Strategy of the Ministry

Arab Republic of Egypt

Ministry of Water Resources and Irrigation

Strategy for the Development and Management of Water Resources until 2050

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- 1-Introduction

Freshwater resources are considered among the most important natural assets for all countries, vital not only for life but as a cornerstone of sustainable development. Because water is often not available with the required quantity and quality at the right time, countries strive to secure needs, protect against droughts and floods, and maintain water quality. Egypt, located within arid belts, is highly sensitive to its limited water resources that largely originate beyond its borders, relying mainly on the Nile, with other sources contributing no more than 7%. Traditional resources include Egypt's Nile allocation of 55.5 b cm per year due to *the 1959 Egypt–Sudan agreement*, limited rainfall and flash floods, and deep non-renewable aquifers in the Western and Eastern Deserts and Sinai, which can be planned for long-term, plus desalination for coastal drinking supplies and some brackish aquifers. Non-conventional resources include reuse of agricultural, municipal, and industrial return flows, and shallow groundwater in the valley and delta recharged by seepage from the Nile, canals, drains, and agriculture water.

Egypt faces rising water challenges: population growth and higher living standards increase demands across sectors, widen the food gap requiring more cultivated land (hence more irrigation), and raise pollution risks in waterways, while climate change may affect Nile inflows and domestic demands, especially irrigation. Egypt's water system is quasi-closed, relying on multiple reuse cycles that, without suitable treatment, risk quality degradation; thus, environmental pollution and water quality decline are key challenges to protect public health and safe reuse. A long-term strategy must be grounded in sound understanding of climatic, hydrologic, environmental, economic, social, and geopolitical contexts, recognizing solutions often lie beyond the water sector (e.g., agriculture, housing, industry). The 2050 Strategy has been prepared as a document that highlights expected future changes in resources and management to meet essential national needs under anticipated scarcity.

1-1 Strategic Objective

Achieving Egypt's water security now and in the future is the strategic objective through 2050, requiring strong political will and prioritization, given worsening challenges if not addressed comprehensively. Scientific, realistic, and actionable water strategies are needed, with flexible plans and alternatives to choose implementable options; the 2050 Strategy provides technical, economic, social, environmental, and organizational frameworks to support decision-makers.

1-2 General Goal

The 2050 Strategy aims to achieve water security via sustainable management: developing and managing limited water resources while managing present and future demands. The 2050 Strategy is anchored in Integrated Water Resources Management principles.

1-3 Methodology for Preparing, Approving, and Implementing the Strategy

Methodology for Preparing, Approving, and Implementing the Strategy is Built on three pillars:

- **inclusiveness/participation/integration in preparation and approval.**
- **phased implementation.**
- **Following the scientific, and applied approaches to developing and managing water resources in Egypt.**

1-4 Strategy Pillars

The 2050 Strategy aims to ensure water security through four main pillars. That aim to provide urgent and long-term solutions for sectoral needs within an environmental and developmental perspective at main time led to protect all water resource and its environment.

- **Development of conventional and non-conventional resources.**
- **Rationalization of water use and maximizing returns in agriculture, industry, and drinking water.**
- **Improving water quality by combating pollution across all water bodies.**
- **Enabling environment for integrated water resources management.**

2 Current Water Status

2-1 Water Footprint

Egypt's high total water needs amount to approximately 110 billion cubic meters annually. Egypt imports virtual water in the form of agricultural and livestock products... amounting to approximately 20 billion cubic meters annually (the amount of water required to produce these products if they were grown and produced in Egypt). The total water needs, after excluding the virtual water imported, amount to approximately 80 billion cubic meters annually. In contrast, Egypt's total water resources amount to approximately 59.25 billion cubic meters annually. Thus, there is a water gap between (growing) water needs and limited water resources, currently amounting to 20.75 billion cubic meters annually.

2-2 Water Resources

The total annual water resources of conventional, currently available, surface water are approximately 59.25 billion cubic meters. This includes Egypt's share of the Nile River (55,5 billion cubic meters), deep groundwater (2,1 billion cubic meters), rainwater and flash floods (1,3 billion cubic meters), and desalinated brackish and brackish water (0,35 billion cubic meters).

2-2-1 Nile Water

The Nile River represents the majority of Egypt's surface water resources. Originating in the Ethiopian Highlands, it accounts for approximately 85% of the Nile's flow at the Ethiopian Highlands. The Equatorial Lakes region and South Sudan contribute about 15% of the Nile's flow at Aswan.

2-2-2 Deep Groundwater

Groundwater is a strategic reserve under scarcity; management aims to safeguard future generations' rights and optimize use, with cautious assessment to ensure sustainability and maximize water productivity per land and use unit.

2-2-3 Rainfall and Floodwater Harvesting

Rainfall rates on the northwestern coast increase by an average of about 200 mm per year, decreasing as one move eastward and decreasing rapidly as one move southward. Rainfall is also higher in the Red Sea Mountain range and its surrounding areas. Floods are common in arid and semi-arid regions, caused by heavy rainfall over a short period.

Rainwater and floodwater along the Red Sea, Sinai, and Mediterranean coasts are among the most important sources of fresh water for Bedouin and tribal communities in these areas, used for drinking and agriculture.

2-2-4 Seawater Desalination

Desalination is a critical future source for coastal development; Egypt's coasts along the Red Sea and Mediterranean are favorable, with cost the main constraint. Near-term reliance on desalination is expected to increase for coastal and remote areas with brackish groundwater.

2-3 Water Reuse

2-3-1 Reuse of Agricultural Drainage Water

Suitable quality drainage water is reused, along with Nile River water, to meet the water needs of the Nile Valley and Delta.

The total volume of reused agricultural drainage water is currently estimated at approximately 21 billion cubic meters annually. This includes reuse in Lower and Upper Egypt, reused agricultural drainage water in Fayoum, shallow groundwater in the Nile Valley and Delta, and treated wastewater

2-3-2 Use of Shallow Groundwater in the Valley and Delta

The use of shallow groundwater in the valley and the Delta is a form of reuse, as this water is not an independent resource. These aquifers are recharged from existing irrigation systems and canal networks. Therefore, this water is part of the water supply and is used as a supplementary source to surface water in some areas

2-3-3 Reuse of Treated Municipal and Industrial Wastewater

Expanding wastewater treatment is essential to improve water quality, especially where reuse occurs; treated wastewater

is directly used in agriculture in various areas per the Egyptian reuse code, which dictates crop types by treatment level and measured effluent quality.

2-4 Water Uses by different Sectors

Water consumption in Egypt is increasing significantly due to rapid population growth and the resulting increase in the needs of various sectors. Agriculture, drinking water, and industry are the largest water users. Priority is given to meeting the needs of the drinking water sector, as it is a fundamental human right and essential for life. Water is also crucial for maintaining ecosystems and biodiversity. Furthermore, electricity generation and navigation are essential sectors, as they are water users rather than consumers. A portion of water resources is also used for tourism, recreation, and fisheries.

2-4-1 Water Uses in the Agricultural Sector

The agricultural sector is the largest water user in Egypt, accounting for approximately 75% of the total water needs (agricultural, drinking, and industrial sectors). Factors that have helped meet this sector's requirements in recent years include expanding the reuse of agricultural drainage water and groundwater, as well as reducing the amount of freshwater required to maintain biostability, particularly during periods of low demand, to a minimum of 0,2 billion cubic meters annually. This has led to problems in the Nile River (especially in the Rosetta branch), impacting drinking water needs in the northern governorates.

Providing the additional water required for the agricultural sector in the future depends on changes in the needs and priorities of drinking water and industry, along with expanding the use of groundwater from the potential of aquifer basins and implementing measures to achieve biostability in the northern lakes.

2-4-2 Water Uses for Drinking Water Sector

The steady increase in population and the shift towards urbanization at the expense of rural areas, along with the transfer of drinking water from rural areas, has led to a significant increase in consumption rates and the total quantities used for drinking and industry in recent years. According to data from the Ministry of Housing, Utilities, and Urban Development Coverage reached about 99% nationwide by 2015.

The amount of drinking water produced in 2015 reached approximately 10, 6 billion cubic meters. This figure includes a portion of the water used by small and medium-sized industries located in cities and villages, estimated at about 15-30% of the total drinking water produced.

2-4-3 Water Uses for Industry

Water uses in industry vary according to the nature of the industrial activity. The needs of the industrial sector have increased significantly in recent years. The water requirements of the industrial sector, excluding cooling water used in power plants, were estimated at approximately 5.40 bcm in 2015 Industrial facilities obtain a portion of their water from drinking water networks, ranging between 15–30% of the total industrial sector usage, with the remainder coming from the Nile, the irrigation network, and groundwater wells.

Industrial demand (excluding power-plant cooling) was about; is supplied from municipal networks, with the remainder from the Nile, canals, and wells.

2-4-4 Water Uses for Navigation

Navigation is a sector that uses and consumes water. The Nile River is used as a navigable waterway, in addition to canals and some main irrigation ditches. The construction of the Aswan High Dam has improved navigational conditions on the Nile throughout the year by regulating the river's flow, allowing for suitable navigation in both summer and winter. Navigation depends on River water is released from the High Dam to meet the needs of all sectors, and no additional water is released for navigation purposes.

2-4-5 Hydroelectric Power Generation

The total annual hydroelectric power generated from industrial works on the river is estimated at approximately 13,545 gigawatt-hours (GWh). Hydroelectric power is generated through the High Dam, Aswan Reservoir, Aswan Reservoir 2, the new Esna Barrages, the new Nagaa Hammadi Barrages, and the Lahun Power Station on Bahr Yusuf Canal. New Assiut hydroelectric power stations are currently under construction, and the use of turbines is being studied.

Non-traditional hydroelectric power generation is available at all available locations along the Nile River and its branches. Currently, hydroelectric power accounts for approximately 7.3% of Egypt's total electricity generation. Hydroelectric power generation relies on the water released from the High Dam to meet the needs of all sectors; no additional water is released during high tide for hydroelectric power generation

2-5 Legal Framework

Irrigation and Drainage Law No. 12 of 1984 serves as the foundational law for irrigation and drainage works. The Ministry is responsible for implementing all aspects of this law. This law governs irrigation operations, water distribution, and the construction and maintenance of drains in the Nile Valley and Delta. Law No. 213 of 1994 and its executive regulations provide the legal basis for reimbursing the costs of development and optimal drainage projects, as well as for the formation and participation of water user associations along the waterways.

Law No. 48 of 1982 and its executive regulations govern the procedures for protecting the Nile River and waterways from pollution. The law specifies fines and penalties. There is also Law No. 4 of 1994 concerning environmental protection, amended by Law No. 9 of 2009.

These laws are currently being developed through the drafting of a unified water law, which aims to modernize the system of legislation and laws related to water issues. This modernization seeks to overcome implementation obstacles and make the necessary amendments to meet the needs of the next phase.

2-6 The Institutional Framework for Water Resources Management

The Ministry of Water Resources and Irrigation is the primary entity responsible for developing and managing water resources in Egypt. It collaborates with several other relevant ministries, most notably the Ministry of Agriculture and Land Reclamation, the Ministry of Housing, Utilities and Urban Communities, the Ministry of Energy and Electricity, the Ministry of Industry, the Ministry of Health and Population, the Ministry of Local Development, the Ministry of Environment, the Ministry of Transport, and the Ministry of Planning.

3 Water Resources Development and Management Strategy until 2050

The 2050 strategy aims to achieve modern water security through the implementation of sustainable water resources management.

This management encompasses both water safety and the management of limited financial resources, on the one hand, and the management of current and future financial needs, on the other.

3-1 Resource Development Policies

3-1-1 Nile Water

The Egyptian strategy for water resources development and sound management relies on strengthening relations between Egypt and the Nile Basin countries, supporting and consolidating the historical relationship between Egypt and the Nile Basin countries, enhancing developmental and economic cooperation, establishing regional economic entities, creating and supporting economic ties between Egypt and the Nile Basin countries, building mutual trust, and working to enhance joint regional cooperation and bilateral cooperation in various fields of development. The Nile Basin is conducive to stability and progress, encompassing economic, social, and cultural spheres. This includes encouraging the presence of Egyptian companies, investors, and the private sector. The Egyptian state is making significant efforts to preserve Egypt's share of the Nile waters, which is considered a red line, especially given the development projects undertaken by upstream Nile Basin countries without consultation or agreement with the upstream nations. There are also attempts to increase Egypt's share of the Nile waters through cooperation in projects that maximize benefits within the Nile Basin while mitigating negative environmental impacts, thereby enhancing the overall water resources of the basin.

3-1-2 Groundwater

There is potential for expanding the use of groundwater by implementing policies that promote its optimal development and sustainability. These policies aim to protect groundwater reservoirs from degradation, both in terms of quantity and quality, and to direct studies and research, as well as amend legislation, to serve this vital resource. Important measures in this regard include:

- **Utilizing shallow groundwater in the Nile Valley and Delta, taking into account the need to prevent seawater intrusion and to continuously monitor water levels and the quality of the extracted water.**
- **Utilizing groundwater from the Nubian Sandstone Aquifer, based on precise calculations of the quantities of water that can be safely extracted to ensure the aquifer's sustainability and maximize the economic benefit per unit of water, especially given its very limited and finite nature.**
- **Utilizing new and renewable energy sources, particularly solar energy, in the development and exploitation of groundwater.**
- **Expanding the implementation of rainwater and flood harvesting projects to increase the recharge of the coastal aquifer. Although the amount of water available in the coastal aquifer is not large and depends on the amount of rainwater replenishing it, this aquifer is considered a very important source of drinking water and industrial water supplies in those areas.**
- **Reducing excessive extraction from groundwater aquifers that are subject to over-extraction to reach their equilibrium capacity through a phased plan.**
- **Expanding the use of advanced technology in monitoring operations and establishing a system for periodic and continuous monitoring of water levels and quality in all groundwater aquifers through a network of monitoring wells to take appropriate preventive measures that ensure the sustainability of the groundwater reserves.**
- **Working to utilize brackish groundwater.**

3-1-3 Rainfall/Flood Harvesting and Protection

Rainfall in Egypt is concentrated in the Red Sea Mountain range, the Sinai Peninsula, and the North Coast, especially the Northwest Coast. To maximize the utilization of rainwater and floodwater, and to protect against the dangers that may arise from them, several measures should be taken, which can be outlined as follows:

- **Constructing reservoirs and lakes to utilize rainwater, particularly in the Eastern Desert and the Sinai Peninsula. This will contribute to achieving security and social stability in these areas, while also maximizing the economic benefits of harvesting this water.**
- **Preparing and updating the Egyptian Atlas of Critical Flood-Prone Areas. This atlas should include a classification of priority areas and their sizes according to risk levels, identifying safe zones for various development activities, and outlining the necessary protection works.**

- **Preparing the Egyptian Flood Code, which includes defining storm design requirements and protection structures. Identifying hydrological models to determine the size and behavior of flash floods and the protective measures that can be implemented.**

- **Implementing an early warning system in areas most prone to flash floods, as this system can predict flash floods within a reasonable timeframe.**
- **Reconstructing all structures located in (random) flood channels in cooperation and coordination with relevant authorities.**

3-1-4 Reuse of Agricultural Drainage Water

The reuse of agricultural drainage water, after mixing it with canal water according to the standards stipulated in the *Tamil Regulations, Law No. 18 of 1982*, is a key measure to improve the overall efficiency of water management in the agricultural sector. The main problem lies in the deterioration of water quality in some drains due to pollution from untreated sewage and industrial wastewater that reaches agricultural drains. Therefore, it is important to focus on preventing the pollution of this water and treating it with economically effective methods where necessary. The availability of agricultural drainage water should be considered in expanding irrigation development projects. The most important procedures for reusing agricultural drainage water can be summarized as follows:

- **Expanding the mixing of drainage water from branch drains with canal water, which is called intermediate reuse.**
- **Reconsidering the maximum salinity of reused wastewater in light of mixing ratios and the nature of agricultural crops, as the salinity of irrigation water mixed with crops can be increased to mitigate this salinity.**

3-1-5 Reuse of Treated Municipal Wastewater

Within the framework of maintaining water quality in waterways in general, it is important to treat wastewater. Most of this water ends up in waterways, and some quantities are directly reused in irrigating certain crops according to the Egyptian Code for Reuse. The most important procedures for this can be summarized in the following:

- **Expanding the construction of wastewater treatment plants and increasing the coverage of wastewater treatment services in urban and rural areas.**
- **Expanding the construction of wastewater treatment plants with cost-effective technologies in villages and working to encourage civil society organizations and NGOs, providing them with financial and technical support for the construction, operation, and maintenance of these plants.**

- **Prioritizing the locations of wastewater treatment plants in conjunction with the mixing of water uses in areas adjacent to waterways.**
- **Types of precautions and correct standards when using treated wastewater for irrigation, as defined by the Egyptian Code in terms of treatment type, crop type, and health and safety precautions.**
- **Work on educating the processes of disposing of wastewater from septic tanks.**
- **In villages lacking proper drainage services, wastewater should be safely transported to the nearest pumping station.**
- **Encouraging the private sector and investors through financing packages will encourage their participation in this field.**

3-1-6 Desalination of Seawater and Brackish Water

Desalination is one of the most important strategic options for addressing the anticipated water scarcity for drinking water use. Expanding this sector is crucial for Egypt, particularly in coastal and tourist areas far from surface water sources, while considering the cost-effectiveness of desalination processes. Desalination capacity, plant size, and required energy are determined based on usage conditions, location, and water quantity. The most important strategic directions in the field of desalination can be summarized as follows:

- **Considering desalinated water as a primary water source for the future and working towards a gradual shift towards reliance on desalination. This can be achieved by designing desalinated water for use in coastal and secondary areas, and by expanding its application to tourist destinations and other uses that can afford it.**
- **Prohibit the construction of new drinking water plants that rely on Nile water in areas where desalinated water is available. Implement plans to replace older plants that have reached the end of their lifespan with desalination plants, instead of renovating or replacing them with conventional plants.**
- **Give priority to the desalination of brackish or highly saline water and increase the overall capacity of desalination plants used for this purpose.**
- **Ensure the safe disposal of highly saline water produced by desalination processes and incorporate disposal mechanisms within the processes to guarantee no negative impact on the marine environment.**
- **Develop an ambitious scientific research plan in collaboration with relevant ministries and authorities to achieve cost-effective desalination technologies that meet local standards in Egypt.**
- **Leverage scientific and technological advancements in water desalination using renewable energy sources, such as solar power, which is abundant in Egypt, to significantly reduce costs.**

- **Developing desalination technologies in Egypt, including the most common reverse osmosis methods, developing plant membrane production, and utilizing dual-purpose desalination plants that combine power generation and seawater desalination, thus reducing the cost of freshwater production.**
- **Developing the institutional framework and establishing specialized desalination centers in ports, and adopting human resource development programs related to research, development, production, operation, and maintenance of desalination plants.**
- **Increasing economic incentives for investors, such as tax exemptions and customs reductions on desalination stations supplies.**

3-1-7 Virtual Water and Agriculture Beyond Borders

Agriculture beyond borders is a strategic option for the future, especially given the scientific evidence of population growth and the resulting increase in water needs on the one hand, and the limited water resources on the other. Cooperation with countries that have financial resources is possible in cultivating various crops, especially those with high financial needs, and developing livestock on their lands, exporting these products to Egypt.

3-2 Rationalizing water Use and Maximizing of water unite Return

3-2-1 Rationalizing Uses in the Agricultural Sector

The limited quantity of saline water for agriculture is one of the biggest challenges facing the expansion of cultivated land in Egypt. Therefore, especially given the limited water resources and the increasing competition for water between sectors, it is necessary to address this issue. Improving water use efficiency in the agricultural sector is a key objective of the strategy. It aims to enhance the efficiency of water transport and distribution at all levels, improve the efficiency of existing land and financial resources, increase agricultural production, maximize the benefit derived from each unit of water, and minimize the food gap in the coming years. This requires implementing a set of measures, in coordination and cooperation with the Ministry of Agriculture, which can be summarized as follows:

- **Updating and developing field irrigation systems, either through the use of modern irrigation rings or by improving flood irrigation in older agricultural lands. This will reduce water loss and increase irrigation efficiency.**

- **Developing new crop varieties that are drought and salinity tolerant, expanding their cultivation, and providing guidance and assistance to farmers in their cultivation.**

- **Expanding the production of short-duration crop varieties, which will reduce water consumption on the one hand, and increase crop intensification rates on the other.**

- **Preventing the cultivation of water-intensive crops in newly reclaimed lands and implementing a program to apply modern irrigation systems in all new lands, whether drip irrigation, subsurface irrigation, or other methods.**

- **Determining the areas designated for water-intensive crops, enforcing the law, and collecting fines from violators.**

- **Stopping the export of water-intensive crops (such as rice).**

- **Supporting water-intensive crops.**

- **Encouraging reciprocal farming**

- **Encouraging the private sector to expand agricultural processing, in addition to consolidating landholdings and promoting industries based on agricultural crops.**

- **Replacing illegal fish farms established on land reclamation projects with modern fish farms in desert areas, utilizing groundwater.**

- **Studying and implementing proposals for water recycling at the local level and expanding intermediate mixing.**

- **Adopting hydrological basin systems, studying each region according to its natural characteristics and water conditions, in accordance with the Ministry of Housing's strategy regarding wastewater.**

- **Implementing systems for the reuse of wastewater to reach a stage of minimizing its use, while employing evaporation ponds, in appropriate locations, to collect salts and flush them out of irrigation systems, thus achieving salinity balance with the lowest possible amount of wastewater.**

- **Implementing a national program to raise farmers' awareness of the irrigation water problem and the importance of conserving it for the continuation of agriculture. Providing agricultural and technical guidance to farmers regarding the water requirements of crops in different regions and throughout all growth periods.**

- **Raising awareness, activating and encouraging the role of farmers, and motivating them to manage and regulate water use through water user organizations.**

3-2-2 Rationalizing the Use of Drinking and Domestic Water

Drinking water is the top priority in water allocation across various sectors. Therefore, solutions must be developed to rationalize water use in this sector. These solutions require full coordination and cooperation with the Ministry of Housing, the primary authority responsible for this sector, to implement a number of measures, which we summarize below:

- **Improving the efficiency of drinking water distribution networks and expanding the use of water-saving devices and equipment.**

- **Using treated sewage or industrial wastewater, or brackish groundwater, for irrigating gardens, playgrounds, and green spaces, while adhering to measures and procedures that ensure the safety of those handling this water.**

- **Expanding the construction of wastewater treatment plants and reusing the treated water for irrigating green spaces in tourist villages instead of using the groundwater aquifer in these areas.**

- **Reliance on seawater desalination to meet the financial needs of coastal and secondary regions that have access to donor groundwater.**

- **Review individual water consumption rates according to the Egyptian Water Code, taking into account fluctuations in available financial resources and the anticipated water scarcity in the coming period.**

- **Implement a tiered pricing system for domestic water consumption, considering social factors, and install and rehabilitate drinking water meters in all residential units. Measure consumption in cubic meters for each subsequent use.**

- **Separate wastewater from sinks and toilets and recycle it for appropriate purposes.**

- **Expand the use of groundwater to meet drinking water demands, as groundwater is considered a safe source for this purpose.**

- **Invest in specialized technologies for treating or removing iron and manganese, which will increase the opportunities for using larger quantities of groundwater to supply drinking water treatment plants from reservoirs containing measured percentages of these water sources.**

- **Prohibit non-potable uses of drinking water (such as street cleaning, car washing, etc.)**

3-2-3 Rationalizing Water Use in the Industrial Sector

The need to rationalize water use in the industrial sector is crucial, as industry has developed significantly in recent decades, leading to a marked increase in water requirements. With the anticipated industrial growth until 2050, coordination with the Ministry of Industry and Trade is essential to rationalize water use in the industrial sector

This can be achieved through the following measures:

- **Mandating that all industrial zones or units adopt modern technological systems and utilize various water treatment systems for industrial wastewater. Water supply to factories should be limited to the amount of water consumed within the factories.**
- **Establishing incentives and benefits to encourage factories to adopt integrated management systems that promote water conservation.**
- **Promoting the use of desalinated seawater and brackish water in new areas and recycling desalinated water in open-circuit systems, while simultaneously increasing the tariff for potable water supply.**
- **Expanding and encouraging the use of air-cooled equipment in factories instead of tent-based cooling systems.**
- **Replacing old, inefficient cooling units that consume large quantities of water with new, high-efficiency units.**
- **Reassessing water pricing for industrial use to contribute to rationalizing water consumption.**

- **Relying on modern technology and communication methods to enhance the efficiency of continuous monitoring systems for industrial facilities.**

- **Targeting for the renewal of water allocations for each type of industry and linking this to the quantities of waste they generate.**

3-2-4 Uses in the River Transport Sector

It is certain that clearing and demarcating the navigation channel within the Nile River and main navigable canals will have a positive impact on water resource management. The transport sector (both freight and tourist transport) is a water user, not a consumer. Full coordination with the River Transport Authority at the Ministry of Transport, the primary body responsible for this sector, is essential to implement the following measures:

- **Clearing the navigation channel and resolving any discrepancies.**
- **Demarcating the navigation channel within the river and equipping it with appropriate navigational equipment.**
- **Building capacity and providing the necessary resources to improve the efficiency of river navigation.**

3-2-5 Water Use in the Hydroelectric Power Generation Sector

Hydroelectric power generation does not consume any water, and at the same time, it is a source of clean, new, and renewable energy. The Ministry of Electricity and Energy is currently conducting studies on utilizing cooling water outlets from thermal power plants for electricity generation, as well as utilizing all wastewater treatment plant outlets nationwide for electricity generation using unconventional turbines. This contributes to maximizing the benefit from limited water resources.

3-2-6 Completing and Rehabilitating National Water Infrastructure

To address the numerous challenges facing the Ministry regarding water resource management, it has become necessary to provide a realistic assessment of the current state of the water networks, drains, and irrigation facilities across Egypt's governorates. This assessment should include alternatives for improving and enhancing the efficiency of financial management and water use, while considering the economics of implementing these alternatives. Accordingly, the Ministry has adopted the development of integrated plans for all governorates of the Republic. These plans aim to evaluate the condition of the networks and facilities in preparation for rehabilitating the water resources and irrigation system.

The maintenance, prevention, repair, and periodic follow-up of all major infrastructure projects on the Nile, its branches, canals, and irrigation ditches are among the top priorities of the Ministry. These projects include strengthening and maintaining barrages and their associated structures, such as navigational dams and overpasses, rehabilitating canal and drainage networks, developing methods for cleaning and maintaining waterways using

advanced equipment, and completing and rehabilitating secondary and public drainage networks. The Ministry is also developing operational and maintenance systems for irrigation and drainage stations throughout the country. These projects encompass all mechanical and electrical work, in addition to civil works.

Proposed strategies for rehabilitating the irrigation network, drains, financial facilities, and stations include:

- **Continuing the rehabilitation of the irrigation network at both the main and secondary levels, and developing control systems for canal and irrigation ditches to ensure their capacity is adjusted to the level of branch canals and throughout the day.**
- **Continuing the protection and reinforcement works of the High Dam and the Aswan Reservoir.**
- **Continuing the plan to replace and renovate major hydraulic structures on the Nile River and its main canals.**
- **Protecting, developing, and improving the course and banks of the Nile River, its canals, and irrigation networks.**
- **Prioritizing the rehabilitation of canals, pumping stations, and open drains in areas where irrigation is being developed, to ensure the development is integrated into a complete hydraulic system.**
- **Developing methods for cleaning and maintaining waterways using advanced equipment and with the participation of the private sector.**
- **Improving and developing the methods for constructing, operating, and maintaining covered waterways, and reviewing with local authorities regarding the implementation of new covering works for waterways in residential areas.**
- **Continuing the construction and rehabilitation of covered drainage networks, which helps improve soil properties and increase agricultural productivity.**
- **Completing the construction of the agricultural drainage system as part of the national infrastructure works for major national projects.**
- **Establishing a national program for rehabilitating open public drain networks to restore their design sections, taking into account the structural dimension.**
- **Expanding the application of intermediate mixing and reuse requirements and works at the lower levels of canals and drains.**
- **Developing planning, design, implementation, and maintenance methods for open and covered drainage networks**
- **Incorporating new construction materials and advancements in implementation, operation, and maintenance equipment**
- **Engaging beneficiaries in the planning, management, operation, and maintenance phases of drainage networks**

- **Developing a comprehensive plan for the replacement and/or reinforcement of financial facilities and operational premises by 2050 and beyond, including a timetable for their replacement, reinforcement, and maintenance, along with a classification and prioritization of facilities and stations for replacement and renovation.**

- **Address the challenges facing irrigation and drainage networks encroachments.**

3-2-7 Climate Change Adaptation

There is ample evidence of climate change globally, which is expected to lead to rising global temperatures and consequently disrupt the hydrological cycle, resulting in increased intensity of rainfall and droughts worldwide, as well as rising sea levels due to the melting of ice in polar regions. The water sector in Egypt is expected to be affected by climate change in several key areas, including:

- **Given Egypt's reliance on the Nile River as its primary water source, supplying approximately 93% of its water needs, it will not only be affected by changes within its borders but also by the impact of climate change on the Nile Basin, including alterations in rainfall patterns and locations, and the resulting changes in the volume of floodwater reaching Lake Nasser.**
- **The decline in the water level of some coastal areas in the Delta exposes them to the risk of flooding due to rising sea levels associated with increased temperatures, in addition to the natural subsidence of the delta, as well as the increased intrusion of seawater into the Delta's aquifer.**
- **Increased evaporation rates, resulting from rising temperatures, lead to increased financial demands on the agricultural sector.**

<u>Adaptive strategies to climate change include</u>:

- **Continuous monitoring of rainfall patterns, water flow, and changing water trends to determine appropriate adaptation strategies.**
- **Updating and developing the High Dam's operating policies in light of potential changes, to provide maximum flexibility for the system in dealing with these changes and to respect the safety limits of drought or flood severity.**
- **Following up on the results of regional climate models from related scientific research.**
- **Cooperating with Nile Basin countries on projects to mitigate flood and drought risks, maximize benefits, and develop water resources.**
- **Raising awareness of climate change issues at all levels and linking them to the need for rationalizing consumption.**

- **Capacity building and training of personnel in the field of preparing national and regional projects to benefit from available funding opportunities for sustainable projects and to mitigate the effects of climate change.**

- **The necessity of coordinating with all relevant stakeholders and increasing awareness of climate change and establishing a unified entity capable of implementing a national strategy to address the risks of climate change.**

- **Identifying areas at risk of erosion (including the northern Mediterranean coast, the northern lakes, the Nile Delta, and the eastern coast (Red Sea)) and studying and implementing the necessary protection measures.**

- **Preserving natural protection systems against sea-level rise, such as Rayleigh dunes.**

- **Integrated coastal zone management and capacity building in the technologies used in this field.**

- **Developing new crop varieties that are tolerant to high temperatures, salinity, and drought, conditions expected to prevail in the future under climate change.**

- **Developing new crop varieties with a longer growing season to reduce their water requirements.**

- **Adjusting planting dates to suit new weather conditions, in addition to planting varieties in suitable climatic regions, increases crop yield per unit of water per crop**

3-3 Improving Water Quality and Combating Pollution

Water quality and its suitability for various uses are among the most significant determinants of water resources in terms of abundance or scarcity. The proposed policies for combating pollution and its harmful effects fall under two main axes: pollution reduction policies and agricultural wastewater reuse policies

3-3-1 Pollution Reduction

It should be noted that the policies outlined in this section for reducing water pollution depend primarily and significantly on other relevant ministries, such as the Ministries of Agriculture, Industry, Housing, Environment, Health, and Interior, in addition to the

participation of citizens. Therefore, close cooperation between the Ministry of Water Resources, all local ministries and administrations, and all civil society organizations and associations is essential for the success of these policies, along with raising public awareness. Pollution sources are divided into four main categories: sewage, industrial wastewater, agricultural runoff, and solid waste.

The most important measures for dealing with pollution sources in the region and improving water quality can be summarized in the following points:

- **Expediting the completion of wastewater treatment plants in the area, while also finding economical alternatives for treating wastewater in rural villages.**
- **Ensuring that wastewater discharged from septic tanks and collection tanks in rural homes and areas lacking sanitation services reaches the nearest treatment plants.**
- **Implementing integrated management systems for water basins, particularly regarding treatment and reuse.**
- **Increasing the number of stations receiving waste from tourist vessels and strengthening oversight of these vessels.**
- **Developing an effective and immediate crisis management system for emergencies in the waterway at all locations, addressing various types of pollutants, and ensuring the protection and security of drinking water treatment plants.**
- **Implementing the principle of penalizing polluters by requiring them to pay for pollution (polluter pays principal). Stricter penalties should be imposed on factories whose waste discharges (liquid or solid) pollute waterways, ensuring that the penalty is commensurate with the pollution load rather than the concentration of the pollution, and considering its negative impact on water quality.**
- **The use of modern waste recycling or safe treatment technologies should be encouraged to reduce pollution from industrial wastewater.**
- **Legal measures should be taken to enforce fines and strengthen monitoring of manufacturing and production processes in industrial facilities.**
- **Industrial projects should be relocated from existing industrial areas and waterways to new urban centers.**
- **The efficiency of continuous monitoring systems should be improved, and effective and ongoing monitoring methods for industrial facilities should be modified to ensure the safe treatment and disposal of industrial wastewater.**
- **Fish cages should be prohibited from being used in rivers and streams, particularly in the Rosetta and Damietta branches of the Nile, with alternatives provided through drainage canals, the sea, or northern lakes.**
- **An integrated system for managing solid waste should be developed to prevent its dumping into waterways.**

3-3-2 Policies for Reusing Agricultural Drainage Water

Reusing agricultural drainage water constitutes an important and complementary source of irrigation water. Sometimes, agricultural drainage water includes sewage and industrial wastewater received by the water network. The most serious threat to reuse is pollution, which must be mitigated. In addition to the above, the following measures are implemented to maximize the benefit derived from agricultural drainage water:

- **Expanding the mixing of suitable-quality wastewater from secondary drains with water from canals or secondary irrigation channels, known as intermediate reuse.**
- **Reducing pollution of main drainage water before its discharge into main canals or irrigation ditches using low-cost biological methods (e.g., wetland technology or other suitable and feasible methods).**
- **Reconsidering the maximum salinity of reused wastewater in light of mixing ratios and the nature of agricultural crops, as the salinity of the mixed irrigation water can be increased by cultivating salinity-tolerant crops.**
- **Coordinating with the Ministry of Housing, Utilities, and New Urban Communities in preparing site plans for drinking water intakes on the irrigation network, especially for agricultural wastewater mixing stations.**
- **Coordinating with the Ministry of Housing, Utilities, and New Urban Communities in preparing site plans for the final discharge of current and future wastewater treatment plants, especially for agricultural wastewater mixing stations.**
- **Preparing an atlas of Egyptian water resources, equipped with a database to support decision-makers, to be developed in cooperation with the relevant ministries. The atlas should include a definition of the various uses of each watercourse (agriculture, drinking water, industry, navigation, fisheries, etc.) based on this, a plan for drinking water and wastewater projects should be prepared, outlining current and future uses. Additionally, a map of cities with desert hinterlands should be created, and the feasibility of implementing treated wastewater reuse projects should be studied.**

3-3-3 The Role of Scientific Research in Combating Pollution

The National Water Research Center, through its Drainage Research Institute and several other research institutes, may play a role in continuing research on wastewater reuse, a strategic priority to address the increasing demand for water resources. This research should also focus on monitoring water quality and pollution sources, as well as meeting the operational and maintenance needs of drainage networks. Furthermore, it should aim to enhance human resources by providing trained personnel and establishing clear long-term

policy objectives for building the capacity of technical and administrative staff at its all levels .

3-3-4 Environmental Awareness

The policy for spreading environmental awareness to combat pollution relies on implementing a comprehensive system of awareness and educational programs that include the following:

- **Developing an effective national program to spread environmental awareness and highlight the dangers of pollution to public health and the environment. This program should be implemented in cooperation with media and educational institutions, civil society organizations, and unions, in collaboration with the Ministry.**
- **Integrating educational programs into school curricula to increase water and environmental awareness, while continuing to cultivate a generation that understands the dangers of pollution and the importance of water conservation and its rational use.**

3-4 Developing an Integrated Water Resources Management System IWRM

Implementing an integrated water resources management approach requires an effective and appropriate institutional structure and a strong legal framework. Without these, water policies cannot be implemented. Developing an integrated management system requires several measures, including:

- **Implementing the principles of decentralization in water resources management.**
- **Supporting the participation of beneficiaries in the development and management of water resource.**
- **Legislative reform through the issuance and implementation of a unified water law and related laws.**
- **Human resources development and capacity building for those working in water resources management.**
- **Developing data and information exchange systems among all relevant parties.**

- **Developing a system for technical inspection, evaluation, follow-up, and crisis and disaster management.**
- **Developing water-related media and raising awareness of water issues and challenges.**
- **Developing communication mechanisms with the international community regarding water resources.**

- **Private sector participation**
- **Supporting cooperation and coordination among all ministries and relevant bodies.**
- **Developing economic tools to secure the necessary investments for water resource management.**
- **Developing and enhancing the role of scientific research.**

3-5 Strategy Implementation Mechanisms

The relevant ministers, including the Minister of Water Resources and Irrigation, and the Technical Secretariat of the Council, headed by the Minister of Water Resources and Irrigation, comprise decision-makers from the relevant ministries. The primary task of this committee is to oversee the policy established by the Supreme Council for the Protection of the Nile and Waterways, in addition to monitoring the implementation of this policy at the regional level.

At the governorate level, the formation of water resources committees and regional committees in each governorate is considered an effective and necessary factor in preparing, monitoring, and implementing regional plans. This is achieved through the following tasks:

- **Implementing the water policies established by the Supreme Council for the Protection of the Nile and Waterways within the governorate.**
- **coordinating between local ministries in implementing these policies.**
- **monitoring water resources management within the governorate.**
- **preparing studies and proposals for developing water resources management and presenting them to the governorate's executive council; and submitting monthly reports to the committee and the relevant ministries' undersecretaries to identify the most significant obstacles and propose solutions.**

3-6 Monitoring and Evaluation Mechanisms

The Ministry of Water Resources and Irrigation, in coordination and cooperation with relevant ministries, established a monitoring and evaluation mechanism for water policies, strategies, and plans. This mechanism includes developing general performance indicators at the input, output, and objective levels. These indicators are designed to be realistic, measurable, and have a defined timeframe. They facilitate the assessment of progress and the proposal of appropriate strategy adjustments based on this progress.

The monitoring and evaluation mechanisms include the following:

- **Performing periodic reviews of progress achieved and identifying ways to enhance it, with an emphasis on evaluating and monitoring the responsiveness of influential groups, such as decision-makers and those most affected.**
- **Disseminating information on progress, successes, best practices, failures, and lessons learned.**
- **Community participation in monitoring and following up on the implementation of relevant plans.**

3-7 Risks

While it is possible to develop the necessary plans to address challenges, taking into account potential changes under different scenarios, several risks must be considered when anticipating the future and making overall planning decisions. By 2050, the most significant risks can be identified as follows:

- **The continuation of current high population growth rates and the resulting increase in the required needs, and an increase in rainfall rates**
- **The risks of climate change and the many expected negative impacts not only on Egypt's water supply but also on water needs. Furthermore, rising sea levels will affect the northern coasts and groundwater resources near the Mediterranean coast, which are impacted by the intrusion of saltwater.**
- **The availability of the necessary investments to finance projects in the water sector.**
- **The extent to which tangible results have been achieved in raising awareness regarding the need to rationalize various water uses at all levels.**
- **Urban expansion at the expense of agricultural lands in the Nile Valley and the Nile Delta.**