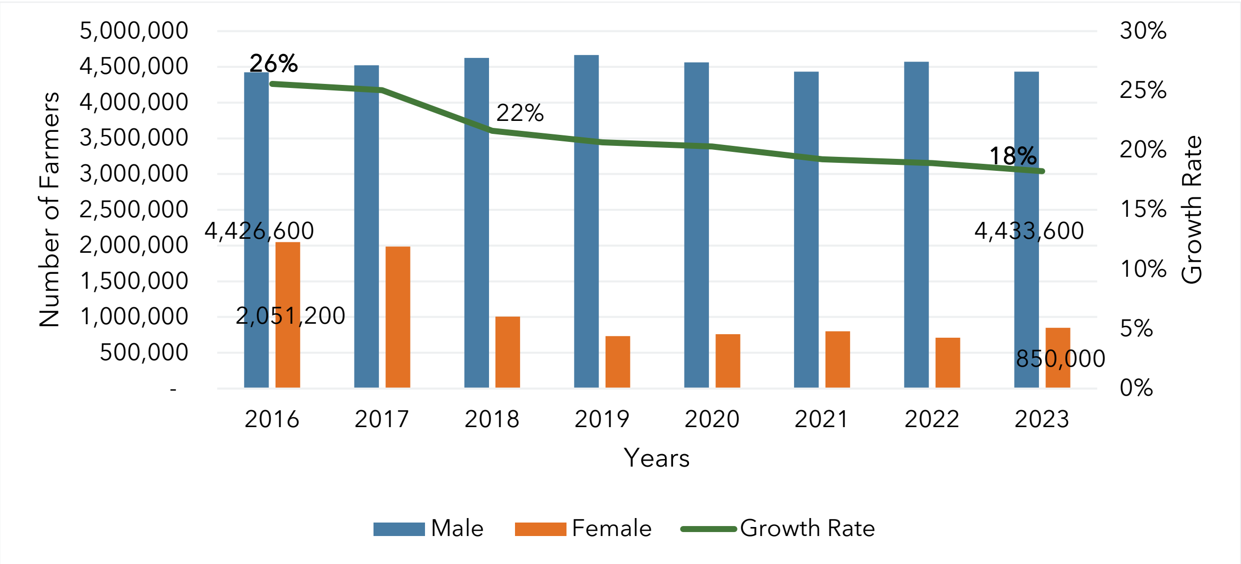
The table below shows the level of domestic production, where Egypt produces almost half of the consumption needs in wheat and maize (51.4 and 48.5 percent respectively) and produces 63.8 percent of consumption needs for fresh meat (Table 2) (CAPMAS 2023a, 2024a). The Aquaculture sector is significant in providing food security, where it accounts for 78.7 percent of total fisheries production in 2021, producing 1,570,664 tonnes per year, which meets 89.9 percent of domestic demands for the same year (CAPMAS 2024a).

Table 2: Domestic Crop Production from 2017 to 2021

Crops	2017	2018	2019	2020	2021	2022
wheat	34.5	35.5	40.3	41.4	48.2	51.4
Maize	47	50.5	51.1	44.8	46	48.5
Rice	94.2	90.7	76.2	98.1	98.6	97.4
Fresh Vegetables	103	102.7	105.5	103.5	106.9	108.7
Fresh Fruits	99.3	100.7	99	100.6	98.8	103.8
Fresh Meat	55.9	48.8	55	46.5	56.6	63.8
Fresh Fish	85.6	79.5	79.6	75.6	89.9	90.1

Despite this horizontal expansion of the cultivated areas, proportionate job opportunities have not been created. Notably, employment in agriculture has fallen from 26 to 18 percent of total employment. According to the recent data provided by CAPMAS Egypt in Figures 2024, the agricultural sector in Egypt currently consists of 5.2 million farmers (as of 2023). While the number of men practicing farming has remained relatively stable, the number of women farmers has sharply dropped from approximately two million in 2017 to 850,000 in 2023 (Figure 10) (CAPMAS 2018, 2019, 2020, 2021, 2022b, 2023b, 2024c).

Figure 10: Number of Employed Males and Females in Agriculture and Percentage of Employment in Agriculture from Total Employment - Egypt

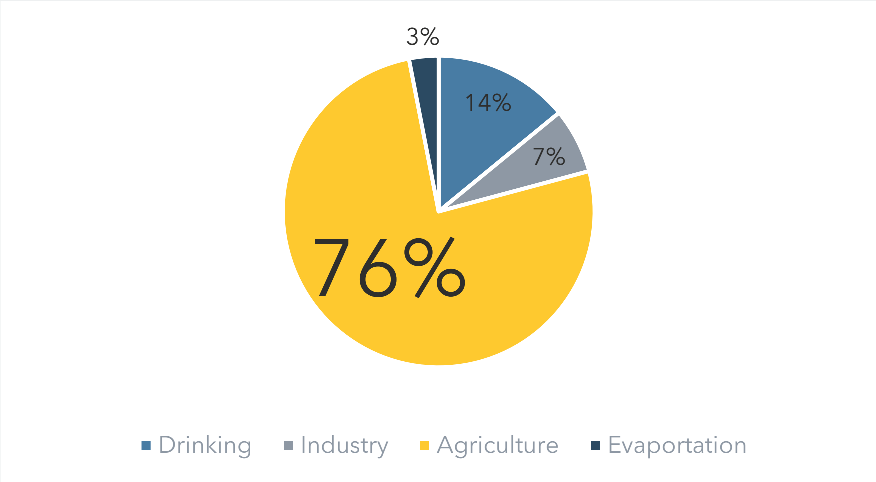


Source: Authors, based on CAPMAS Egypt in Figures 2018 to 2024

2.1.2. Water demands outstripping water supply

The Nile River is the main source of water in Egypt, and its share has remained consistent under the Nile Water Agreement with Sudan since 1959 to be 55.5 billion cubic meters (CAPMAS 2024d). While the water supply has remained constant, the Egyptian population has quadrupled since 1959. This has resulted in the decline of water share per capita, which reached 585 m^3 in 2018, falling short of the 1,000 m^3 threshold required to overcome water poverty (CAPMAS 2022c).

Figure 11: Percentage Share of Agriculture of total Water Resources



The total water resources are estimated at 81.63 billion cubic meters (CAPMAS 2024d). The agriculture sector remains the largest consumer of water in Egypt because its share reached 62.13 billion cubic meters of water in 2021/2022, equal to 76 percent of total water resources supporting agricultural activities (Figure 11) (CAPMAS 2024d). Overall, the share of agriculture has declined over the last 10 years but remained steady over the past three years. To address food demands, the government relied on other traditional and non-traditional sources, besides the Nile River, from shallow and deep groundwater, reuse of drainage water, desalination, floods, and rain. According to Figure 12, the release of Nile water to agriculture has decreased from 50 to 45 billion cubic meters. This is partially due to the establishment of smart irrigation techniques and the increased use of other water resources such as wells and drains from 18.3 to 21.2 thousand cubic meters in 2021 from wells, and 6.1 to 7.2 billion cubic meters in 2021 from agricultural drains (Figures 13 and 14). In addition, it minimizes the use of water by relying on virtual water trade by importing high-water consuming commodities that use around 20 billion cubic meters to grow locally (El Qausy et al. 2011).

Figure 12: Amount of Irrigation water used from the Nile, wells, and agricultural drains

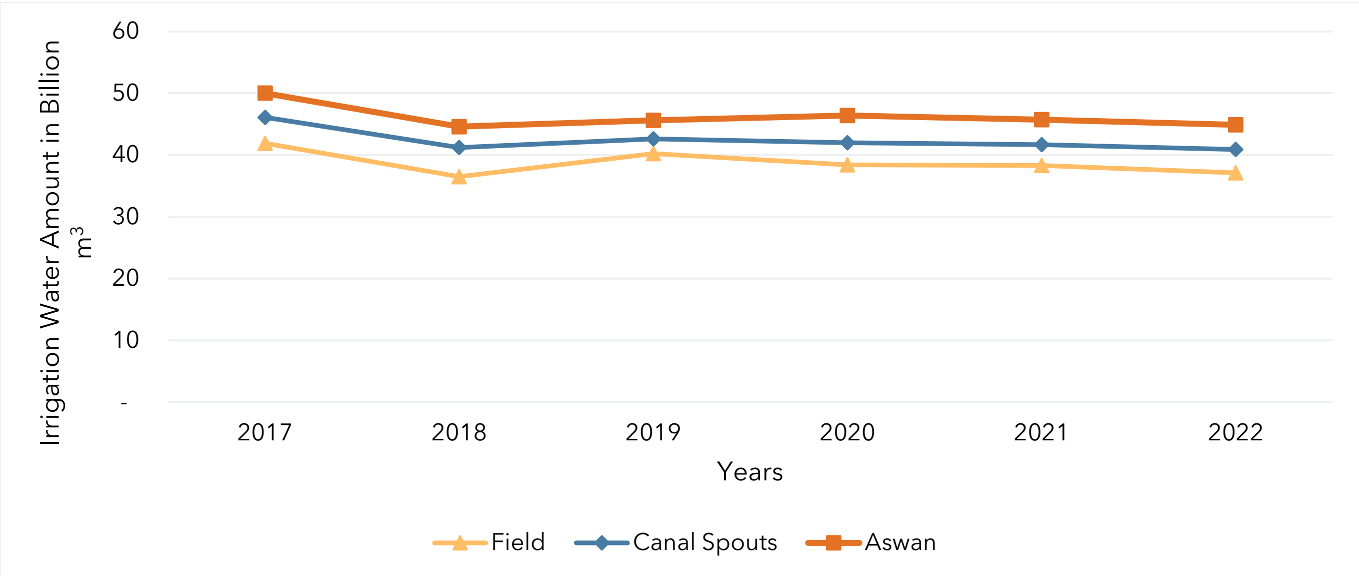


Figure 13: Amount of water used from wells over the years

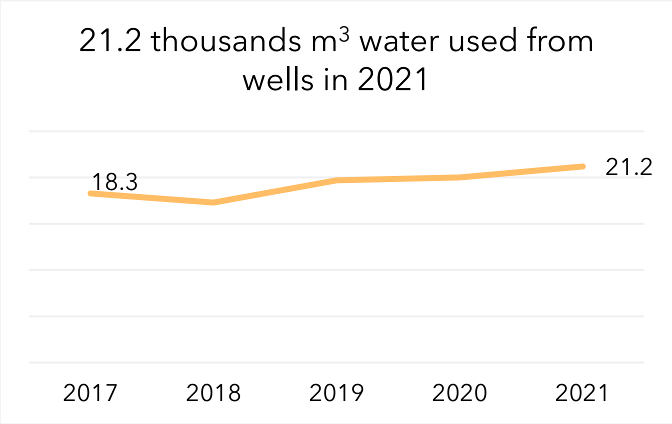
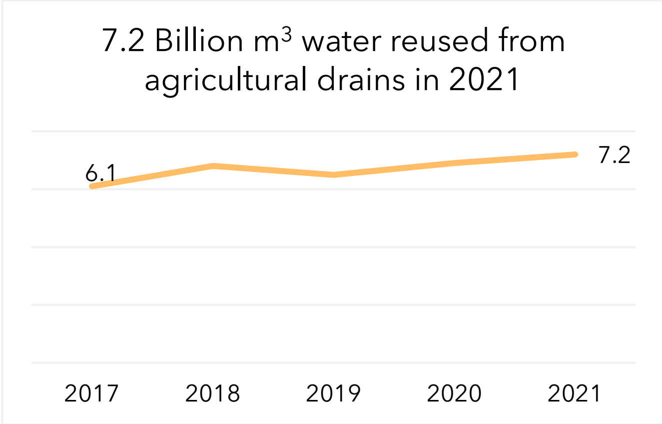


Figure 14: Amount of water used from drains over the years



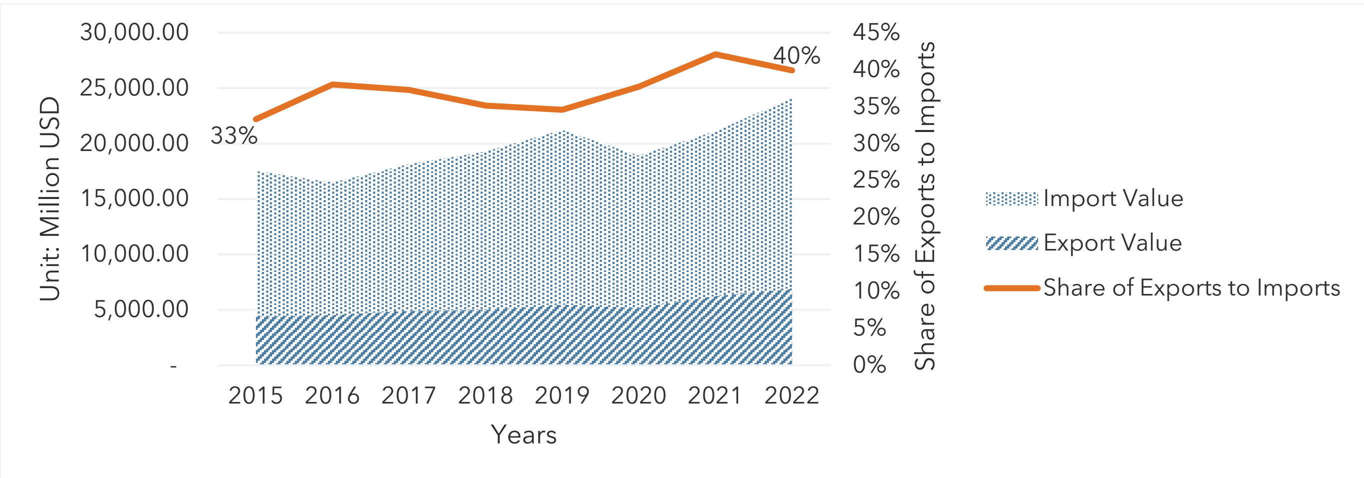
2.1.3. Balancing food and social justice with the government budget

The IMF has imposed strict austerity measures through its structural adjustment program through 2016, 2022, and 2024 (Al-Anani 2022). These programs had four main axes: 1) currency devaluation; 2) curtail public expenditure including reform food subsidy programs, 3) increase in-flows of domestic taxes and budget revenue; and 4) encourage private sector growth.

Since 2016, the government has increasingly relied on high levels of public-sector borrowing to finance its developmental projects. This substantial borrowing has led to a rise in external debt with Egypt's debt-service ratio reaching 47.4 percent in the proposed FY 2024/2025 budget, making a notable increase from 37.4 percent and 35.4 percent in 2023/2024 and 2022/2023 respectively (Saleh 2024). The increase in the debt-service ratio would severely constrain public spending capacities on various policy sectors in the upcoming years, including water, land, and food social protection programs. Moreover, the total percentage of Egyptians living in poverty was almost one-third of the total population (29.7 percent) in 2020 (CAPMAS 2024b; World Bank 2021). Poverty is most dominant in rural areas with 42.8 percent in rural Upper Egypt and 23.1 percent in rural Lower Egypt, especially with the decrease in employment growth in the agricultural sector (CAPMAS 2024b).

Figure 15 shows a dynamic increase in the value of agricultural and food exports over the years, which accounted for 40 percent of the value of agricultural and food imports in 2022, compared with 38 percent in 2016, and 28 percent in 2010 (FAOSTAT n.d.). However, the export of aquaculture products represented only 1.5 percent of domestic production, indicating that the export market has hardly been exploited (Goulding and Kamel 2013).

Figure 15: Agricultural Products Export Value covers around 40% of Agricultural Products Import Value



Several constraints face the export and competitiveness of the markets, including weak institutions and coordination, delays in complying with globally accepted quality and safety standards (especially in the EU market), harvesting methods, inadequate infrastructure for storage and transportation, strained land and water resources and damages induced by climate change (Bush 2007; Tellioglu and Konandreas 2017).

2.1.4. Climate Change Impact

Egypt is located in an arid region which exposes it to frequent heatwaves, droughts, and the impact of the Mediterranean sea level rise (SLR) along the coast of the Nile Delta. Heatwaves increase water requirements for summer crops, and thus irrigation demands (World Bank 2021). In addition, heatwaves will shrink water resource availability and increase water loss (World Bank 2021). Furthermore, they increase the impact of SLR, which leads to a gradual intrusion of salt into the Delta groundwater, causing water and land salinization and decreased agricultural production in some areas of the Delta (Abd-Elaty et al. 2024; World Bank 2021). A study expected that 12 to 15 percent of arable land could be lost because of SLR (Haggag et al. 2013). With an anticipated increase in water loss, agricultural production and laborers whose livelihoods depend on nature-based sources would be at a disadvantage (World Bank 2021).

Identify a Policy Frame

2.1.5. Current Sectoral National Strategies of Food, Land, and Water Systems

The aforementioned challenges are reflected in different governmental policies. This study defines policies as strategies, national plans, laws, decrees, regulations, and programs aimed at regulating and managing natural resources. The study of food, land, water, and climate coherence would take three main national strategies as its main pillar of analysis (Table 3). These national strategies encompass long-term strategic goals and plans at the national level aligning with the Sustainable Development Strategy 2030. It includes a multidimensional perspective related to FLW, and encompasses institutional plurality in design and implementation and cross-sectorial potential impact.

Table 3: Three main national strategies of FLW

Strategy Name	Primary Ministry
Sustainable Agriculture Development Strategy 2009–2030	Ministry of Agriculture and Land Reclamation
Water Resources Development and Management Strategy 2050	Ministry of Water Resources and Development
National Climate Change Strategy 2050	Ministry of Environment

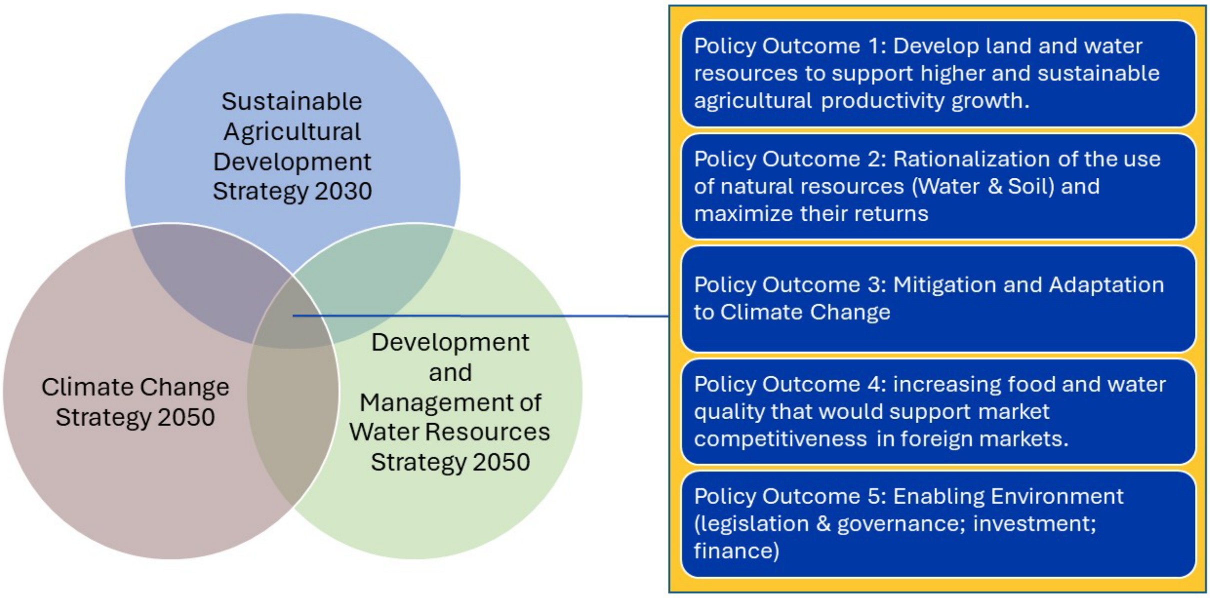
By analyzing the key strategic objectives of each strategy, the study highlighted five sectoral common goals (Figure 16):

- The first sectoral common outcome encompasses the rationalization of natural resources by sustainably managing water and land, balancing water demands, and maximizing its return through the expansion of resilient irrigation canals and drainage infrastructure systems and reducing water loss by applying water-saving techniques.
- The second sectoral outcome includes developing new land and water resources. It includes horizontal expansion in the deserts and the expansion of wastewater and agricultural drainage reuse to support the growth of agricultural productivity – not only in quantities but also in its higher economic value, generating income and employment.
- The third sectoral outcome includes mitigation and adaptation to climate change by setting up a crop management system resistant to drought, salinization, and heatwaves, reducing water loss by evapotranspiration, and enhancing climate change action governance.

- The fourth sectoral outcome includes food trade competitiveness by managing the food trade balance between imports and exports through improving globally accepted quality and safety standards of water and food and increasing the economic value of water.
- The fifth sectoral outcome comprises an enabling environment based on legislation and governance including decentralization, flows of investments, and green finance, including private sector participation.

By analyzing the interlinkages between these common goals, the study argues that they fall under a holistic policy framework which is enhancing "Climate-Adaptive Water Productivity" (CAWP).

Figure 16: Common strategic outcomes between the three sectoral national strategies



Climate-Adaptive Water Productivity: Policy Frame of Improving Policy Coherence of FLW

Policy coherence of FLW is examined by focusing on the design and implementation of policies related to increasing climate-adaptive water productivity. Water productivity (WP) generally refers to the ratio of outputs produced per unit of input used taking into consideration climate change attributes (Sivakumar 2021). It is divided into three types: biophysical, economic, and social water productivity (FAO 2022; Molden et al. 2010).

- **Biophysical water productivity** describes the use of less water (input) in agriculture or aquaculture (Box 1) while producing more yield, crops, or fisheries (output), increasing the efficiency of each drop of water (FAO 2022). The "more crop per drop approach" has gained significant attention due to its multiple benefits for water management, food security, and climate adaptation.

$$\text{Biophysical Water Productivity} = \frac{\text{Yield}}{\text{Water Use}}$$

  - Biophysical water productivity describes three management scenarios – either decreasing water use and producing the same quantity of plants, using the same amount of water and increasing the production of plants, or decreasing water use and increasing the production of plants which is the optimum solution.

- Reduce Water Input Use: There are several practices related to reducing the use of agricultural water either by improving the irrigation and drainage infrastructural network, establishing land and plant sensors for exact water needs, or developing drought-tolerant seed varieties (FAO 2022; Molden et al. 2010). Water productivity also considers the expansion of non-conventional water resources over the use of fresh water.
- Increase Yield Output: Higher quantity and quality of yield either can be produced by fortifying soil fertility through the safe application of fertilizers, mitigating salinization, pest and disease control, and developing highly productive seed breeding and varieties (FAO 2022; Molden et al. 2010).

Box 1: Toward Water Productive Aquaculture using the In-Pond Raceway Culture System "Evidence from WorldFish"

The In-Pond Raceway Culture system (IPRS) is one of the smart water-productive technologies in fish farming. The IPRS improves water use efficiency by effectively managing water circulation within the pond and cleaning organic waste. This system allowed WorldFish to only compensate water for evaporation and seepage (NPO H, pers. comm., 3 October, 2024). This system maximizes fish yield from each drop of water (Figure 17).

Figure 17: Site Visit to IPRS at WorldFish premises. Taken by the research team, 3 October, 2023

- **Economic water productivity** describes the use of less water (input) in agriculture or aquaculture while increasing the economic return of yield (FAO 2022; Molden et al. 2010). Economic returns encompass income at the farm gate, local markets, and export markets. The "more US dollars per drop" approach brings opportunities for increasing agricultural investments, access to better markets, and promoting agricultural and food exports.

$$\text{Economic Water Productivity} = \frac{\text{Economic return (\$)}}{\text{Water Use}}$$

- It entails several practices, either using less amount water and stabilizing the value of crops, or using the same amount of water and selling when the value of crops is high, or the optimum solution which is using less amount of water and increasing high-value crops (FAO 2022).
- Increasing the value of crops is dependent upon greater compliance with food and water quality and standards and effective trade policies.

- **Social water productivity** describes using less water (input) in agriculture or aquaculture while increasing social equity. Social equity entails increasing the income of the laborers or smallholders, increasing employment opportunities, heightened self-sufficiency, and higher food affordability (Christoforidou and Vos 2020).

$$Income\ Generating\ Water\ Productivity = \frac{Income\ for\ Labourers\ and\ smallholders}{Water\ Use}$$

$$Jobs\ Creation\ of\ Water\ Productivity = \frac{Jobs\ Created}{Water\ Use}$$

  - Biophysical and economic water productivity should be completed by a social aspect because the production of high-value crops is mostly geared toward export, which could create an unequal distribution of economic benefits between value chain actors – retailers, multinational traders, large land owners, and laborers, or smallholders. Furthermore, creating high-value crops leads to the increase of virtual water trade at the expense of subsistence farming that meets domestic demands (Christoforidou and Vos 2020; FAO 2022).

Increasing water productivity is at the core of climate adaptation because climate change affects water temperature, reduces water availability and water quality, and groundwater recharge. It is thus important to determine the impacts of climate change on water resources to develop possible adaptation strategies for ameliorating water productivity (Sivakumar 2021). Climate adaptation could span different strategies including local weather data on the expected rainfall or evapotranspiration rates through remote sensing and spatial maps of agricultural water consumption in the fields (Cai et al. 2019; Gafurov 2020) and by setting up a crop management system resistant to drought, salinization, and heatwaves.

Chapter conclusions

This chapter demonstrated the current state of food, land, water, climate, economy, and society, and the different policy outcomes entailed to address these policy priorities. By analyzing the strategic policy outcomes of the three national plans – the Sustainable Agriculture Development Strategy 2009–2030, the Water Resources Development and Management Strategy 2017–2037, and the National Strategy for Climate Change (NSCC) 2022–2050 – we delimited a policy frame of improving "Climate-Adaptive Water Productivity" that will shape the basis of analyzing policy coherence of food, land, water, and climate.

3. Policy Coherence Analysis Tools

Introduction

To conduct a policy coherence analysis focused on climate-adaptive water productivity, the study used several data collection tools to capture the sectoral linkages and understand the institutional arrangements of water, land, and food management, their interplay with climate and environmental adaptation, and their effects on economic and social outcomes. The tools included: a database on the different policies, one consultation session at the 6th Cairo Water Week, semi-structured interviews, a database on CAWP institutional mapping through the power and interest matrix, and the social network analysis.

3.1. Database of policies and laws

The database included 17 laws and decrees (Annex III: Database of Water Productivity Laws) and 121 developmental programs on improving CAWP. The laws highlighted the coordination between MWRI and MALR on water-intensive crops. They also highlighted the application of crop cultivation methods, types of seed, fertilizers, pesticides, and irrigation techniques. Other laws focused on postharvest practices in storing and purchasing agricultural commodities through the Egyptian Commodity Exchange as well as the expansion of contractual farming.

3.2. Consultation Sessions and Semi-Structured Interviews

The study convened one consultation session at the 6th Cairo Water Week and conducted 20 semi-structured interviews with various stakeholders in the network to discuss policy coherence and incoherence in improving CAWP and the different interactions between FLW. When analyzing policy interactions, the study considered whether these relationships are intrinsic, or whether negative or positive interactions could result from other dependent variables/factors, such as location and context-specific, timeframe (long- or short-term), governance, and technology (Capon et al. 2017).

1. **Location and context-specific**: Positive or negative interactions could differ based on the biophysical environment of each geographical location, the type of soil and land, the existence of water resources and their types, and climate.
2. **Timeframe (long- or short-term):** Positive interactions could be produced in the short-term on land and water, but in the long run, it will negatively influence them.
3. **Governance:** Negative interactions could be the result of poor governance.
4. **Technology**: Mitigating trade-offs and creating positive linkages could be the result of adopting new technologies.

Moreover, interactions between food, land, water, and climate could take different forms, whether unidirectional, bidirectional, circular, or multiple relationships (Capon et al. 2017)

- **Unidirectional:** A policy goal/intervention (X) affects (Y), but (Y) does not affect (X).
- **Bidirectional**: A policy goal/intervention (X) affects (Y), and (Y) affects (X).
- **Asymmetrical**: A policy goal/intervention (X) affects (Y) in different ways, compared to how (Y) affects (X).
- **Circular**: A policy goal/intervention (X) affects (Y), which affects (Z), which in turn affects (X).
- **Multiple**: A policy goal/intervention (X) affects (Y), (Z), etc.

3.3. Database of Food, Land, and Water Institutions

This study used laws, decrees, and developmental programs on climate adaptive water productivity to delimit all the stakeholders involved, their roles and mandates, and the implementation activities in Egypt. The study found fragmented institutional arrangements involved in climate-adaptive water productivity. They may focus on specific aspects or cover a broader range of activities related to climate-adaptive water productivity. Based on this analysis, the study categorized the institutions into two groups: stakeholder affiliation, and their governance area (Table 4). By mapping institutional affiliations and governance areas, the study aimed to analyze power dynamics and the extent of the influence of different stakeholders.

Table 4: Categorization of Stakeholders related to Climate-Adaptive Water Productivity

Affiliation	Governance
•Donors	•International
•Non-Profit Organizations	•Regional
•Development Finance institutions	•National
•Ministry (decision-maker)	•Governorate
•Governmental Institutions	•Community
•Holding Companies	
•Parliament	
•Private Sector	
•Research Centers	
•Community-Based Organizations	

Definition of different stakeholders

- **Donor-states:** As per the Organisation for Economic Cooperation and Development (OECD), donor-states are the Development Assistance Committee (DAC) members who promote the economic development and welfare of developing countries through Official Development Assistance (ODA) in the form of grants or concessional development financing (soft loans). These include the United States Agency for International Development (USAID), the European Union (EU), the Swedish International Development Cooperation Agency (SIDA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Agence Française de Développement (AFD), the Government of the Netherlands (NL), and Japan International Cooperation Agency (JICA).
- **Non-profit organizations (International, Regional, and National):** These are internationally, regionally, and nationally based organizations. They usually receive grants to implement climate-adaptive water productivity programs in Egypt. This category includes Food and Agriculture Organization (FAO), CARE Egypt, International Water Management Institute (IWMI), WorldFish (WF), and the Arab Water Council (AWC).
- **Development Finance Institutions (DFI):** DFIs are specialized development banks that invest and provide loans to developing countries or businesses with the aim to improve climate-adaptive water productivity according to the OECD. These banks vary in size and scope; they could be bilateral or multilateral and international, regional or national. They usually source their capital from national or international development funds. DFIs include the World Bank Group (WBG), African Development Bank (AFDB), the International Fund for Agricultural Development (IFAD), the European Investment Bank (EIB), the Arab Fund for Economic and Social Development (AFESD), KfW Development Bank, and the National banks of Egypt.
- **Ministries:** Defined as all ministries or affiliated departments that are involved in climate-adaptive water productivity. This category includes the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation (MALR), the Ministry of Environment, Lakes and Fisheries Resources Development Agency (LFRPDA), the Ministry of Electricity and Energy (MOEE), and the Ministry of Planning, Economic Development and International Cooperation.

- **Holding Companies:** Two holding organizations are involved in increased water productivity, i.e., the holding company for water and wastewater and the holding company for irrigation and drainage.
- **Parliament:** One parliamentary committee is involved, which is the Agriculture, Irrigation, Food Security, and Livestock Committee.
- **Private sector:** This comprises of several types of companies that differ in their scope, including those responsible for water infrastructure, pesticides or fertilizers companies, remote sensing companies, or consulting services. In addition, it includes start-ups, digital platforms and innovations, and micro, small, and medium enterprises (MSMEs). Furthermore, it includes corporate social responsibility (CSR) funding.
- **Research Centers - national-based centers:** It includes centers affiliated with different ministries, but also universities. This category includes National Authority for Remote Sensing and Space Sciences (NARSS), National Water Research Center (NWRC), Agricultural Research Center (ARC) under MALR, and Universities.
- **Community-Based Organizations:** Entails all organizations or community social networks which are regulated by the community to give services and goods to the community. It includes community development associations (CDA), farmer field schools (FFS), and water users associations (WUAs).

The institutional arrangement around climate-adaptive water productivity demonstrates a diversity of actors affiliated with ministries, institutions and their various concerned departments, non-profit organizations, donors and community-based organizations, and financial institutions. They generally operate at the national level, but some are international in scope; others operate at the governorates or community levels.

3.4. Power and Interest Matrix

3.4.1. Determine the extent of Power and Influence in CAWP

This study analyzed the extent of power and influence that each stakeholder can yield on policymaking and policy implementation. In general, power is an interactionist relationship characterized by resource mobilization to coerce others to adopt a certain behavior (Hermet et al. 2015). Hence, the study analyzed various types of power that each actor acquires to move action on climate-adaptive water productivity. Power definitions and criteria were selected based on several pieces of literature (Hermet et al. 2015; Hunjan and Pettit 2011; Schiffer and Waale 2008; Zimmermann and Maennling 2007). Each stakeholder was analyzed based on seven power dimensions related to climate-adaptive water productivity (Table 5).

Table 5: Seven Power Dimensions of Climate-Adaptive Water Productivity

Criteria of Power	Definition	Rubric According to authors' definition	Question	Answer
Power of Arrest/Injunction	The power of arrest/injunction refers to the authority to use legitimate coercion to enforce laws on members of society, impose restrictions on the freedom of others, or punish members violating laws related to water productivity.	Actors who have the legitimate coercion to enforce laws or punish violating them.	Does this actor have the legal use of force (coercion) over the water productivity process?	Yes No
Mobilization of economic capital	Economic capital is defined as mobilizing grants, loans, and public budgeting toward increasing water productivity or the ability to gain and acquire and	Economic power is defined as mobilizing or acquiring funds more than 100 million dollars in loans	Does this actor mobilize or exert effort for mobilizing economic capital resources to	Yes No

	accumulate financial capital that produces some benefits.	or 10 million dollars in grants.	increase water productivity?	
Mobilization of social capital	Social capital refers to the number and types of networks that an actor forges with other categories of actors.	The actor has at least one relationship with: - Donors - NPOs - Ministries/Public agencies - Research Centers - Private Sector - Community-Based Organizations	Does this actor mobilize social capital to manage water productivity?	Yes No
Mobilization of knowledge, skills, and expertise	It pertains to the extent of capacity-building and knowledge-transfer activities they do.	The actor builds the capacity and transfer knowledge on three or more themes related to: - Land - Water - Food - Market Linkages - Energy and Water - Remote Sensing/digital applications - Climate resilience	Does this actor possess the required knowledge and expertise on the topic of water productivity and be able to mobilize it?	Yes No
Mobilization of technology, innovation, and infrastructure	It refers to the capacity of an actor to create and deliver efficient and up-to-date technologies and resilient infrastructure that support more crops and fisheries and more income per drop.	At least in two projects.	Does this actor possess and mobilize the technology, innovation, and infrastructure means toward water productivity?	Yes No
Vertical relationships	It refers to the frequency of coordination with national institutions, and the ability to advocate and influence policymaking.	At least in two projects.	Does this actor engage in vertical or horizontal relations and engage with policymakers to establish rules and incentives related to water productivity?	Yes No
Degree of organization	Eisenstadt and Weber argued that institutions have rules enforced on all members to regulate their actions and their social	Robust Institutions have: ▪ Clear roles and responsibilities ▪ Respond to society's needs.	Does this actor acquire a degree of organization to support water productivity?	Yes No

	relationships to address societal needs.	▪ Autonomy of action

3.4.2. Determine the Extent of Interest in CAWP

Interest is defined in literature (Brouwer and Brouwers 2017; Retolaza 2022; Smith 2000) as the amount of potential interaction of actors with a development intervention issue and change objectives. Their interests lie particularly in the inputs and outputs related to a specific intervention and that addresses their needs. Identifying interests was done through a literature review of all programmatic activities these stakeholders engaged in to enhance climate-adaptive water productivity. The delimitation of the impact areas of interest was done through a literature review on the components of strengthening climate-adaptive water productivity according to (Cai et al. 2019; Kassam et al. 2007; Molden et al. 2010; Sivakumar 2021). Interest is hereby measured across seven impact areas related to climate-adaptive water productivity (Table 6).

Table 6: Seven Impact Areas of Interest in Climate-Adaptive Water Productivity

Impact Areas	Definition
Impact area 1: water management	The infrastructure of using less quantity of water comprises of canals, irrigation, wells, and wastewater management which includes agricultural drains and treatment plants.
Impact area 2: Land management	Increasing land productivity through the consolidation of smallholding (same crop plantation), land leveling, improving soil fertility by rationalizing the use of fertilizers, and mitigating salt-affected soils.
Impact area 3: Food and nutrition	Improving the quantity of quality of production through crop/fish selection and improvement and pest and disease control.
Impact area 4: Capacity Building	Human resources are an integral part of the process of improving climate-adaptive water productivity by increasing the knowledge and skills of different stakeholders, local government, extension services, and farmers.
Impact area 5: Digital applications	The application of water accounting, remote sensing, GIS, and early warning systems in the study of water availability and water balance.
Impact area 6: water and energy nexus	The type of energy used to distribute water to fields is either grid-connected or solar irrigation.
Impact area 7: Exports and access to better market	The economic water productivity includes better connectivity to markets, increasing food standards, and promoting agribusinesses.

3.5. Social Network Analysis

This study also explores the institutional coherence of climate-adaptive water productivity using social network analysis (SNA) (Borgatti et al. 2009; FAO 2018). SNA determines the position of each actor in the network, their extent of power or dominance over others, identifying key stakeholders at the center of interactions, the partnerships and type of exchange they engage in, the funds they provide or receive, and the different activities delivered.

Social networks describe the type of social capital that each institution holds and consequently, the number of resources, opportunities, and constraints they encounter (FAO 2018). The more diverse the social network of an institution is, the more it improves decision-making quality by taking into consideration diverse views and opinions (Borgatti et al. 2009). However, it can imply some barriers linked to conformity to earn and retain social approval within the network. To define the relationships that exist between stakeholders, the study relied on the review of laws and decrees, 121 programming, internal consultations within IWMI, and key informant interviews with key stakeholders. To identify the 121 developmental programs, the research has outlined the inclusion criteria (Table 7).

Table 7: Criteria for Inclusion of Developmental Programs in this research

Criteria	Description
1) Objectives	Programs must support improving climate-adaptive water productivity in its three forms: biophysical, economic, and social.
2) Data source	Ministries/donors/NPO websites or project proposals and reports published online, especially MOIC and FAO.
3) Data are Publicly shared	Open-Source Data
4) Funding Source	International Fund, excluding local funding.
5) Time frame	Programs started or ongoing from 2016 till 2023.
6) Monetary value	Precise monetary value (Euros, USD, or EGP).

The study defined four types of edges to capture the complexity of the relationships within climate-adaptive water productivity networks. These edges represent various relationships and types of resource exchanges, including funds, technical assistance, information exchange, and hierarchy. Each type of relationship was assigned a distinct color, as detailed in Tables 8 and 9. The study used the "Social Network Visualizer"[1] to draw the network. This program facilitated the representation of the stakeholder relationships and provided a visual understanding of the connections among different stakeholders in the climate-adaptive water productivity landscape.

Table 8: Type of Relationships between Stakeholders in the Social Network Analysis

Type of Network	Definition	Color
Flow of hierarchy	Command and hierarchy.	Black
Flow of Fund	The flow of funds means the provision of loans and/or grants.	Red
Flow of Technical Assistance	Technical assistance comes in two shapes: Soft, which is about capacity-building activities in a water productivity area. Hard, which is about the provision of equipment, technologies, or infrastructure. This technical assistance could be provided through grants or the purchase of these goods and/or services.	Blue
Flow of information	Agreements, protocols, and coordination mechanisms through reporting mechanisms or meetings.	Green

[1] Access to the "Social Network Visualizer" software: https://socnetv.org/

Table 9: Graphical Illustrations of Edges in the Social Network Analysis

Direction of Arrows	Definition
→	One out-degree arrow signifies dominance from one actor to another.
↔	Two in-degree and out-degree arow between two actors signify reciprocal exchange.

The fund-based social network analysis examines the relationship between the size of nodes and the amount of funds invested by entities in climate-adaptive water productivity from 2016 to the present. As entities increase their funding, the size of their node within the network also increases, indicating their growing power and influence over climate-adaptive water productivity initiatives (Table 10). To provide a comprehensive overview, the research categorizes funding entities based on their percentile rank. These entities are then grouped into four main node sizes in the network, allowing for a better understanding of their relative positions and influence within the fund network.

Table 10: Calculation of the Node Size in the Fund Network

Percentile Rank	Node Size
75%< “percentile rank” >=100%	50
50%< “percentile rank” >=75%	40
25%< “percentile rank” >=50%	30
“percentile rank”<=25%	20

Chapter conclusions

This chapter presented the different research tools used to analyze policy coherence of FLW systems toward improving climate-adaptive water productivity. The tools covered the analysis of linkages between policymaking and implementation as well as the power dynamics of the institutional arrangements governing these natural resources.

4. Research Findings on Key Policy Interactions between Food, Land, and Water

Introduction

This chapter explores horizontal and normative coherence across different sectors using a matrix with five sectoral linkages under CAWP. This matrix provides an analysis of the different causal and functional relations revealing positive or negative interactions (synergies or trade-offs) between food, land, water, and climate along with their interlinkages with economics and social protection. A key objective of the matrix is to provide a starting point for policymakers and other stakeholders to measure interactions and set coherent policies in terms of design, implementation, or monitoring.

Matrix Findings

CAWP Dimensions	Policy Linkages	Variables	Directionality	Synergies or Trade-Offs
Improving Biophysical Water Productivity				
Sectoral Policy Linkages 1: Efficient water rationalization increase agricultural productivity, enable climate adaptation, and reinforce water availability for other sectors	1) Modern and smart irrigation infrastructure and technology are indivisible from reducing water loss and food improving productivity.	Technology and Infrastructure	Unidirectional	Synergies
	2) The expansion in modern irrigation affects drainage water availability which constrains fish farms' productivity, old and reclaimed lands, and thus employment and fair income.	Governance; timeframe (short- and long-term)	Multidirectional	Trade-offs
	3) Incoherence between agricultural expansion in the desert and water availability.	Governance	Multidirectional	Trade-offs
	4) Developing crop varieties and breeds is intrinsic to rationalizing water management and increasing food production.	Technology, Research and Development	Multidirectional	Synergies
	5) Decreasing planting of high-water consuming strategic crops constrains farmers' income, increases salt-affected soils, and increases illegal cultivated lands, especially in the Delta.	Governance; location-based	Bidirectional	Trade-offs

	6) Animal husbandry (access to safe, nutritious, and sufficient food) counteract water management and contributes to climate change.	Governance	Multidirectional	Trade-offs
	7) Water reuse mechanisms between fish farms rationalize water but constrain fish farms' productivity.	Governance	Unidirectional	Trade-offs
Sectoral Policy Linkages 2: Developing new sources of land and water resources supports higher and sustainable agricultural productivity growth and employment	1) Developing non-conventional water resources enables the sustainability of agricultural productivity.	Technology and Infrastructure	Unidirectional	Synergies
	2) Crop consolidation increases agricultural productivity, farmers' income, and ease of installing modern and smart irrigation technologies.	Governance	Multidirectional	Synergies
Sectoral Policy Linkages 3: Sustaining water quality reinforces food production and competitiveness in local and foreign markets	1) Prohibition of fresh water in fish farms constrains fish farms' quantity, and quality competitiveness to access better markets.	Governance	Multidirectional	Trade-offs
Improving Economic Water Productivity				
Sectoral Policy Linkages 4: Enhancing agricultural commodities competitiveness by balancing food trade and assessing virtual water trade, and their impact on social security, income, and employment of farmers	1) The absence of calculation of the annual depreciation of water assets constrains the economic value of water and the real value of food production in the economy.	Governance; timeframe (short and long-term)	Multidirectional	Trade-offs
	2) Contractual Farming and agricultural commodity exchange enable addressing demands and needs and avoid oversupply in the market.	Governance	Unidirectional	Synergies
	3) Achieving food security of wheat is synergetic to balancing imports and exports in the food trade but it counterbalances the use of land and water.	Governance	Multidirectional	Trade-offs
Improving Social Water Productivity				
Sectoral Policy Linkages 5: Improving the financial and	1) Modern and smart irrigation techniques decrease the labor-intensive traditional farming.	Governance	Unidirectional	Trade-offs

governance frameworks of biophysical and economic food production and quality, preserves livelihoods and maintains fair incomes	2) Complexities of registration and legalization of fish farms limit investments, sustaining food production, and opportunities for export to EU markets.	Governance	Multidirectional	Trade-offs

4.1. Improving Biophysical Water Productivity

4.1.1. Sectoral Policy Linkages 1: Efficient water use and consumption increase agricultural productivity, enable climate adaptation, and reinforce water availability for other sectors

The three national strategies have outlined the significance of implementing water rationalization and increasing the efficiency of irrigation systems. The responsibilities, however, could differ between ministries. MWRI oversees waterways performance, maintenance, and purification (irrigation and drainage), while MALR supervises on-farm irrigation management and cropping varieties that use less water and withstand heatwaves and salinization.

1	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Modern and smart irrigation infrastructure and technology are indivisible from reducing water loss and improve food productivity.	Technology and Infrastructure	Unidirectional	Synergies

Canal lining

As part of MWRI's adaptation to reduce 10 to 20 percent of water seepage and increase water availability for irrigation, it installed a water accounting unit at the national level to monitor agricultural water use. In addition, MWRI launched several national infrastructural projects on canal lining, where it finalized 8,000 of the intended 200,000 kilometers (Cairo Water Week, 31 October, 2023).

Modern irrigation (drip – sprinkler – subsurface irrigation)

Moreover, in collaboration with MALR, there is a joint effort to transition the irrigation method of 3.5 million *feddan* from traditional flooding to modern irrigation techniques (Figure 18). The purpose is to increase water use efficiency, improve agricultural productivity, and reduce the energy use associated with water pumping, which will ultimately increase farmers' income (Cairo Water Week, 31 October, 2023; farmer A, pers. comm., 29 February, 2024). Several interventions have been implemented to upgrade the irrigation network, including the EU – Joint Rural Development Program, modernizing plot irrigation in the Nile Delta, and the Farm-level Irrigation Modernization Project (FIMP).

Figure 18: Menoufia Field Visit – 29 February, 2024. Taken by the authors.

2	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	The expansion in modern irrigation affects drainage water availability which constrains fish farms' productivity, old and reclaimed lands, and thus employment and fair income.	Governance; timeframe (short- and long-term)	Multidirectional	Trade-offs

Some reclaimed lands in the desert use treated drainage water, which will have dire consequences for water demands in the old lands and the aquaculture sector that depends on it to fill the water gap. The drainage flow of the Delta is currently directed to the desert to reclaim land, which is suspected to affect the aquaculture farming growth in the Beheira governorate, especially in Idku, Abu Hummus, and Kfarshima cities (NPO H, pers. comm., 3 October, 2023).

Moreover, when drip irrigation is expanded, the availability of drainage water will start to decrease. Therefore, future trade-offs will intensify between the use of drainage water in the agricultural old lands, horizontal agricultural expansion in the desert, and the needs of the aquaculture sector (NPO H, pers. comm., 3 October, 2023; NPO A, pers. comm., 26 March, 2024).

3	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Incoherence between agricultural expansion in the desert and water availability.	Governance	Multidirectional	Trade-offs

Despite inter-ministerial coordination efforts, horizontal incoherence occurs between the vision for agricultural horizontal expansion and the availability of water resources. The land reclamation project of one-and-a-half million *feddan* relies heavily on groundwater for irrigation. However, in some desert areas, there is insufficient groundwater available to support such an extensive expansion or it exists at a depth of 1,000 m or more, making it economically unfeasible to cultivate strategic low-value crops with such deep-water extraction (Ministry A, pers. comm., 6 December, 2023) (Research B, pers. comm., 25 March, 2024). Due to the limited availability of surface groundwater, only 400,000 *feddan* have been cultivated thus far, a figure significantly lower than the proposed cultivation (Ministry A, pers. comm., 6 December, 2023).

4	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Developing crop varieties and breeds is intrinsic to rationalizing water management and increasing food production.	Technology, Research and Development	Multidirectional	Synergies

International and national research centers are exploring different breeds of rice and wheat that could grow with limited water and withstand drought, which in turn will increase water availability and food security (Table 11).

Table 11: Amount of water saved from water-intensive crops according to SADS 2030

Crop	Water Requirement for Traditional Rice Breed per feddan	Water Requirement for New Rice Breed per feddan	Amount of Water that could be saved
Rice	7,500 m^3	5,500 m^3	200 m^3
Maize	3,614 m^3	3,000 m^3	614 m^3
Wheat	2,700 m^3	2,300 m^3	400 m^3

However, the success of these innovations relies on more than just scientific advancements, it depends on the adoption of a sociological-anthropological coherence to engage farmers. This approach involves fostering strong community-level associations, local partnerships between research centers and farmers, establishing farmer field schools, and promoting peer-to-peer learning.

In Kafr Elsheikh governorate, the Sakha rice research center has exemplified a successful partnership at the local scale between researchers and farmers (Lasheen 2022). Farmers created a network where some volunteered to test the new rice breeds on their plots of land and their effect in saving water, energy costs, resisting disease and ecological conditions, and providing more yield. If these test trials prove successful, the network of farmers will distribute it to other peers on a larger scale. The partnership between farmers and local-based researchers was informal, where farmers were freely and frequently accessing the research center to ask technical questions about their rice fields, and where researchers were monitoring the rice growth regularly.

5	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Decreasing planting of high-water consuming strategic crops constrains farmers' income, increases salt-affected soils, and increases illegal cultivated lands, especially in the Delta.	Governance; location-based	Bidirectional	Trade-offs

Rice is a strategic crop in Egypt; it is highly regulated by the state and prioritized in each water conservation policy because it consumes an estimated 6 percent of Egypt's freshwater resources annually in light of water scarcity increase in the last two decades (Lasheen 2022).

Policymakers issued new laws to manage high-water intensive crops, including the law on water management and irrigation number 147 of 2021 and Law 34 of 2018 which amended the initial agricultural law number 53 of 1966 related to Articles (1) and (2). These amendments stipulate that MWRI should cooperate with MALR to determine the designated areas for rice cultivation yearly and other higher water-consuming crops. They should also jointly announce the non-cultivation of some crops in hot spots, such as wheat and rice in Upper Egypt.

Contradiction arose when the updated Sustainable Agricultural Development Strategy (SADS) in 2019 acknowledged the need to decrease areas planted for rice from 1.7 to 1.1 million *feddan* to save an estimated 12.4 billion cubic meters of water annually, while MWRI announced the need to reduce rice fields from 1.1 million *feddan* to only 724,200 *feddan* in January 2018.

On the other hand, the restriction on rice production had adverse effects on the means of subsistence of around 10 million farmers in the Nile Delta region (Lasheen 2022). In addition, the Delta's land productivity has declined due to several reasons, including increased salinity in the soil due to seawater intrusion from the Mediterranean; overuse of irrigation water; and poor drainage networks. The farmers depend on flood irrigation used in rice cultivation to clear their soils of accumulated sodium and restore soil fertility for the following agricultural cycle. Accordingly, the limitation imposed on rice cultivation affects their land management, food production, and stable livelihoods and income. In this context, one of the interviewees highlighted that the total planted areas of rice fields in 2022 (formal and informal) increased to 1,800,00 *feddans* compared with only 724,200 legalized *feddans* by MWRI (Research A, pers. comm., 24 September, 2023). Imposed restrictions on rice plantations in the Delta have other unintended environmental consequences, which reveal interconnections between water accessibility, land management, food security, and socio-economic attributes. This marks a vertical incoherence and misalignment between top-down and bottom-up management and decision-making. It also sheds light on the type of horizontal coherence mechanisms between MWRI and MALR.

6	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Animal husbandry (access to nutritious, and sufficient food) counteracts water management and contributes to climate change.	Governance	Multidirectional	Trade-offs

Animal husbandry is excluded from water rationalization policies in the three national strategies. Animal husbandry is particularly concerning with intensive commercial farms, which constitutes a large barrier toward rationalizing water (Research B, pers. comm., 25 March, 2024). The production of one kilo of beef meat requires approximately 16,000 cubic meters of water. This is not by the water consumed by the livestock, but by the feed (clover or maize) they consume, which needs a lot of water for their growth. The production of clover reached 1.4 million *feddan* with 40 million tons produced for animal feed in 2023 (CAPMAS 2023c).

7	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Water reuse mechanisms between fish farms rationalize water but constrain fish farms' productivity.	Governance	Unidirectional	Trade-offs

Fish farms reuse water from one farm to another, which makes them a less-water consuming sector creating positive interactions between maximizing fish production from each unit of water used. However, this system encompasses fragility elements, because of the inexistence of water filters at the in-take and out-take, particularly for small-scale farms. Thus, if a disease or a virus outbreaks in one farm, it will spread to other farms affecting their total productivity, which could potentially spread to lakes and affect the entire ecosystem (NPO H, pers. comm., 3 October, 2023).

4.1.2. Sectoral Policy Linkages 2: Developing land and water resources support higher and sustainable agricultural productivity growth and employment

The three national strategies focus on developing new lands by increasing reclaimed lands in the desert, consolidating crops in small-scale old lands, and developing new water resources in parallel by expanding wastewater and agricultural drainage reuse.

1	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Developing non-conventional water resources enables the sustainability of agricultural productivity.	Technology and Infrastructure	Unidirectional	Synergies

Developing non-conventional water resources in a context characterized by water scarcity fills the water resource demands, which amount to 40 billion cubic meters per year. It therefore creates positive conditions to sustain agriculture in the old lands and supports horizontal agricultural expansion in the deserts. Developing non-traditional water resources resonates with the three policies reflecting on water quality through enhancing the infrastructure and capacities of treated wastewater and drainage treatment plants (Ministry A, pers. comm., 6 December, 2023). Several drainage water treatment stations were established and operationalized. These policy implementations are illustrated through several development programs, such as the water sector reform phase II, the national drainage project, and the Kitchener drain rehabilitation and depollution project.

2	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Crop consolidation increases productivity, farmers' income, and ease of installing modern and smart irrigation technologies.	Governance	Multidirectional	Synergies

The majority of farmers in Egypt are smallholders who own relatively small plots of land. Land fragmentation reduces farmers' income and productivity and also diminishes their motivation to cultivate. The slow progress of policies toward consolidating land holdings hinders efficiency and limits the ability to implement modern agricultural techniques effectively.

Currently, there is no unified cropping pattern, and each farm cultivates crops independently. As a result, MWRI is unable to accurately estimate water requirements due to the absence of these cropping patterns. Consequently, the water supply exceeds the actual water demand because MWRI relies on past experiences rather than specific cropping patterns provided by MALR (NPO A, pers. comm., 26 March, 2024)

4.1.3. Sectoral Policy Linkages 3: Sustaining water quality reinforces food production, increasing food competitiveness in local and foreign markets

The three national strategies emphasized treated water quality and food quality by regulating and rationalizing the use of fertilizers and monitoring wastewater and drainage water treatment plants. However, the quality and safety pillar in the Food Security Index of 2022 is the lowest of the other three pillars, 45.9; furthermore, it declined from previous periods (Economist Impact 2022). Food safety legislation is absent as highlighted by the same index. The positive or negative linkages associated with water quality are dependent upon the type of governance and institutional arrangements regulating and monitoring the process.

1	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Prohibition of fresh water in fish farms constrains fish farms' quantity, and quality competitiveness to access better markets.	Governance	Unidirectional	Trade-offs

The law on water management and irrigation number 147 of 2021 prohibited the use of fresh water in cultivating fish; it only permitted the use of drainage or brackish salinized groundwater. On one side, it means that fish farms are being produced at the end of the water cycle using drainage water, which could be contaminated with fertilizers and pesticides. The untreated drainage water restricts fish farm productivity and export opportunities. The EU markets prohibited aquacultural exports from Egypt because it violates the required quality standards, especially with the type of water used (NPO H, pers. comm., 3 October, 2023). On the other side, it restricts efforts toward the integration of aquaculture-agriculture where fish farms would use fresh water at the beginning of its cycle and then direct it to agricultural purposes, while considering its interlinkage with health considerations.

Law number 146 of 2021 mentioned the responsibility of the Protection and Development of Lakes and Fish Resources Agency (LFRPDA) to grant permission for aquaculture-agriculture integration systems. This law, in addition to the three national strategies, neglects the necessary cooperation between MWRI, MALR, and the Egyptian Environmental Affairs Agency (EEAA) with LFRPDA in the establishment of this system for effective land distribution and water channeling and utilization. Policies do not explicitly highlight the integration with aquaculture as one of the strategies to improve climate-adaptive water productivity, ensuring its scalability to both old and new lands, and raising water quality and capacities for exports.

4.2. Improving Economic Water Productivity

4.2.1. Sectoral Linkage 4: balancing agriculture and food trade between import and export impacts virtual water trade, and income and employment of agricultural communities

The economic cost of water means adding the annual depreciation cost and balancing the distorted price of markets, without compromising the social outcomes of agricultural and food workers.

1	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	The absence of calculation of the annual depreciation of water assets constrains the economic value of water and the real value of food production in the economy.	Governance; timeframe (short- and long-term)	Multidirectional	Trade-offs

The value of agricultural productivity could be financially profitable, but not economically in the longer term (Research B, pers. comm., 25 March, 2024). The economic sector at the Ministry of Agriculture calculates the irrigation costs as the electricity/fuel used by farmers to pump the water from the narrow canals (Mesqa) to the field and hence calculates the final price of products. However, it is also important to assess the economic cost of water in the price of products, considering the full supply cost from assets, operation, and maintenance to convey water from the Aswan dam in the south of Egypt or wells to the fields.

Therefore, to accurately calculate irrigation costs and thus identify the value of water, there is a need to calculate the annual depreciation costs of water assets, which are defined as the value of fixed and variable assets costs over the years of utilization (Research B, pers. comm., 25 March, 2024). The annual depreciation cost is measured by the following formula:

$$\text{Annual Depreciation of An Asset} = \frac{\text{Fixed or Operational Asset Cost}}{\text{Economic life of the asset}}$$

Fixed assets are defined as digging, pipelines, and pumping power devices, while **operational assets** are defined as fuel/diesel from generators or electricity, maintenance, and repairs. Because physical or fixed assets in water and agriculture are operated by hour, it is important to estimate the depreciation cost per hour. Calculating the capacity of water discharge in one hour and the depreciation cost per hour can reveal the cost of pumping one cubic meter per hour, thus identifying the economic value of water.

There are two types of economic costs of water: 1) discharging surface water from canals to fields; and 2) discharging water from wells. MWRI is mainly responsible for all waterways, their maintenance, and their operations mechanisms, hence, it is the responsibility of MWRI to produce data on the economic cost of water and coordinate with MALR to arrange agricultural commodities and food values. In the one million-and-a-half-reclaimed land project, it was discovered that in certain areas, wells are at a depth of 1,000 m, which entails a higher cost of fixed and operational assets, and a higher economic cost of water that will necessitate converting these lands into crops with very high value (Research B, pers. comm., 25 March, 2024).

According to one interviewee, rice could be profitable because it does not include the economic cost of the 7,000 cubic meters of water used due to the citizenry paying for it through taxes (not the farmer paying its price) (Research B, pers. comm., 25 March, 2024). This also opens the wider discussion on exporting virtual water for free without adding its economic cost.

2	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Contractual Farming and agricultural commodity exchange enable addressing demands and needs and avoid oversupply in the market.	Governance	Unidirectional	Synergies

The absence of a mandatory agricultural cycle allows farmers to cultivate crops on their own. Hence, potential drawbacks could arise if a particular crop, like garlic, becomes highly profitable in one year. There is a risk that all farmers will decide to cultivate that crop, i.e., garlic in the following year, which could lead to an oversupply of garlic resulting in financial losses (Private sector B, pers. comm., 10 October, 2023; NPO A, pers. comm., 26 March, 2024; Ministry D, pers. comm., 9 May, 2024).

The new law of contractual farming number 14 of 2015 and decree number 182 of 2020 on commodity exchange constitute new hope and opportunities to create synergies between cultivation, addressing food demands in the market, and stabilizing or increasing the livelihood of farmers. Contractual farming is a contract between producer and buyers before the start of a cultivation season, based on which the buyer identifies the crop they want, varieties, quantities needed, price, and any other conditions enlisted in the contrast. Under this law, a contract farming center was established on the national level, which farmers will benefit from when it is upscaled at decentralized levels. Furthermore, the agricultural commodity exchange establishes an organized market for trading storable commodities. However, the executive orders for both laws are still pending.

3	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Achieving food security of wheat is synergetic to balancing imports and exports in the food trade but counterbalance the use of land and water.	Governance	Multidirectional	Trade-offs

Wheat is a highly strategic commodity for Egypt, where it currently produces 51.4 percent of its consumption needs, and imports almost half of it. Thus, importing wheat is important because of its significance as a strategic national security topic, and thus, poses a huge weight on public spending, especially during an economic crisis. However, since the Ukrainian crisis, Egypt has been working toward increasing its domestic cultivation of wheat. Nonetheless, this policy approach pulls more water and uses more land for wheat; it also comes at the expense of the cultivation of other crops. As a result, the domestication of wheat leads to social stability, increases self-sufficiency, and reduces the burden on the import budget, however, it comes at the cost of land and water use for other high-value crops. It is important to balance the dynamics between the trade balance, land and water use, and food self-sufficiency (NPO B, pers. comm., 17 April, 2024).

4.3. Improving Social Water Productivity

4.3.1. Sectoral Policy 5: Improving the financial and governance frameworks of biophysical and economic food production and quality, preserves livelihoods and maintains fair incomes

The three national strategies need to emphasize the dynamics of social inclusion of youth and women by stabilizing job creation and retention in the agriculture and food industries. In addition, they should improve access to credit for smallholders.

1	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Modern and smart irrigation techniques decrease the labor-intensive traditional farming.	Governance	Unidirectional	Trade-offs

Using smart irrigation tools reduces the reliance on labor-intensive traditional irrigation. Thus, a reduction in labor requirements leads to cost-savings for farm owners, which marks a positive linkage to increasing the landowners' income (Farmer A, pers. comm., 29 February, 2024). However, this transition also decreases employment opportunities for landless farmers and laborers, which contradicts the objective of SADS 2030 of eradicating poverty in rural areas, by creating 4 million jobs. Other experts have argued that modern and smart irrigation techniques could create top-notch technical laborers which should increase their income (NPO E, pers. comm., 16 April, 2024).

2	Key Interaction	Variables	Directionality	Synergies or Trade-offs
	Complexities of registration and legalization of fish farms constraints livelihoods, sustaining food production, and opportunities for export to EU markets.	Governance	Multidirectional	Trade-offs

The aquaculture sector is facing challenges related to the lack of an enabling policy environment in the three policies that support its growth, particularly in accessing green funds, license registration complications, competition over land and water use between agriculture and aquaculture and adopting smart and robust aquaculture practices.

Laws number 146 of 2021 and number 147 of 2021 reveal complexities related to obtaining licenses to operate a fish farm. Farmers must navigate through five governmental agencies including MWRI, MALR, the Ministry of Environment, and the Ministry of Health and Population. In addition, diverse fees are being collected for the tenancy of the land, operations, and maintenance of wells or drainage networks, and for the use of each cubic meter of water that serves the fish farms. These challenges amplified the illegal operations of fish farms that reached more than 60 percent and the absence of a database of the tenants; in addition, many fish farmers fell into a debt cycle. Moreover, there is a contradiction in the executive order of law number 147 of 2021 between Article 54 and Article 107. Article 54 sets the duration of licenses for non-agricultural water use at 10 years, while Article 107 specifies a shorter period of 5 years. This discrepancy adds further confusion and inconsistency to the licensing process.

Chapter conclusions

Policy coherence explores positive and negative linkages that exist between sectoral policy design and implementation to achieve climate-adaptive water productivity. This chapter explored five sectoral policy linkages that address improving biophysical, economic, and social water productivity. There are strong correlations related to improving water rationalization to support increased food demands, as well as several policy implementations on developing new water and land resources, but complex and embedded social issues still arise. Negative interactions are most apparent related to improving economic and social water productivity.

5. Findings on institutional coherence

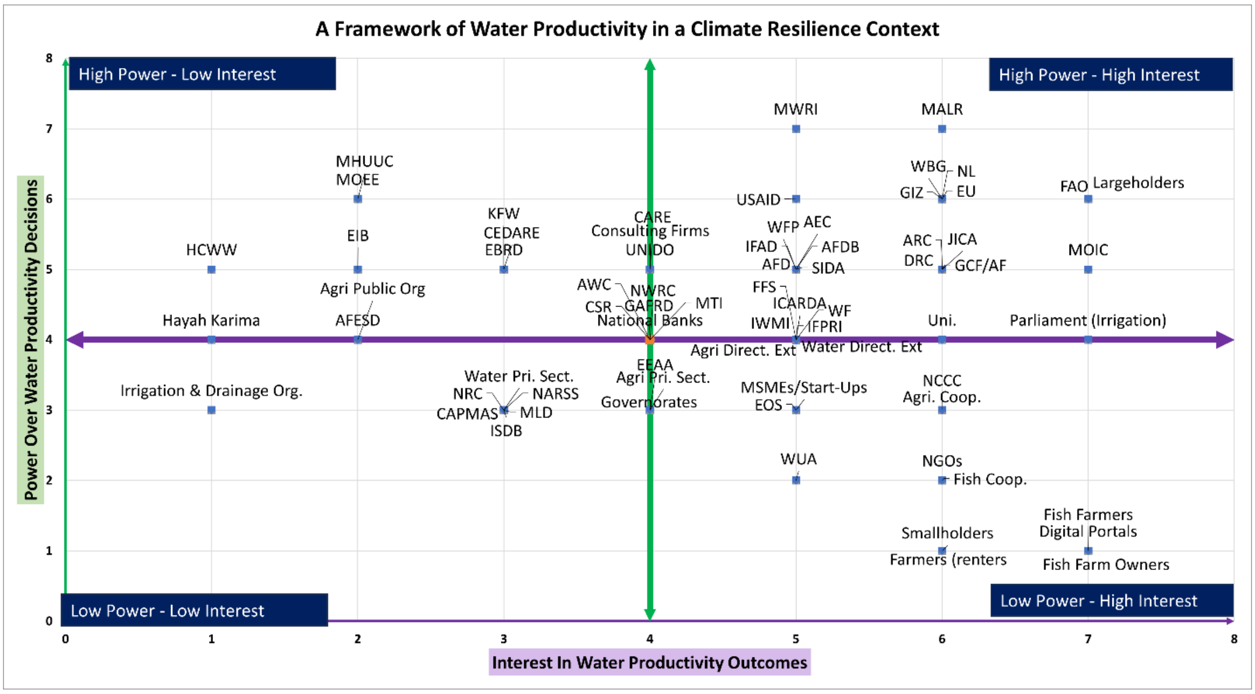
Introduction

This chapter explores the power dynamics within the institutional arrangements governing the policymaking and implementation of improving CAWP. It presents findings on the extent of the influence and dominance exerted by these institutions through their different types of interactions with other entities in the network. To analyze the institutional coherence and power dynamics, this study examined CAWP laws and developmental programs, and qualitative data collection through one CWW consultation session, and semi-structured interviews.

Power and Interest Matrix

Summarizing Chapter III on power and interest, this study defined them according to 7-point criteria. Power was defined according to the power of arrest/injunction, mobilization of economic capital, social capital, knowledge and skills and expertise, technology, innovation, and infrastructure, vertical relationships, and the degree of organization. Interest was defined according to its ability to act on several impact areas such as water and land management, food and nutrition, capacity building, digital applications, water and energy nexus, and exports and access to better markets.

Figure 19: Power and Interest of Different Institutions on Climate-Adaptive Water Productivity



Social Network Analysis Matrix

Summarizing Chapter III on social network analysis, nodes represent institutions. A node's position in a network determines the extent of influence, and what information, opportunities, and constraints there is access to. Four types of flows are identified in the networks: flow of hierarchy, fund, technical assistance, and information/partnerships.

Figure 20: Social Network Analysis: Total Relationships Based on the Degree of Centrality

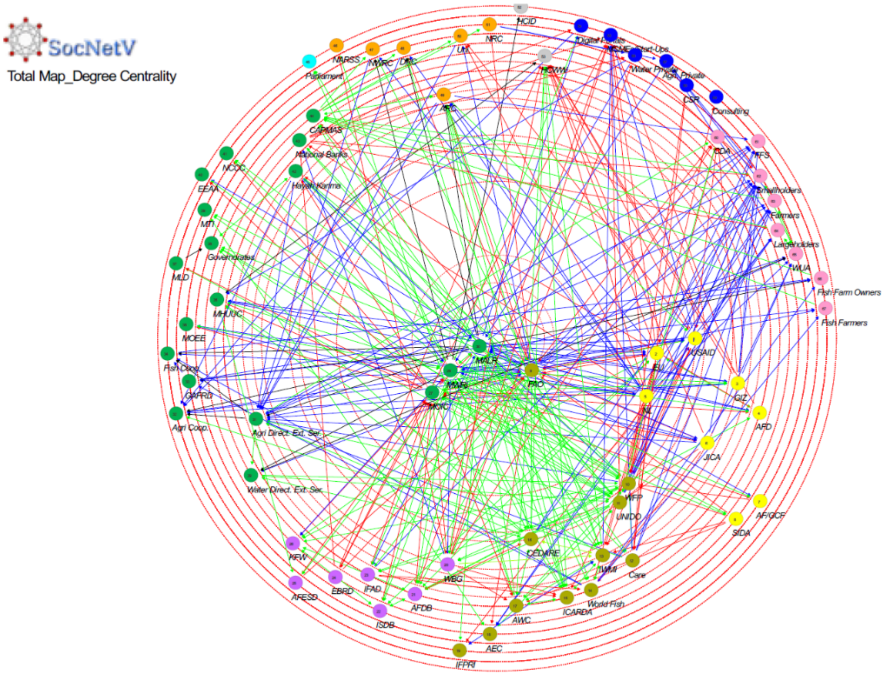


Figure 20 describes the CAWP social network based on the degree of centrality. The degree of centrality counts the total inbound and outbound flows from each node/institution.

Figure 21: Social Network Analysis: Total Relationships Based on Betweenness Centrality Analysis

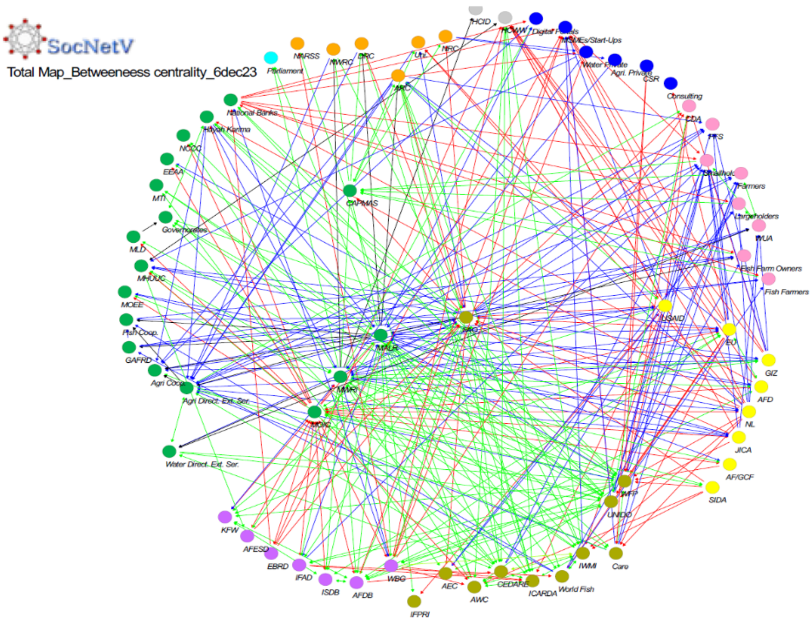


Figure 21 describes the CAWP social network based on the betweenness centrality. Betweenness centrality describes nodes/institutions play mediators between several actors horizontally and vertically, it reflects their power to provide information faster in the network, slows down, or distorts the flow in a way to serve the institution's interests.

Figure 22: Social Network Analysis: Technical Assistance Network

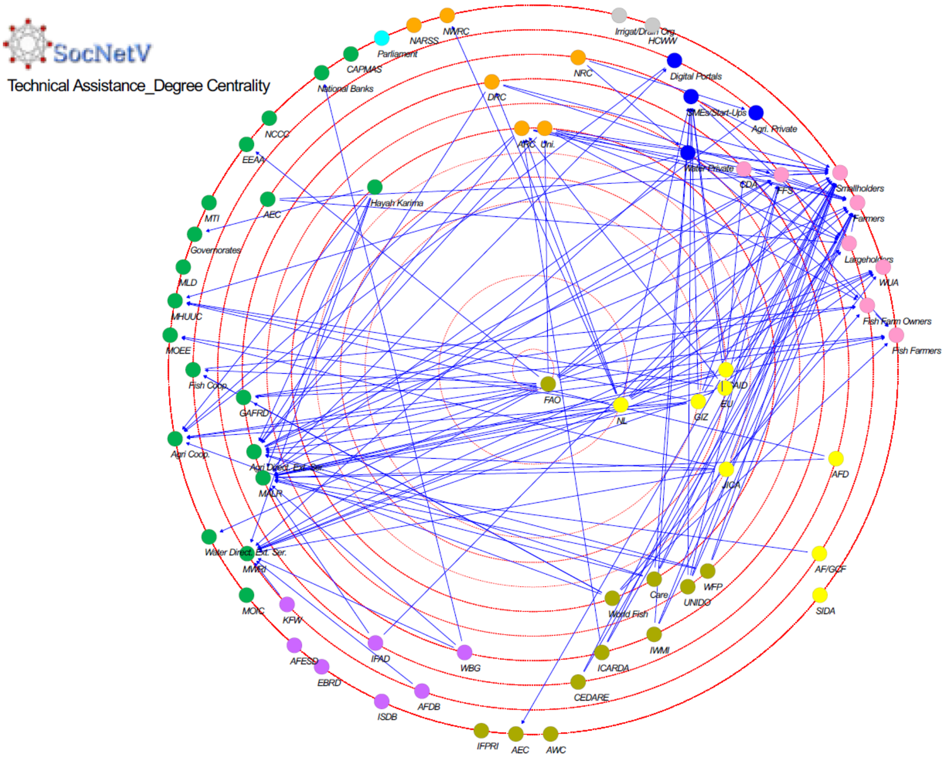


Figure 22 describes the position of powerful/central nodes influencing flows of technical assistance toward improving CAWP. The network is based on the degree of centrality.

Figure 23: Social Network Analysis: Fund Network

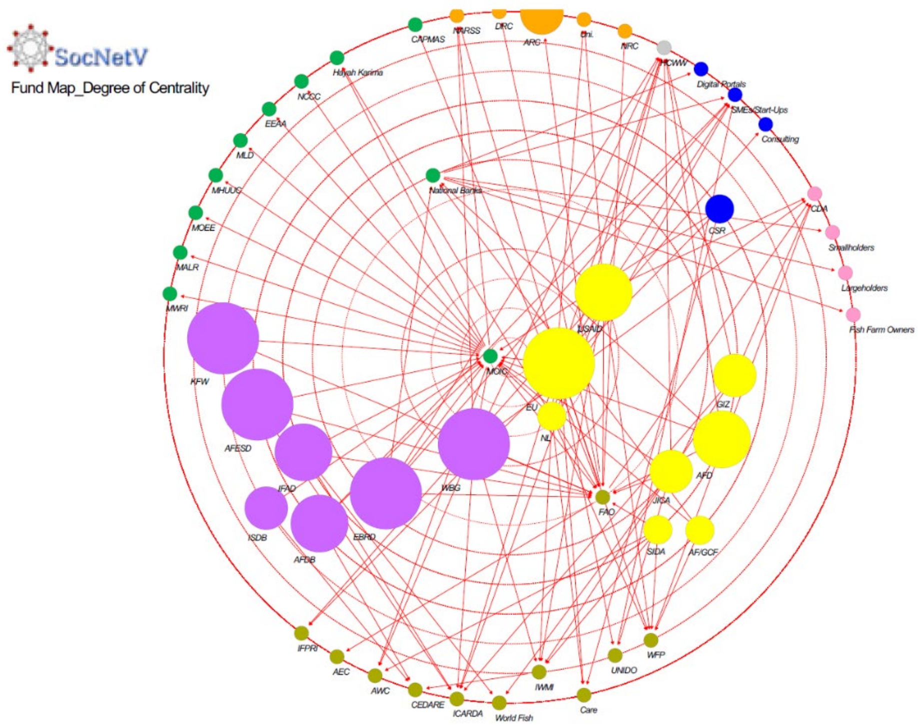


Figure 23 describes the position of powerful/central nodes influencing flows of funds toward improving CAWP. The network is based on the degree of centrality, where nodes at the center reflect the number of inbounds and outbounds flows. The size of the node reflects its allocated funds toward CAWP from 2016 to 2023.

Key finding 1: Power and Influence of National Government - The Centrality of MALR, MWRI, and MOIC in the Social Network

The Ministry of Agriculture and Land Reclamation (MALR) and the Ministry of Water Resources and Irrigation (MWRI) significantly influence and dominate the decisions related to enhancing CAWP. These ministries occupy a central position within the network because they leverage their bureaucratic institutions[2] and socioeconomic resources, knowledge, and expertise with the majority of stakeholders in the network to drive policy transformation linking food, land, water, and climate policy arenas (Fig. 18 and 19).

Several key informant interviewees expressed concerns about the lack of a clear policy to improve the socio-economic conditions of farmers. They noted that MALR's role has shifted to collecting national census data, with minimal interference and coercive power in agricultural operations, cropping patterns, and water usage (NPO A, pers. comm., 26 March, 2024; CDA A, pers. comm., 1 April, 2024; Ministry D, pers. comm., 9 May, 2024). This shift in roles is a consequence of the liberalization of agricultural policies in the 1970s and 1980s where farmers were left to contend with market power, freely cultivating what they perceived to be profitable according to their perception of market demand, which left smallholders with less than two *feddan* (2.07 acres – 8,400 m^2) at a disadvantage.

5.1.1. Horizontal Coherence Between MALR and MWRI

To facilitate efficient water management across sectors, MWRI has established water units within other ministries to track their water requirements for their activities informing planning needs. However, the absence of a state-regulated agricultural cycle has resulted in several challenges in accurately identifying water needs for each governorate. Hence, MALR and MWRI rely on their past experiences to allocate water resources in the canals, which may not always align with optimal water usage, because the water supply could exceed or fall short of the actual water demand for agriculture in this season (NPO A, pers. comm., 26 March, 2024; Ministry D, pers. comm., 9 May, 2024).

- High and Sub-Steering Committees

Since 2017, MALR and MWRI have formed a high-level steering committee following ongoing correspondence. The committee's composition is flexible, allowing for bilateral, trilateral, or even broader arrangements depending on the topics under discussion. There is currently no official decree or formalized structure governing this cross-coordination mechanism; instead, meetings are scheduled based on the emergence of relevant needs that require attention and discussion (Ministry E, pers. comm., 2 May, 2024; Ministry B, pers. comm., 26 March, 2024). When a specific topic demands the joint attention of both ministries, the high-level committee forms a sub-committee of sector experts to study it and provide recommendations for action. One sub-committee is dedicated to the modernization of irrigation and the optimization of crop cultivation techniques. Other sub-committees focus on water rationalization, specifically related to rice, bananas, maize, and wheat (Ministry E, pers. comm., 2 May, 2024; Ministry B, pers. comm., 26 March, 2024). These efforts align with Law 34 of 2018 and Law 147 of 2021, which emphasize the coordination between MALR and MWRI to regulate the cultivation of rice and other water-intensive crops and indicate the designated cultivation areas to foster horizontal coherence. The technical secretariat monitors the implementation of the agreed-upon actions.

Four potential scenarios may unfold after thorough discussions and decision-making within the sub-committees (Ministry E, pers. comm., 2 May, 2024):

1. Successful Completion: The case under consideration may be resolved successfully, indicating that the objectives agreed upon by the committee have been achieved.
2. Further Discussions and Resolution: Some cases require additional examination before reaching a conclusive resolution or action plan.

[2]The extension services sectors, agricultural services sector, land reclamation sector, economic studies sector at MALR; the Egyptian Public Authority for Drainage Projects (EPADP), the Mechanical & Electrical Department (MED), and the irrigation department at MWRI.

3. Referral to the High-Level Committee: Some sub-committees may face difficulties in resolving the case. In such situations, they may seek guidance from the high-level committee, which possesses broader authority and decision-making capabilities.

4. Halted or Temporarily Stopped: In certain cases, external factors beyond the committee's control, such as security or political considerations, may arise, leading to the temporary halt or suspension of the process.

5.1.2. Horizontal Coherence Between MOIC with MWRI, MALR, LFRPDA and Others

Figures 19 and 20 highlight the powerful role of the Ministry of International Cooperation in fostering collaboration and coordination among ministries, donors, and financial institutions. This coordination demonstrates a political commitment to establish horizontal partnerships that mobilize economic and social capital, bridge knowledge gaps, and advance smart technologies for enhancing climate-adaptive water productivity. These collaborative efforts have crystalized in the Nexus of Water, Food, and Energy "*NWFE*" program, also known as "fulfilling pledges". Launched in July 2022, this program aims to put into effect the recently announced Climate Change Strategy 2050 by upscaling adaptation and mitigation measures using various financial tools (Ministry C, pers. comm., 15 April, 2024). The NWFE program is structured around three main pillars: water, food, and energy. Each pillar is overseen by a primary donor organization – African Development Bank (AFDB) for water, International Fund for Agricultural Development (IFAD) for food, and European Bank for Reconstruction and Development (EBRD) for energy.

5.1.3. Horizontal Coherence Between LFRPDA with MWRI and MALR

The marginalization of the aquaculture sector is evident in the social network aimed at improving CAWP. MWRI's limited engagement with LFRPDA has resulted in the underrepresentation of the needs of fish farmers in policy discussions and steering committees, leading to trade-offs that may challenge the aquaculture sector's development. Redirecting drainage water from lakes to support agriculture and land reclamation projects such as the New Delta Project, could reduce aquaculture farming in the Beheira Governorate, highlighting the complex dynamics between agricultural and fisheries interests on drainage water (NPO H, pers. comm., 3 October, 2023). Furthermore, the network indicates that LFRPDA's integration into NWFE and major climate financing mechanisms is limited, which may impede progress toward producing more aquatic food per drop.

5.1.4. Horizontal coherence between CAPMAS and Sectoral Ministries

The role of the Central Agency for Public Mobilization and Statistics (CAPMAS) is significant within the network, particularly in terms of its betweenness centrality (Fig. 20). Access to reliable data is essential for effective policymaking and for ensuring accurate assessments. Betweenness centrality suggests that data may encounter challenges in flow or clarity between different institutions. This situation underscores the necessity for enhanced coordination and information sharing among relevant stakeholders to foster a clearer understanding of cultivated productivity, ultimately supporting more effective resource planning.

Land Data: There is a notable discrepancy in the capture and reporting of land data. In governorates adjacent to deserts, numerous lands have been illegally reclaimed without registration. While MALR does not recognize the unregistered lands, MWRI does account for them due to the reliance on water reserves from these areas. As a result, in the national census, MALR reports fewer cultivated lands than MWRI, because it only considers legally registered land. One interviewee indicated that the actual cultivated area may exceed 11 million *feddan*, while MALR and CAPMAS reported only 9.5 million *feddan* (CAPMAS 2024a) (Research A, pers. comm., 24 September, 2023).

Fisheries Productivity per Capita: Data also vary related to fisheries production per capita. The economic sector in MALR calculates two-thirds of the fish weight because it leaves the inedible third to account for lost weight. On the other hand, LFRPDA calculates the whole fish's weight. Consequently, CAPMAS and FAO rely on LFRPDA data for policy and programming design, which may not align with MALR's calculations. This divergence highlights the need for a more unified approach to data reporting to support effective policy development and resource management.

Key Finding 2: Vertical Coherence between National Research Centers, Local Extension Services and Other Knowledge End-Users

Collaboration with Local Extension Services: Research centers affiliated with sectoral ministries, such as the Agriculture Research Center and the National Water Research Center, are the most influential in improving the CAWP by providing technical support and/or local funding. Local researchers and extension services cooperate with national-level researchers to implement their recommendations. However, the collaboration between different research centers, cooperatives, and extension services remains limited to small-scale and pilot projects. This can hinder the full potential of achieving policy outcomes (Research A, pers. comm., 24 September, 2023; Private sector B, pers. comm., 10 October, 2023).

Collaboration with Small and Medium-Sized Businesses: Two small- and medium-sized businesses highlighted the fragmentation of non-conventional solutions and innovations between several disconnected research centers and institutions because of weak information exchange in the network (Private sector B, pers. comm., 10 October, 2023; Private Sector A, pers. comm., 11 October, 2023). Both emphasized their partnerships with farmers and the importance of strengthening the research and development component in their work through enhanced collaboration with research centers.

Key Finding 3: Partial Effectiveness of Decentralized Organs and Local Governance

Horizontal Coherence at the Local Level: The social network analysis indicated that agricultural directorates and extension services have established connections with donors and non-profit organizations involved in CAWP programming which has contributed to enhancing their social capital within the network. During the semi-structured interviews, the complex, yet weak horizontal coherence between the local organs was demonstrated. The effectiveness of local management within these directorates appears to be significantly influenced by individual characteristics, suggesting that the presence or absence of particular individuals can either advance or impede policy initiatives (NPO A, pers. comm., 26 March, 2024; CDA B, pers. comm., 1 May, 2024). Additionally, the sector experiences a notable turnover among local officials, attributable to comparatively low compensation, in addition to low budgetary resources placing them in a position of reduced influence and power.

Horizontal and Vertical Coherence with Extension Services: Public extension services have a limited role in the network of technical assistance (Fig. 21). Several interviewees have highlighted five factors contributing to the challenges faced by public extension services (Private sector B, pers. comm., 10 October, 2023; NPO A, pers. comm., 26 March, 2024; CDA A, pers. comm., 1 April, 2024; Ministry D, pers. comm., 9 May, 2024) : 1) the lack of cohesive policies or strategies linking research centers and extension services; 2) the traditional approach of extension services, which often results in insufficient engagement with new knowledge and innovations; 3) the absence of an agricultural cycle leading to complications for extension workers to support farmers in adopting new crop practices in shorter growing seasons; 4) low reachability to farmers because of insufficient staffing of extension services, where many personnel have retired, without replacement; and 5) the implementation of pilot projects without a clear path to scalability.

Key Finding 4: Power and Centrality of Donors and Financial Institutions

Currently, MWRI has engaged with Kreditanstalt für Wiederaufbau (KFW) on the Joint Integrated Sector Approach in the irrigation sector (JISA) project. The goal of this project is to create an interactive database that includes information on completed and ongoing projects (Ministry A, pers. comm., 6 December, 2023). This database will serve the ministry to track allocations and expenditures and identify its needs and areas for improvement, enabling financial coherence between national and international agendas.

The major categories close to the center of the network are donors and financial institutions. The financial coherence assessment complements the institutional coherence of entities involved in promoting CAWP. The fund social network shows how the World Bank Group, the EU, the Netherlands, and USAID are at the center of interactions in CAWP implementation (Fig. 22), followed by AFDB and IFAD.

International Finance Institutions: The World Bank Group (WBG) occupies a leading financial role because it encompasses many entities including the International Bank for Reconstruction and Development (IBRD), the Global Environment Facility (GEF), and the International Finance Corporation (IFC). The data also show the prevalence of the EU with all its investment tools through concessional development financing from the European Investment banks and/or grants from the European Commission. The Netherlands cooperation is a key player in providing technical assistance, educational support, and networking platforms to research centers, small and medium-sized businesses, farmers, and WUAs, through their universities and private sectors.

National Finance Institutions: National banks are among the better-positioned actors in the fund social network (Fig. 22) and have recently increased their power and influence over agrifood systems policies. They cooperate with financial institutions to offer loans to farmers to adopt good agricultural practices and install water-saving techniques. However, small and medium-sized aquaculture farms face barriers in accessing these bank loans because of their activities being deemed as high-risk. Consequently, private companies provide these loans to fish farmers with high interest rates (NPO H, pers. comm., 3 October, 2023).

Key Finding 5: High power and Centrality of FAO in Managing Flows of Funds, Technical Assistance and Information in the Network

The FAO is at the center of interaction, where it forges horizontal and vertical partnerships with the majority of institutions in the network aiming to improve CAWP (Figs. 19 and 20). The FAO hosts the water scarcity initiative which is built on "partnerships" with stakeholders and works on two levels: knowledge and technical assistance, and the coordination of activities with partners through meetings and bilateral exchange (NPO E, pers. comm., 16 April, 2024). The FAO can mobilize funds from donors and capacities to support the implementation of these activities at a bigger scale. It also has its private economic capital to regularly fund its annual program (NPO C, pers. comm., 16 April, 2024). FAO has an investment center that looks at unique ideas for nexus projects that support agrifood transformation in policy design and implementation (NPO D, pers. comm., 16 April, 2024). It also operates through FFS in most of its projects, which are designed to include a gender approach by including women in these FFSs.

Key Finding 6: Limited Engagement of Grassroot Organizations with Digital Applications

Despite many opportunities to leverage agrifood entrepreneurial activities in recent years, there are still untapped opportunities that foster farmers' machinery and equipment exchange through digital applications, biochar fertilizers, and upscaling solar panels for water distribution and irrigation (NPO A, pers. comm., 26 March, 2024). To increase interest in improving biophysical water productivity, many smallholders and renter farmers do not have access to digital innovations (weather forecasting, irrigation controllers, farm contract applications, etc.) because they only own basic phones without internet coverage and due to the absence of training on digital literacy to enable them to improve their water productivity. These digital innovations are only applicable to large landowners possessing high digital literacy to operate their farms (NPO G, pers. comm., 9 October, 2023; CDA A, pers. comm., 1 April, 2024).

Key Finding 7: Limited Engagement in Policies from Civil Society Organizations, Cooperatives, and WUAs

The analysis of the power and interest matrix reveals that Community Development Associations (CDAs), agriculture and aquaculture cooperatives, and WUAs stand at the margins of social networks with limited policy engagement in influencing public policy decisions related to CAWP.

Community Development Associations: The engagement of CDAs in agriculture and water-related activities remains relatively limited. Their interventions often prioritize immediate short-term outputs rather than long-term outcomes and address the root causes of land and water resources. This limitation is attributed to two main factors (CDA A, pers. comm., 1 April, 2024) and (CDA B, pers. comm., 1 May, 2024): 1) poor funding opportunities targeted at supporting community-based organizations working in the field of water and agriculture, and 2) many community-based organizations having difficulties in taking effective action on the causes of climate change in rural areas.

Cooperatives: Farmers struggle to secure fair prices for agricultural inputs while selling their products at low prices (Research B, pers. comm., 25 March, 2024; CDA A, pers. comm., 1 April, 2024). Smallholder farmers typically market their products individually and often lack negotiation skills, which limits their bargaining power. As a result, they sell their product cheaply to a set of intermediaries. This extended distance between end-users and farmers, with multiple parties involved in the process, affects market pricing, which becomes very expensive and impacts the prices of agricultural inputs. Parallel to agriculture, fish farming cooperatives face challenges with limited presence, there being around 13 cooperatives in 2020 (CAPMAS 2022a). In addition, the AsmakNet initiative, designed to connect suppliers with customers to enhance marketing strategies within the aquaculture sector, has struggled to persist (NPO H, pers. comm., 3 October, 2023).

WUAs: The power analysis revealed low power among WUAs, where only a few demonstrate effective cooperation (NPO A, pers. comm., 26 March, 2024). The effectiveness criteria were defined as follows: 1) farmers are collaborating under an agreed institutional framework using law 147 of 2021, 2) managing conflicts successfully without compromising interests, 3) mobilizing financial resources from members to purchase agricultural machinery or maintenance of water channels, 4) identify and distribute the quantity of water needed for each field, and 5) structured dialogue channels between WUAs and the irrigation and agricultural directorates.

WUAs are the cornerstone of future irrigation governance because they empower local beneficiaries to manage water resources for their interests, fostering a sense of ownership and accountability at the Mesqa or branch level. However, a significant challenge persists in accurately measuring water consumption across farms, necessitating the promotion of water accounting mechanisms. This also highlights an ongoing need for coherence in enhancing farmers' knowledge and capacity to manage these associations, because training efforts often become fragmented between the extension services of MALR and MWRI (Ministry A, pers. comm., 6 December, 2023).

Several key informant interviewees argued that smallholder farmers wield informal power over regulations and law enforcement due to their large numbers and the social and familial ties they form at the community level (NPO G, pers. comm., 9 October, 2023; Private sector A, pers. comm., 11 October, 2023). External stakeholders can leverage these community-based farmers' associations to deliver services and share new knowledge with peer farmers. Therefore, the ability to improve climate-adaptive water productivity lies in upscaling the structure of extension services and farmer field schools with community-based associations (CDAs, cooperatives, and WUAs) to apply new approaches to soil-water conservation, especially in saline lands in the Delta region, and equipping farmers with new skills on market product standards and negotiations strategies.

Chapter conclusions

This chapter explored the power dynamics of the institutional arrangement aimed at enhancing CAWP. Findings showed the centrality and significant steps toward building horizontal coherence between national governmental entities – including MWRI, MALR, and MOIC – in forging partnerships and advancing policies focused on water conservation and agricultural productivity, with horizontal incoherence related to engaging the aquaculture sector and coherent data with CAPMAS. In addition, findings discussed vertical incoherence between national research centers, local extension services, and other knowledge end-users, where innovations are fragmented and limited in scope, challenges are associated with decentralization entities responsible for managing land and water resources, and the weaknesses of public extension services, power and centrality of international and national financial institutions, high power and centrality of FAO in managing flows of funds, technical assistance and information in the network, limited engagement of grassroots organizations with digital applications, and limited engagement in policies from civil society organizations, cooperatives, and WUAs.

6. Recommendations to Improve Policy Coherence between Food, Land, and Water (FLW) Systems

6.1. Recommendations to Improve Policy Linkages between Food, Land, and Water Systems

Policy coherence between food, land, and water (FLW) systems can be framed into measurable outcomes such as improving climate-adaptive water productivity. Strengthening policy coherence refers to improving holistic planning and the use of natural resources.

6.1.1. Improve biophysical water productivity

Crop consolidation and the increase in agricultural production (Medium-Term)

Many stakeholders have advocated for the return of the agricultural cycle (consolidating crop cultivation in a given area) given its synergies with enhancing CAWP. To ensure the success of this cycle, it is essential to strengthen regulations governing contractual farming. Moreover, the cycle would ease the work of agricultural and irrigation extension services in adopting best practices. It will also support a robust collective action of farmers, who cooperate on pesticide or fertilizer management and adopt uniform water-saving practices. To maintain the trust of farmers, the effectiveness of the cycle must be adaptable year by year, with a degree of flexibility for farmers to opt out of this process if needed.

Aquaculture-Agriculture Integration (Medium-Term)

The integration of aquaculture-agriculture poses a potential solution to mitigate trade-offs, by directing water to the aquaculture sector at the start of the water cycle and subsequently to agriculture. The Integrated Agri-Aquaculture Systems (IAAS) Project in the Center for Applied Research on the Environment and Sustainability (CARES) at the American University in Cairo is an illustrative example of generating synergies between farm components that generate high crops and fish production with less water. The use of crop by-products as supplementary feed for fish, the use of pond sediments as terrestrial crop fertilizers, and the use of aquaculture wastewater for crop irrigation are the most common positive interactions of agriculture-aquaculture systems. Although this system started to operate in different research centers, it requires detailed legislation across sectoral strategies and upscale innovation at the grassroots levels.

Holistic Sectoral Planning (Long-Term)

It is suggested to build on existing initiatives to develop one holistic strategy that addresses the interlinkages between FLW and its impact on the economy and society. This strategy should cover quantitative and qualitative assessment of synergies and trade-offs across sectoral policies focusing on establishing water-saving techniques, enhancing land fertility, promoting agricultural productivity, improving water quality, adapting to dry weather, boosting market competitiveness, and enabling the institutional, policies, and investment environment. Additionally, holistic planning must consider water allocation to the fish farm sector. An illustrative example of sectoral planning involves effectively managing horizontal expansions in desert areas because it entails developing new lands and new water resources, adaptability to climate change, and preserving the ecosystems to support economic growth and social equity. Moving forward, sectoral cooperation needs to ensure that future land reclamation projects are aligned with water availability and sustainable irrigation practices.

6.1.2. Improve Economic Water Productivity

Water Index for Better Economic Productivity (Medium-Term)

The existing water index should be better capitalized for fish farm production. This water index will be based on water quality and standards, water usage efficiency, social impact, and climatic readiness to increase economic water productivity. It will address the underrepresentation of the aquaculture sector in the export market, because the EU does not accept Egypt's aquaculture produce due to the violation of safety regulations. The Ministry of Trade and Industry could engage the Egyptian Organization for Standardization & Quality in integrating the water index as a sort of certification system for the safety of trade products for small and medium fish farms. This system will enable access to better markets and fairs.

Economic Cost of Water (Long-Term)

To accurately estimate the profitability of crops for both the state and farmers, it is recommended to measure the economic cost of water. This measurement involves considering two key aspects: the calculation of depreciation of physical and operational assets per hour along with the study of market distortions caused by taxes and subsidies and their impact on water pricing.

6.1.3. Improve social water productivity

One-stop shop for aquaculture activities (Short-Term)

A centralized platform or a one-stop shop for fish farmers can streamline the process of obtaining or renewing their licenses. The ease of bureaucratic procedures will increase the legality of privately-owned fish farms, and hence, their access to credits and subsidized inputs. Moreover, there is a need for legislation that specifically addresses the quality of drainage water used by fish farms and provides incentives to farmers to establish water treatment units for both incoming and outgoing water in each farm to prevent the transmission of epidemics.

Incentives for CAWP (Short-Term)

According to some interviewees, it is important to recognize that farmers are essentially businessmen. Therefore, to ensure long-term sustainability, any incentives provided to them to enhance CAWP must directly contribute to increasing their financial profit. To create incentives, direct monetary rewards have been emphasized by many interviewees (Private sector B, pers. comm., 10 October, 2023; NPO A, pers. comm., 26 March, 2024; CDA A, pers. comm., 1 April, 2024; NPO C, pers. comm., 16 April, 2024). However, it is pivotal to calculate the economic cost of water to ensure the fairness and accuracy of these incentives.

To further strengthen the impact of incentives, contractual farming arrangements can be explored, wherein farmers agree to adhere to specific standards and practices in exchange for a portion of their agricultural production being purchased. Such an arrangement not only provides financial incentives to farmers but also ensures adherence to quality standards and sustainable agricultural practices.

6.2. Recommendations to Strengthen Institutional Cross-Coordination

6.2.1. Horizontal Coherence

Capitalize and Replicate NWFE's Programs (Short-Term)

The NWFE initiative should be replicated by maximizing its benefits by applying the same nexus approach to an agreed geographical area to monitor the interlinkages between water use, energy efficiency, and food production.

Aligning Egypt Priorities with Donors and Development Partners (Medium-Term)

Currently, MWRI is establishing an interactive database of all past and ongoing developmental projects. This database should serve to analyze the level of engagement from donors or lenders, assess how existing projects contribute to the ministry's strategic outcomes, track monitoring indicators, and identify priority areas for donor engagement with national needs. It is recommended to expand this database practice across the main ministries (MALR, MWRI, and EEAA) to serve in managing coherent donor funding.

6.2.2. Vertical Coherence

Strengthen the Operational Framework of cooperatives and associations (Short-Term)

The collective action of farmers and innovative leaders should be supported to facilitate networking and develop common interests with various stakeholders in the network, including public officials, donors, or civil society organizations (CDA A, pers. comm., 1 April, 2024; NPO F, pers. comm., 16 April, 2024; CDA B, pers. comm., 1 May, 2024). In addition, this collectivity strengthens social ties, by promoting peer-to-peer learning, sharing best practices, exchanging agricultural input, and marketing their products. These social associations could serve as hubs to harness digital inclusivity for smallholder farmers because access to technology and smart applications supporting CAWP can be costly or challenging to use, especially related to optimal irrigation practices. These collective actions or associations could take different shapes: cooperatives, water users associations, and champion farmers.

- Cooperatives

Companies and factories typically prefer to not source from individual farmers with small land plots of one or two *feddan*; they often seek larger yields to meet their operational demands. In this context, the formation of a cooperative could focus on the cultivation and development of specific plants linked to public and private sector needs. This approach allows companies interested in purchasing agricultural products to engage with the cooperative as a cohesive entity, rather than dealing with individual farmers, thereby enhancing market access and negotiating power for the participating farmers. Robust and sustainable cooperatives are linked to strengthening regulations on crop consolidations and contract farming.

- Water Users Associations

The existence of water accountability mechanisms would support the community to accurately measure water distribution to each farm. In addition, the WUAs still need to transcend barriers of mobilizing financial resources from members to purchase agricultural machinery or undertake repairs or maintenance to water channels and establish structured dialogue channels between them with the irrigation, drainage, and agricultural directorates.

- Champion Farmers

It is suggested to state-sponsor pioneering farmers who volunteer to convert their lands into a farm field school that adopts water productivity innovations. This serves to build a farmer-to-farmer dialogue, where they meet weekly to ask about productivity, diseases, and the price of selling. If successful, this can create peer pressure to enable other farmers. In this regard, farmers could benefit from the "FAO track" opportunity, which was launched at the 6th edition of Cairo Water Week. This platform sponsors and honors the best water conservation practices.

Conclusions

This report presents a policy coherence framework analysis between FLW systems. This study argues that improving climate-adaptive water productivity is the common policy frame across sectoral policies in Egypt. Through this frame, the researchers were able to understand the complexities of policy linkages between natural resources and governance, and the existing institutional arrangement. This study mainly focuses on vertical and horizontal coherence aimed at achieving an improvement of biophysical, economic, and social water productivity.

This study uncovers five main sectoral policy linkages aimed at improving water productivity in the three dimensions (biophysical, economic, and social): 1) efficient use of water and rationalizing water consumption to increase agricultural productivity, enable climate-adaptive water management, and reinforce water availability at the tail of the canals and for other sectors; 2) developing land and water resources to support higher and sustainable agricultural productivity growth; 3) sustaining water quality to reinforce food production, increasing food competitiveness in local and foreign markets; 4) balancing the food trade and increase food trade competitiveness; and 5) improving the financial and governance frameworks of biophysical and economic food production and quality, preserving livelihoods and maintaining fair incomes.

Many policy synergies are related to improving biophysical water productivity coherence. Synergies exist between current water rationalization infrastructural development programming, the development of drought-tolerant varieties that increase productivity, and water availability for agricultural expansion or other sectors. In addition, policy synergies focus on developing new water resources and new lands by developing non-conventional water resource treatment stations and consolidating fragmented lands. However, trade-offs are mostly apparent in outcomes related to improving economic and social productivity, and the biophysical production of fisheries. The limitation on cultivation of high-water consuming crops impacts farmers' incomes and livelihoods. The absence of calculating the economic cost of water and the measurement of the impact of market distortion influence the real cost of agricultural and food commodities, especially in foreign markets, and impact the overall share of agriculture in the economy. Moreover, concerns related to job creation and imbalances between export investments and food domestic needs hinder improvement in social water productivity. Finally, many small-scale fish farms operate illegally while struggling with bureaucratic complexities, and they depend on low water quality, which incumbers their productivity, and the potential for exports.

This study uncovers the power dynamics and the institutional coherence of FLW systems. It reveals eight findings related to the Centrality of the Ministry of Agriculture and Land Reclamation, the Ministry of Water Resources and Irrigation, and the Ministry of International Cooperation in influencing policymaking decisions related to better integration of FLW systems. There is somehow horizontal coherence at the national level through interministerial committees. However, vertical coherence between national and local levels and the cooperation between public officials at local levels is still underdeveloped. The analysis reveals the influence of donors and financial institutions on improving coherent decision-making. Moreover, the analysis showed the significance of research centers and knowledge transmission in building powerful agrifood start-ups and farmers' peer learning through farmer field schools. In addition, the analysis also shows the marginalization of farmers' associations from the policymaking decisions and the fragile vertical coherence between farmers and decision-makers.

This study hence recommends holistic horizontal planning across sectors to manage land expansion, agricultural and aquacultural productivity, and water management, emphasizing the significance of the return of the agricultural cycle aligned with contractual farming. It also recommends establishing a water index in cooperation with the Ministry of Trade and Industry, which can be complemented by incentives for farmers to adopt water-conserving techniques. Related to the status of fisheries, the study recommends legislation to focus on the integration between agriculture and aquaculture by upscaling good initiatives at the grassroots levels and unifying the licensing system under a one-stop-shop that improves the legality of fish farmers, sustains livelihoods, and increases the quality of production.

The study also recommended building on the existing inter-ministerial committee by legalizing its framework of work, adding decision-making mandates, and expanding it to include the Ministry of Trade and Industry and the Lakes and Fisheries Resources Protection and Development Agency. Furthermore, it recommends reviving the integrated water resource management at the district level and supporting a collective association framework of farmers by reviewing policies related to cooperatives, water users' associations, pioneering farmers, and civil society organizations. Furthermore, it advocates for building an integrated database of agricultural, water, and climate programming to monitor progress and align funds toward the same outcome. Moreover, to strengthen financial coherence, it recommends capitalizing and replicating NWFE's experience, capitalizing on domestic funds through national banks and social corporate responsibility, and calculating the economic cost of water to improve the coherence of food, land, and water with economic outcomes. Finally, policy coherence of FLW systems is hard-wired into people's livelihoods, aspirations, and development by empowering social associations of farmers to access knowledge and new innovations from researchers to reach common policy outcomes at the grassroots levels.

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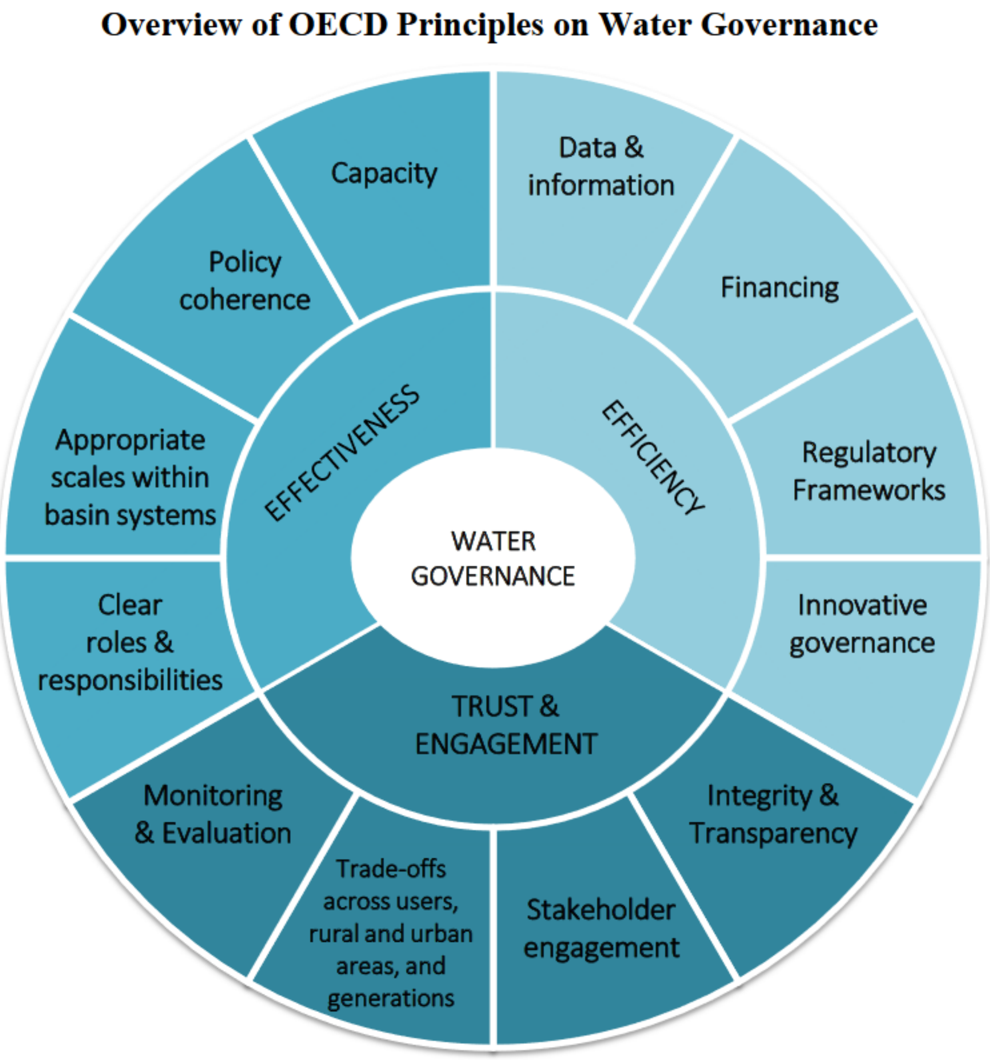
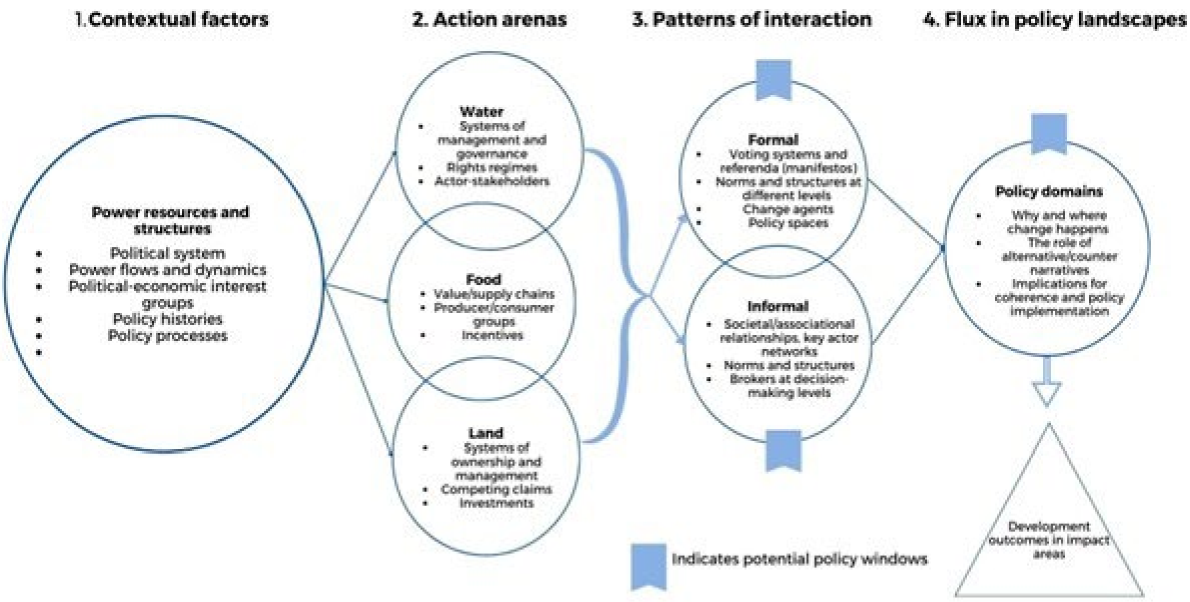
Annexes

Annex I: OECD Water Governance Principles



Annex II: The PILA framework by Nicol et al. forthcoming 2024



Annex III: Database of Water Productivity Laws

Areas	Title of the Documents
Water Management	• National Water Resources Plan (NWRP) 2017–2037 • Water Resources Development and Management Strategy 2050 • Resolution No. 1383 of 2005 concerning the protection of Nile River and coast • Egypt Code for Water Reuse 2015 • 2030 National Vision for Wastewater Re-use in Egypt • Law No. 48 of 1982 concerning the protection of the Nile River and the water channels against pollution, including amendments law 103 of 2015 • Law No. 147 of 2021 promulgating the Water Resources and Irrigation • Law No.146 of 2021 for the Protection and Development of Lakes and Fisheries
Land/Soil Management	• Sustainable Agriculture Development Strategy 2009–2030 • Ministerial Decree No. 590 of 1984 concerning agricultural fertilizers • Law 38 of 1976 Improving and maintaining agricultural lands, including amendments law 14 of 2019 • Agricultural Law No. 53 of 1966, including amendments law 7 and law 34 of 2018 • Laws on rice cultivation: law 58 of 2012 and law 61 of 2013
Food Management	• Ministerial Decree No. 974 of 2017 concerning Registration, Handling and Use of Agricultural Pesticides • Ministerial Decree No 90 of 2007 on Controls for registration, renewal and use of agricultural pesticides • Ministerial Decree No 38 of 1997 on Conditions and procedures for approving agricultural crop seeds, trading, importing, exporting, preparing, storing and trading in them. • Law 12 of 2020 on Organic Agriculture
Food Trade	• Ministerial Decree No 182 of 2020 on Establishing the Egyptian Commodity Exchange • Presidential Decree 14 of 2015 on Agricultural Contracting
Climate/Environmental Adaptation	• National Climate Change Strategy 2050 • Law No. 4 of 1994 on Environment

Authors

Fayrouz Eldabbagh,, National Researcher - Political Scientist, IWMI, Cairo, Egypt
f.eldabbagh@cgiar.org

Noura Abdelwahab, Gender and Social Inclusion Expert, IWMI, Cairo, Egypt
n.abdelwahab@cgiar.org

Youssef Brouziyne, Country Representative – Egypt, IWMI, Cairo, Egypt
youssef.brouziyne@cgiar.org

Juan Carlos Sanchez Ramirez, Research Group Leader - Water Governance and Political Economy, IWMI, Addis Ababa, Ethiopia J.SanchezRamirez@cgiar.org

Alan Nicol, Principal Researcher, IWMI, Addis Ababa, Ethiopia a.nicol@cgiar.org

Fayrouz Eldabbagh,, National Researcher - Political Scientist, IWMI, Cairo, Egypt
f.eldabbagh@cgiar.org

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