Manual for estimating, monitoring and reporting water use in Egypt

SWIM and Horizon 2020 Support Mechanism

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0	Manual for estimating, monitoring and reporting water use in Egypt	Maggie Kossida	

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DISCLAIMER:

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ABBREVIATIONS

CAPMAS	Central Agency for Public Mobilization and Statistics
CAPW	Construction Authority for Potable Water and Wastewater
EEAA	Egyptian Environmental Affairs Agency
EWRA	Egyptian Water and Wastewater Regulatory Agency
HCWW	Holding Company for Water and Wastewater
MALR	Ministry of Agriculture and Land Reclamation
MDWSF	Ministry of Drinking Water and Sanitation Facilities
MEE	Ministry of Electricity and Renewable Energy
MoE	Ministry of Environment
MoHP	Ministry of Health and Population
MOHUUC	Ministry of Housing, Utilities and Urban Communities
MSEA	Ministry of State for Environmental Affairs
MoTI	Ministry of Trade and Industry
MWRI	Ministry of Water Resources and Irrigation
NOPWASD	National Organization for Potable Water and Sanitary Drainage
NWUIS	National Water Use Information System
NWR	National Water Council
NACE	Nomenclature Statistique des Activités Economiques dans la Communauté Européenne
NGOs	Non-Governmental Organisations
PWS	Public Water Supply
PWSS	Public Water Supply System
RMC	Regional Management Committee
SIC	Standard Industrial Classification
SDGs	Sustainable Development Goals
WWT	Wastewater Treatment

1. INTRODUCTION

This manual has been prepared as part of the SWIM-H2020 Expert Facility Activity EFS-EG-1: Improved Watershed Management (decentralized level), local governance and capacity building, with reference to Task 1.1 "Typology of water uses: Develop a common typology/ classification for water uses (sectors and sub-sectors according to the NACE classification, e.g., agricultural, industrial, etc.)" and Task 1.2 "Develop Guidelines for monitoring, reporting and assessment of water uses at the decentralized level (scale, supply source, trend analysis, etc.)".

The overall goal of the aforementioned tasks is to pave the way towards the development of a National Water Use Information System (NWUIS) for Egypt, where water use data are monitored and estimated at a suitable decentralized scale, following common harmonized definitions and procedures, and reported to the NWUIS. It has been acknowledge by the Egyptian Ministry of Water Resources and Irrigation (MWRI) that the development of a National WUIS is a difficult process, which requires significant time, and a coordinated effort within the Country, and thus the goal of the current tasks is to initiate it and set the cornerstones and a solid basis. Thus, their aim is to contribute to the estimation and analysis of water uses in Egypt, following a common national typology and methodology, which is an important element of water resources management, and feed input to the development of the Governorate Water Resources Management Plans. Furthermore, they aim at contributing to better governance at the decentralized water management level, initiating a better coordination between stakeholders at the local level when it comes to the monitoring of water use, the definition of water saving targets, and the design of mitigation measures and demand management interventions. The analysis of water use at the local level will inform the decision makers on the prevailing water use patterns and main users, will help prioritize water demand management efforts, and will help design appropriate interventions and awareness campaigns that will target consumers with significantly high water use.

1.1 PURPOSE AND SCOPE

The purpose of the "Manual for estimating, monitoring and reporting water use in Egypt" is to provide guidelines for preparing and reporting water use estimates in Egypt, following a national harmonized methodology. Water-use categories, data elements and aggregation levels, standard estimation methods and techniques, monitoring, reporting and documentation requirements are defined for the Governorate level water-use compilation. These guidelines are useful both to those responsible for preparing and reporting the estimates and to those who use and analyze the data.

More specifically, the Manual elaborates on:

- **Basic definitions of water use, water demand, water abstraction/withdrawal, water supply**

  It is often observed that stakeholders do not necessarily have a common understanding of the basic definitions of water use related components (e.g. water abstraction, water demand, etc.)

and use the different terms interchangeably. The current definitions provided here, which are endorsed by the Egyptian Ministry of Water Resources and Irrigation (MWRI), will help establishing a common language among stakeholders so that the context of any national-level assessments of water uses in Egypt is well understood and clear, and confusion is avoided.

- **A national typology for water use categories, including definitions.**

  This typology will form a solid basis for common understanding among the Governorates when it comes to defining and analyzing water uses and their associated pressures in their Governorate Water Resources Management Plans. Furthermore, as the current suggested typology is in close relation with internationally accepted typologies, various National reporting requirements towards third parties (e.g. to FAO, OECD, etc.) can be facilitated.

- **Guidelines for the estimation of water uses at the decentralized level.**

  It is often a problem that water use cannot be directly measured for all sectors, and thus different proxies and estimates need to be developed. To this extent it is important to have common proxy methodologies which are also based on primary data which are feasible for the Egyptian Governorates and relatively easy to retrieve.

- **Guidelines for the monitoring and reporting of water uses**

  The information provided on the key parameters to be monitored (including scale, frequency, etc.) will facilitate the implementation and coordination at the decentralized level. The specification of the reporting requirements (format, documentation, frequency, dataflow scheme, etc.) will support the establishment of a regular data collection and reporting from the local up to the national level, and help design a feasible allocation of roles and responsibilities among the relevant stakeholders at the local level.

- **Policy-relevant assessment of water uses**

  Different indicators are proposed in order to conduct policy-relevant assessments and observe meaningful trends.

1.2 BACKGROUND INFORMATION FOR EGYPT

This section reviews (i) the current governance related to water resources management in Egypt, (ii) the current state of development of the Governorate Water Resources Management Plans, and (iii) the current situation regarding water use estimation, monitoring and reporting in Egypt.

These insights will facilitate the definition of the main and secondary water uses (ref. to Chapters 3 and 4) and the design of an adequate governance scheme in relation to the collection, estimation and reporting of water use information (ref. to Chapters 5 and 6).

1.2.1 INSTITUTIONAL SETTING IN EGYPT

The government structure of Egypt consists of three levels. The 1st level is the central government (Ministries). The 2nd level (decentralized government) is structured in Governorates with districts and some cities as 3rd level units (markaz level).

The Ministry of Water Resources and Irrigation (MWRI) is the prime responsible ministry for water resources management. The MWRI has a central organization in (and around) Cairo. It has both strategic and operational tasks. The operational tasks include both national activities (such as the implementation, operation and maintenance of the Nile related infrastructure, the irrigation and drainage canals and the coastal lakes) and activities at the district level. Specifications and permits for groundwater well drilling are also the responsibility of MWRI. Within MWRI, the following sectors and departments are of importance:

- The Nile Water Sector: in charge of cooperation with Sudan and other Nilotic countries.
- The Irrigation Department: provides technical guidance and monitoring of irrigation development, including dams and comprises 6 sections: irrigation; groundwater; horizontal expansion projects; irrigation improvement; grand barrages; Nile protection.
- The Planning Sector: responsible at central level for data collection, processing and analysis for planning and monitoring investment projects.
- The Water Resources and Irrigation Sector in Lower/Upper Egypt (under the Irrigation Department)
- The Water Resources, Irrigation and National Structure Sector in North Sinai (under the Irrigation Department)
- The Mechanical and Electrical Department: in charge of the construction and maintenance of pumping stations for irrigation and drainage.
- Egyptian Public Authority for shore protection

Further to the above institutions, other public authorities are directly related to MWRI:

- Egyptian Public Authority for High Dam and Aswan Dam: responsible for dam operation.
- Egyptian Public Authority for Drainage Projects (EPADP): responsible for the construction and maintenance of tile and open drains.
- National Water Research Centre (NWRC): comprises 12 institutes and is the scientific body of MWRI for all aspects related to water resources management.
- Water Quality Unit
- Institutional Reform Unit

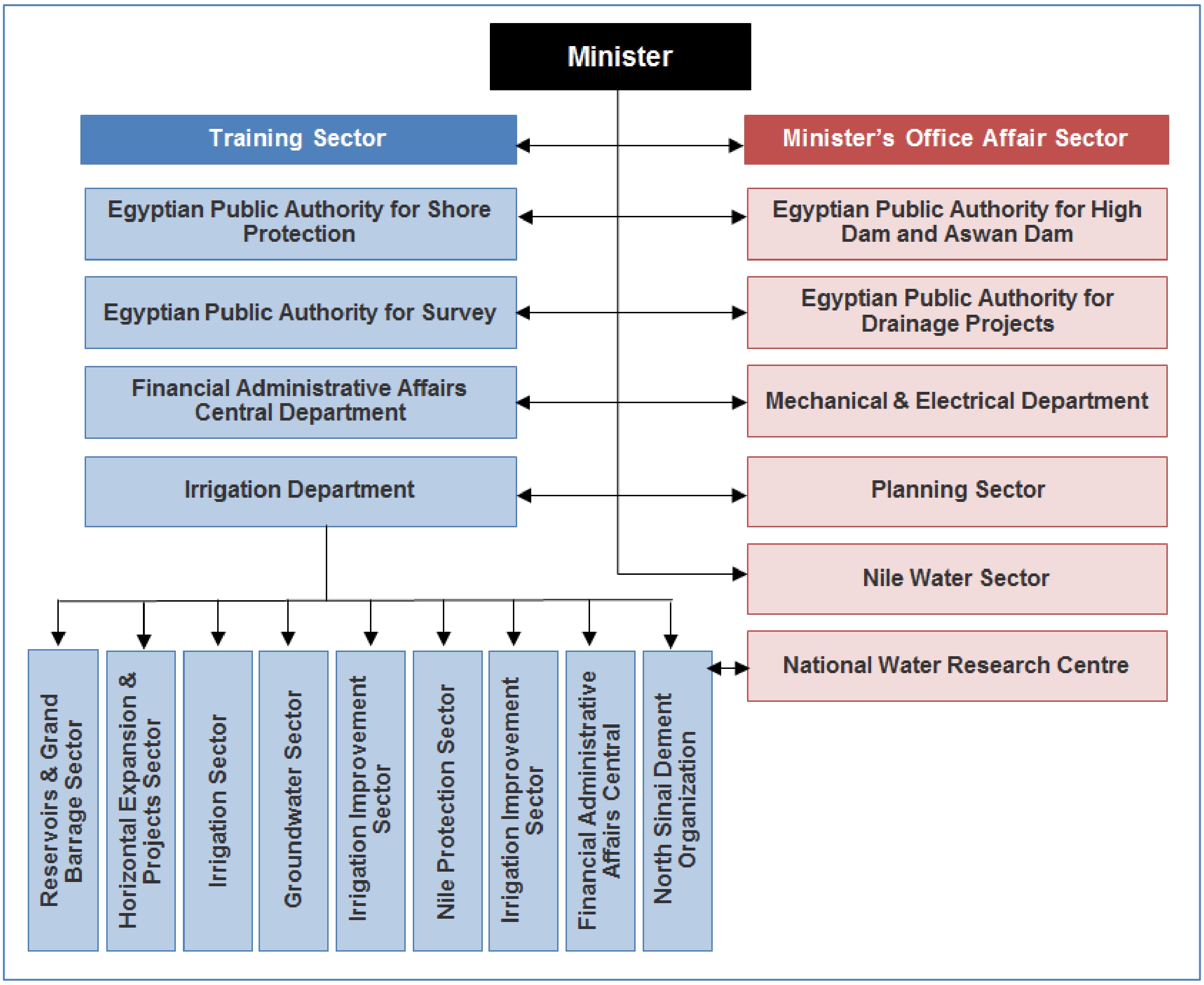


Figure 1-1: Overview of the MWRI organizational structure (Source: MWRI)

At decentralized level, the MWRI distinguished 32 Irrigation Directorates, subdivided into 62 Inspectorates and about 206 Districts (an Inspectorate covers about 4 Districts). The area of a District is between 20,000 to 60,000 feddan (about 40,000 – 100,000 farmers). These 32 Directorates were replaced by "Integrated Water Management Districts" (IWMD) in 2009. Integration of irrigation, drainage and groundwater units was tested with 4 pilots sites established in 2001 and 2003 with the purpose of piloting General Directorates for Water Resources & Irrigation (GDWRI) and Integrated Water Management Districts (IWMD) (USAID, 2011). Water Users Associations (WUAs) exist in parts of the country and operate at mesqa (tertiary) level where farmers on one mesqa select a representative to the association, which meets regularly with the district irrigation engineer to determine the major reports that need to be made. The association is also responsible for organization regular mesqa maintenance and resolving conflicts. WUAs have managerial, financial, and technical autonomy. They make their own budget and set the tariff for irrigation. They operate as independent legal entities, starting from the date of their registration (CEDARE, 2014). Other organization units used in the management of irrigation follow the hierarchical canal classification presented in the Table below. Upscaling of the WUAs to higher level, in particular to the secondary level with the Branch canal through Branch Canal Water Boards formed with mesqa representatives, is projected but still at pilot test scale (MWRI, 2005). Only 53 boards were established in 2002, in particular in the Fayyum and Nile Delta areas (USAID, 2011).

Table 1-1: Water management units (WMUs) and levels (Source: FAO Aquastat, Egypt, http://www.fao.org/nr/water/aquastat/countries_regions/EGY/)

	Number of WMUs	Area (feddans)	Number of farmers
Mesqas (tertiary)	100,000	10 – 100	150
Branch canals (secondary)	4,000 – 5,000	500 – 3,000	1,000 – 5,000
Main canals (or feeder canal)	400 – 600	15,000 – 25,000	10,000 – 20,000
Irrigation district	206	20,000 – 60,000	40,000 – 00,000
Governorates	26	200,000 – 500,000	1,000,000

On the national level, several other ministries have responsibilities related to water resources management and exert influence through their policies, as listed below. Similar to the MWRI, some of these Ministries have operational tasks at a decentralized level, also organized through districts and inspectorates. From the point of view of Integrated Water Resources Management it is unfortunate that the districts and inspectorates of the different Ministries do not coincide.

- The **Ministry of Agriculture and Land Reclamation (MALR)** is in charge of agricultural research and extension, land reclamation and agricultural, fisheries and animal wealth development.
- The new **Ministry of Drinking Water and Sanitation Facilities (MDWSF)**, created in 2012, took over its functions from the Ministry of Housing, Utilities and Urban Communities that had previously been in charge of the sector. It has now been integrated into the Ministry of Housing, Utilities and Urban Communities (MOHUUC) which covers the whole sector of drinking water and wastewater. The following institutions report to the MOHUUC:
  - Egyptian Water and Wastewater Regulatory Agency (EWRA)
  - Holding Company for Water and Wastewater (HCWW) and its 23 Affiliated Companies (AC)
  - National Organization for Potable Water and Sanitary Drainage (NOPWASD)
  - Construction Authority for Potable Water and Wastewater (CAPW) (EU, 2012)
- The **Ministry of State for Environmental Affairs (MSEA)** and the Egyptian Environmental Affairs Agency (EEAA) under its jurisdiction mostly concentrate on the quality aspect of water.
- The Ministry of Planning, the Ministry of Industry, the Ministry of Environment, the Ministry of Health and Population, the Ministry of Transportation, the Ministry of Local Development, the Ministry of Hydropower, and the Ministry of Tourism (tourist related navigation on the Nile, water quality along Northern Coast) come also into interplay.

The **National Water Council (NWC)** ensures inter-ministerial coordination by integrating policies and activities at national and local level, and it is assisted by a technical secretariat and Water & Environment units in the different Ministries and organizations. At the governorate level, a **Regional Management Committee (RMC)** includes all stakeholders and is chaired by the local MWRI responsible.

The public administration at the decentralized level is divided, as mentioned before, in 27 Governorates (or Mohafza) as illustrated in the Figure below.There are two types of Governorates. The first type consist of the 4 one-city Governorates of Cairo, Alexandria, Port Said and Suez. These 4 Governorates are further divided into urban quarters (or hais). The second type consists of 22 complex, multi-city Governorates, which are divided into 156 districts (or markaz[1]), and cities, urban quarters and villages (or qaria). The borders of the markaz (administrative districts) do not coincide with the borders if the 206 irrigation districts.

Twelve national Ministries have Directorates at the Governorates level with decentralized functions and budgets.Amongst others, the Ministry of Health and Population and the Ministry of Housing, play an important roles in the local planning of water resources. Fourteen Ministries have (some) decentralized functions but no decentralized budgets; amongst them is the MWRI. It is clear that, together with the local branches of the Ministries and Authorities who are technically responsible, the Governorates exercise administrative control and are an important stakeholder for water resources planning and management. Between the central government and the local administration conflicts may arise in terms of budget, (complexity of) regulations and staffing. Another main issue is the hierarchical relation of departments at the Governorate level that have to report both to their national Ministry or agency and to the Governorate, This complicates the horizontal coordination of policies at local level.

[1] The borders of the markaz are different from those of the 206 irrigation districts

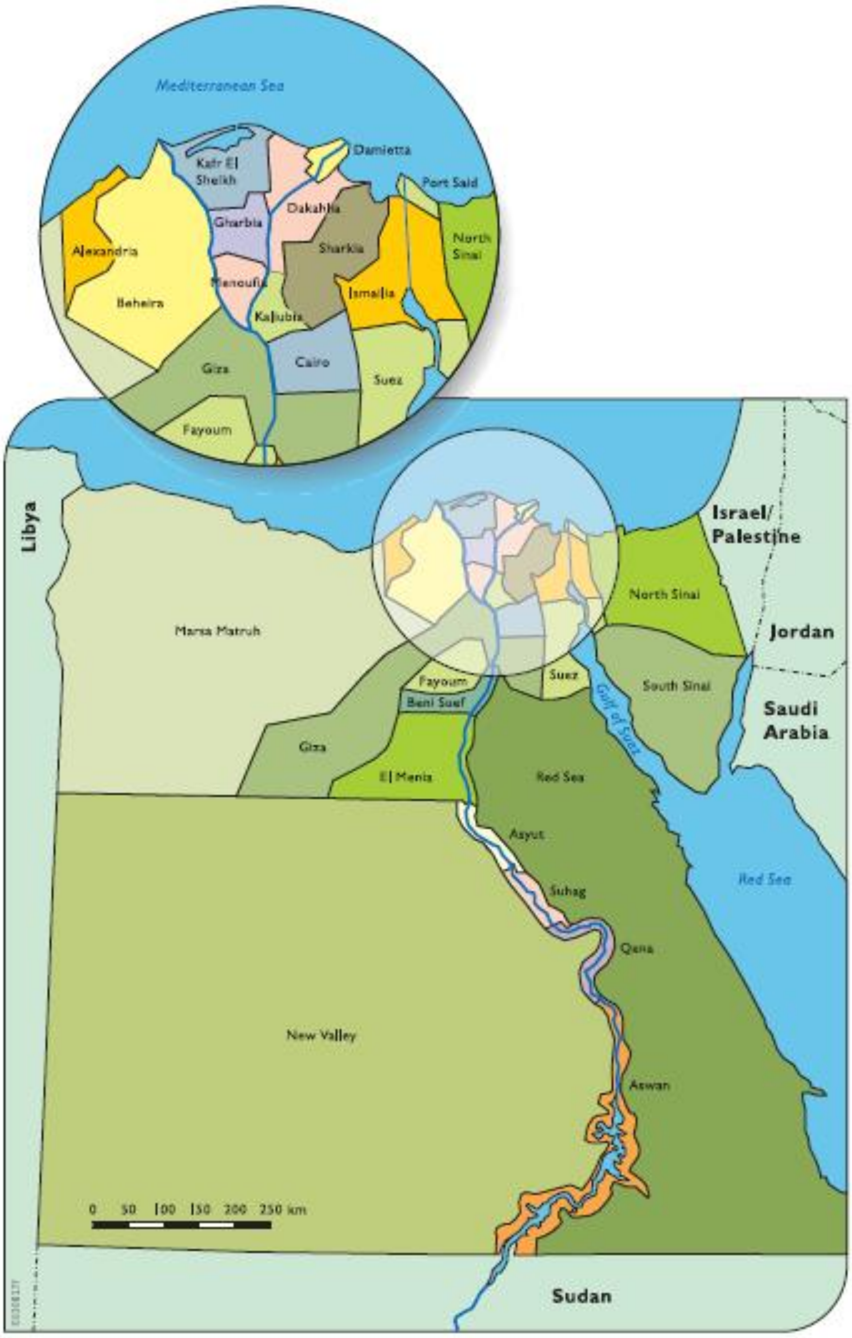


Figure 1-2: Overview of the 27 Governorates in Egypt (Source: MWRI, 2005. National Water Resources Plan for Egypt- 2017. Arab Republic of Egypt, Ministry of Water Resources and Irrigation, Planning Sector, Cairo, January 2005. Available online: http://extwprlegs1.fao.org/docs/pdf/egy147082.pdf)

1.2.2 WATER RESOURCES MANAGEMENT AND WATER USE IN EGYPT

Water abstraction in Egypt sums up to 80.25 billion m^3 per year (data for the year 2017 provided by the MWRI), representing a volume of 771.6 m^3 per capita per year (assuming a population of 104 million inhabitants). The main water using sectors are agriculture, representing 86% of the total water abstraction, municipal (11.5% of the total water abstraction) and industrial (2.5% of the total water abstraction) (Source: FAO Aquastat[2], data for the year 2010). About 94% of the water is abstracted from surface water (the Nile), 4% from groundwater, and 2% is harvested from rainwater.

Under the Nile Waters Agreement of 1959 between Egypt and Sudan, 55.5 billion m^3/year flows annually from the Nile into Egypt, while the internal renewable surface water resources are estimated at 1.3 billion m^3/year. Internal groundwater resources are estimated at 2.45 billion m^3/year. The total renewable water resources of the country (internally generated and external) sum up to 56.8 billion m^3/year, or 546 m^3/year/capita assuming a population of 104 million inhabitants. Egypt's dependency ratio[3] is one of the world's highest with 97.7% of the total renewable water resources flowing into the country from neighboring countries.

Non-conventional water resources contribute about 21 billion m^3 per year: 0.3 billion m^3 desalinated water production, 13.5 billion m^3 direct use of treated municipal water and agricultural drainage water, and 7.2 billion m^3 from shallow water which comes from leakage of irrigated lands.(Source: MWRI). The pressure of abstraction on the water resources is high as the total freshwater abstraction account for approximately 127% of the total renewable water resources. Egypt has adopted a policy of wastewater reclamation and reuse in irrigated agricultural land to alleviate the pressure imposed by increasing demands on freshwater resources (CEDARE, 2014).

The National Water Resources Plan of Egypt is currently under updating for the period 2017-2037 with the support of the EU. Currently, water resources management in Egypt is implemented with a top-down approach (Ministerial level to decentralized Governorate level). At the decentralized level, among the 27 existing Governorates, 5 of them have developed Governorate Water Resources Management Plans (assisted by an EU support programme) and the remaining 22 ones are at the drafting stage.

The main water uses in Egypt are the domestic, the agricultural, and the industrial. Additional water uses include tourism, hydropower/ energy production, navigation, fisheries, recreation and environmental preservation.

[2] http://www.fao.org/nr/water/aquastat/countries_regions/EGY/

[3] Dependency ratio: Indicator expressing the percent of total renewable water resources originating outside the country. This indicator may theoretically vary between 0% and 100%. A country with a dependency ratio equal to 0% does not receive any water from neighboring countries. A country with a dependency ratio equal to 100% receives all its renewable water from upstream countries, without producing any of its own. This indicator does not consider the possible allocation of water to downstream countries. An example of the calculation rules is available in this sheet: http://www.fao.org/nr/water/aquastat/data/wrs/readPdf.html?f=AFG-WRS_eng.pdf (FAO Aquastat).

Table 1-2: Water Use in Egypt for the period 2011/12 -2015/216 (Units in Billion m3, Source: MWRI, CAPMAS 2019 – Egypt in Figure-Water Resources 2018 Bulletin, https://www.capmas.gov.eg/Pages/Publications.aspx?page_id=5104&Year=23447)

Years / Uses	2016/15	2015/14	2014/13	2013/12	2012/11	السنوات / الاستخدامات
	الكمية	الكمية	الكمية	الكمية	الكمية	
Agriculture	62.15	62.35	62.35	62.10	61.10	الزراعة
Loss by Evaporation from The Nile &Canals	2.50	2.50	2.50	2.50	2.20	الفاقد بالتبخر من النيل والترع
Water for drinking	10.40	10.35	9.95	9.70	9.60	مياه الشرب
Industry	1.20	1.20	1.20	1.20	1.20	الصناعة
Total	**76.30**	**76.00**	**75.50**	**74.10**	**74.10**	**الاجمالي**

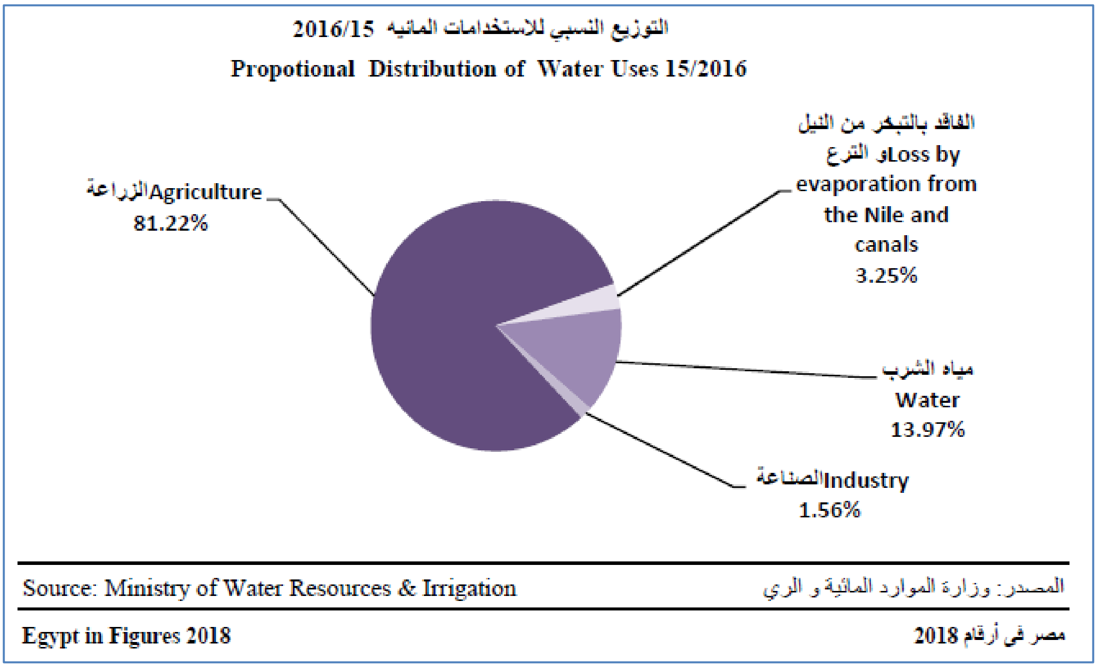


Figure 1-3: Distribution of water uses in Egypt for the years 2015/2016 (Source: MWRI, CAPMA2019 – Egypt in Figure-Water Resources 2018 Bulletin, https://www.capmas.gov.eg/Pages/Publications.aspx?page_id=5104&Year=23447**)**

In the following tables a description of the current main water uses' characteristics in Egypt is provided, incorporating also the results of the relevant participatory exercise conducted during the Closing Workshop[4] organised on 22/01/2019 in Cairo.

[4] The SWIM-H2020 SM project, in cooperation with Ministry of Water Resources and Irrigation (MWRI) has conducted a full-day workshop on water demand management, planning and infrastructure development on 22/01/2019 in Cairo, Egypt. The purpose of this workshop was to present the outputs of the activities undertaken in relation to the developed classification for water uses and the guidelines for their estimation and assessment,

Table 1-3: Overview of the key elements of domestic water use in Egypt (Source: MWRI, SWIM-H2020 SM Closing Workshop 22/01/2019)

<table>
<tr><th colspan="4">Domestic Water Use in Egypt</th></tr>
<tr><td>What is included in this water use?</td><td colspan="3">Domestic water includes water used for indoor and outdoor household purposes, commercial and tourism purposes (e.g. offices, restaurants, hotels), and industrial purposes. Water used for livestock is also included here.
There are no separate measurements of commercial, tourism, industrial or livestock water uses. Nevertheless, in some Governorates the industrial water use is separated from the domestic, e.g. in Banee Suief, and/or the tourism water use is separated from the domestic, e.g. in the Red Sea and South Sinai.</td></tr>
<tr><td>What is the current volume of water used?</td><td colspan="3">The total municipal water use is estimated to be 10.7 billion m^3/yr in 2017 (MWRI). A portion of that water is actually consumed and the rest returns back to the system, either through the sewage collection system or by seepage to the groundwater. There are regions like Alexandria, Suez Canal, and desert areas where that discharge cannot be recovered.
The rate of losses in the municipal PWSS networks (during transmission and distribution) is approximately 31% (CEDARE, 2014). This is partially due to pipe leakage and partially due to unaccounted for water users as it is calculated by subtracting amount of water sold from amount of water produced (EWRA, 2011).</td></tr>
<tr><td>How is this water supplied and delivered?</td><td colspan="3">This water is typically delivered from a public water supplier (PWS) for major urban and rural villages and originates from surface or groundwater sources, as well as from desalination plants (in some cases). The surface water part comes from the Nile system, either through canals or direct intakes on the river.
The water allocation comes from the MWRI, and the water is distributed by the HCWW (Holding Company for Water and Wastewater)</td></tr>
<tr><td></td><td>Public Water Supply (PWSS)</td><td>Self-supply</td><td>Other (please specify)</td></tr>
<tr><td>Surface water</td><td>√</td><td></td><td></td></tr>
<tr><td>Groundwater</td><td>√</td><td>√</td><td></td></tr>
<tr><td>Desalination</td><td>√</td><td>√</td><td></td></tr>
<tr><td>Reclaimed water from WWTP/ Reuse</td><td>√</td><td>√</td><td></td></tr>
<tr><td>Other (specify)</td><td></td><td></td><td></td></tr>
<tr><td>Who are the responsible authorities?</td><td colspan="3">Drinking water supply and sanitation in Egypt has been reformed since 2004 by establishing the Holding Company for Water and Wastewater (HCWW) *Presidential Decree no. 135/2004) and the Egyptian Water Regulatory Agency</td></tr>
</table>

the methods for assessing water balances at the Governorate level and the different demand management options in the domestic sector, and the methods for planning and infrastructure development. The workshop aimed as well to facilitate a participatory discussion on issues related to water use and water balance assessment, constraints, etc., and engage the participants into hands-on collaborative exercises to further build their capacity

<table>
<tr><td></td><td colspan="4">(EWRA) (Presidential Decree no. 136/2004), and by transforming Egypt municipalities into subsidiary companies of the HCWW, reaching 25 subsidiary companies in 2011. In 2012, another enhancement in the governance of drinking water supply and sanitation was achieved by inaugurating the Ministry of Water and Wastewater Utilities (MWWU) (Presidential Decree 178/2012). By this inauguration, HCWW and EWRA has become part of the MDWSF (CEDARE, 2014). The HCWW and the 25 subsidiary Affiliated Companies (AC) are under the status of public sector companies. The mandates of the HCWW and AC are to purify, distillate, transport, distribute and sell drinking water, as well as to collecting, treat and safely dispose the wastewater.

HCWW monitors and provides technical assistance and training to the ACs. HCWW ensures maintenance, operation and rehabilitation of infrastructures. Each AC works on the basis of five years Master Plans. HCWW covers the Egyptian territory except the cities of the Suez Canal area where drinking water is managed by the Suez Canal Authority.</td></tr>
<tr><td>Water use records (monitoring and evaluation)</td><td colspan="4">Domestic water used is measured per building through water meters, at monthly scale, by the HCWW, and for each municipality.

In the cases where no meter readings are available, the volume is estimated based on similar users' volumes of water sold per month.

HCWW collects and send this data to MoHousing who conveys the relevant domestic water use statistics to the CAPMAS (Central Agency for Public Mobilization and Statistics). Water use statistics are also reported to FAOSTAT.</td></tr>
<tr><td></td><td></td><td>Spatial resolution (per municipality, per governorate, per city…)</td><td>Temporal resolution (monthly, bi-monthly, annual, …)</td><td>Proxies used</td></tr>
<tr><td>Measured (with water meters)</td><td>Yes</td><td>muncipality</td><td>monthly</td><td></td></tr>
<tr><td>Calculated</td><td>No</td><td></td><td></td><td></td></tr>
<tr><td>Estimated based on approximations</td><td>Yes</td><td>Municipality, governorate ,city</td><td>monthly</td><td>e.g. population * average per capita rate, volume of water sold, volume from household bills</td></tr>
<tr><td>A mix of the above</td><td>Yes / No</td><td></td><td></td><td></td></tr>
<tr><td>Billing information</td><td colspan="4">The frequency of issuing the water bills is monthly

There are different tariffs/ rates according to the use volume and type of use (as for commercial purposes)

- Billing is made on the basis of the volume consumed

- We can obtain reliable information of the used volume from the water bills

We can differentiate between household, tourism establishments (hotels) and industries from the water bills</td></tr>
</table>

Table 1-4: Overview of the key elements of irrigation water use in Egypt (Source: MWRI, SWIM-H2020 SM Closing Workshop 22/01/2019)

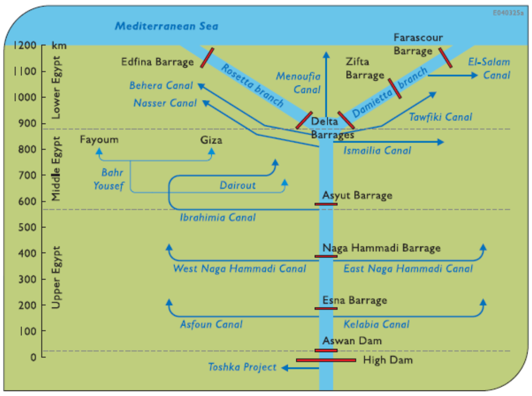
Irrigation Water Use in Egypt	
What is included in this water use?	**Irrigation water** includes water used for agricultural purposes, specifically for irrigation. Water used for livestock is not included here. Fish farms (aquaculture) utilize, by law, agricultural drainage water for fish breeding. It's not allowed to use fresh water in fish aquaculture without being used in irrigation first (CEDARE, 2014). The agricultural sector is the largest user and consumer of water in Egypt, with its share approaching 85% of the total demand for water (MWRI, 2005). The agriculture land base consists of old land in the Nile Valley and Delta, rain fed areas, several oases, and lands reclaimed from the desert (CEDARE, 2014).
What is the current volume of water used?	The total area of irrigated land in 2017 was 8.9 million feddans with an irrigation water demand of 61.65 billion m^3/yr (MWRI). This makes the average water consumption per feddan about 6,850 m^3/ feddan/yr. The volume of water abstracted for agriculture in 2017 sums up to 61.65 billion m^3 (MWRI). Agricultural drainage water recycling is widely practiced (mixing of the water in the canals with agriculture drainage water).
How is this water supplied and delivered?	This water is typically delivered from the Nile system through canals The major canals divert water just upstream of the barrages to the Irrigation Directorates served by those canals. Branch canals that take off from the main or lateral canals deliver the water to smaller distributary canals, which in turn deliver water to the mesqas. In most of the area the water level in the system in below the field level, and thus the water has to be raised through diesel pumps or traditional wheels. In some areas the farm intakes are directly from the distributaries (MWRI, 2005). Schematic diagrams of the major control structures and canals, and the Nile water distribution system (for a Nile annual discharge of 55.5billion m^3) are provided below: 

Figure: Schematic diagram of the major control structures and canals in Nile, Egypt (Source: MWRI, 2005)

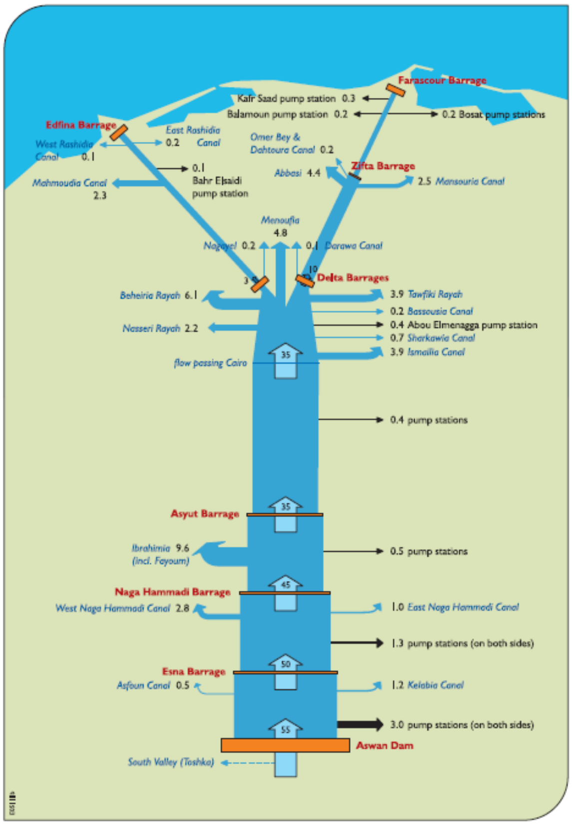


Figure: Schematic diagram of the water distribution Nile system in Egypt (Source: MWRI, 2005 – NAWQAM project)

The groundwater part comes from boreholes, either private or public, while uncontrolled/ illegal wells exist.

	Public Water Supply (PWSS)	*Self-supply*	*Other (please specify)*
Surface water	√		
Groundwater	√	√	
Desalination			
Reclaimed water from WWTP/ Reuse	√		
Other (specify)	*Agricultural drainage water (recycling)* *Saline water* *Rainwater Harvesting*		

Who are the responsible authorities?	The District Engineer of the MWRI is managing the water distribution, controls the releases in the canals and takes measurements of how much water has been released for irrigation Water users associations: they have managerial, financial, and technical autonomy. They make their own budget and set the tariff for irrigation. They

	operate as independent legal entities, starting from the date of their registration. Hundreds of WUAs are now practicing participatory management with different levels of success. Regarding fish farms, agricultural drainage water for fish breeding is used (it is not allowed to use fresh water in fish aquaculture without being used in irrigation first).Fish farm problems arises from the poor water quality of agricultural drains due to the discharge of untreated or partially treated domestic and industrial wastewater in these drains prior to being used in fish farming.			
Water use records (monitoring and evaluation)	Water measurements are performed (with current meters) only for the discharges from the Nile and the main canals; there are no measurements for every single canal. Water use is estimated on the basis of these measurements for the Nile system and the main canals by MWRI. The district engineer of MWRI reports the water flows measured at the flow gages per canal and water use is calculated on the basis of these records. The volume of water sold per year is calculated by the HCWW. MWRI reports statistics to the Central Agency for Public Mobilization and Statistics (CAPMAS) and FAOSTAT			
		Spatial resolution (per municipality, per governorate, per irrigation district, per feddan…)	*Temporal resolution (monthly, bi-monthly, annual, …)*	*Proxies used*
Measured (with water meters)	*No*			
Calculated	*Yes*	*, per canal from the flow readings*	*Daily, Monthly*	
Estimated based on approximations	*Yes*	*per irrigation district, per feddan*	*Daily (Gap fillinngis performed)*	*e.g. crop water needs minus effective rainfall, total crops are * typical water consumption rate…*
A mix of the above	*No*			
Billing information	No charges are applicable for irrigation water use			

Table 1-5: Overview of the key elements of industrial water use in Egypt (Source: MWRI, SWIM-H2020 SM Closing Workshop 22/01/2019)

Industrial Water Use in Egypt	
What is included in this water use?	**Industrial water** includes water used both in the manufacturing process, for cooling, for cleaning the facilities, and used from the employees. Currently industrial water use is included in the municipal (domestic) water use, and no separate measurements exist in some cases.

	Industry is a growing sector in the national economy of Egypt. Further industrial development is expected to play a major role in the socio-economic development of the country, providing employment for a large part of the growing population.
What is the current volume of water used?	It is estimated that the water requirement for the industrial sector during the year 2017 was 5.4 billion m^3 per year (most of which returns back to the system through agriculture drains and sanitary sewer system), making the net industrial water demand about 1.4 billion m^3/yr in 2017 (MWRI). The volume of water abstracted for industrial purposes in 2017 sums up to 5.4 billion m^3 (FAOSTAT). Measured in terms of value of industrial output, the petroleum sub-sector is with 35% the largest, followed by the food industry (24%), the textile industry (13%) and the engineering and electrical industries (13%) (MWRI, 2005). Industrial water is provided through the municipal PWSS. The rate of losses in the municipal PWSS networks (during transmission and distribution) is approximately 31% (CEDARE, 2014). This is partially due to pipe leakage and partially due to unaccounted for water users as it is calculated by subtracting amount of water sold from amount of water produced (EWRA, 2011).
How is this water supplied and delivered?	This water is typically delivered from the municipal public water supplier (PWS) for major urban and rural villages and originates from surface or groundwater sources, as well as from desalination plants (in some cases, such as in the Red Sea Governorate). The surface water part comes from the Nile system, either through canals or direct intakes on the river. Self-supply is also common, either from surface or groundwater or desalinated water, on the basis of permits issued by the MWRI. Self-supply for industrial purposes is also applicable (e.g. in Menofia Governorate). This originates from groundwater.

	Public Water Supply (PWSS)	*Self-supply*	*Other (please specify)*
Surface water	√	√	
Groundwater	√	√	
Desalination		√	
Reclaimed water from WWTP/ Reuse	√		
Other (specify)		*Saline water (in some factories/ industrial zones)*	

Who are the responsible authorities?	The HCWW is responsible for the factories that take water from the Public Water Supply System (PWSS) (as it is for the domestic sector). MWRI is the responsible authority for the factories that extract their share of water directly from the water ways (on the basis of permission granted by the MWRI)

<table>
<tr><td rowspan="2">Water use records (monitoring and evaluation)</td><td colspan="4">Surface water is measured with water meters and reported by the HCWW or the MWRI per building/ factory and per month (by water meter bills)
All Groundwater wells are metered and measured by the MWRI on annual basis
MWRI reports statistics to the Central Agency for Public Mobilization and Statistics (CAPMAS) and FAOSTAT</td></tr>
<tr><td></td><td>Spatial resolution (per city, per municipality, per governorate, per industry)</td><td>Temporal resolution (monthly, bi-monthly, annual, …)</td><td>Proxies used</td></tr>
<tr><td>Measured (with water meters)</td><td>Yes</td><td>Per building/ factory, per municipality</td><td>monthly</td><td></td></tr>
<tr><td>Calculated</td><td>No</td><td></td><td></td><td></td></tr>
<tr><td>Estimated based on approximations</td><td>Yes / No</td><td>Per building/ factry, per municipality</td><td>monthly</td><td>e.g. number of industries * typical consumption rate, based on the wastewater generated by the industry, based on the volume of water sold, volume from the water bills of industrial facilities</td></tr>
<tr><td>A mix of the above</td><td>Yes / No</td><td></td><td></td><td></td></tr>
<tr><td>Billing information</td><td colspan="4">The frequency of issuing the water bills is monthly
There are different tariffs/ rates according to the use quantity or volume consumed
We can differentiate between household, tourism establishments (hotels) and industries from the water bills</td></tr>
</table>

2. BASIC DEFINITIONS

2.1 DEFINITION OF BASIC CONCEPTS RELATED TO WATER USE

This section provides the basic definitions of different elements which relate to water uses, namely water demand, water supply, water abstraction, water consumption and returned water. A schematic chart of the water flows and transfers in a river basin is also provided in Figure 2.2 below to allow for a better understanding of the definitions. These definitions have been endorsed by the Egyptian Ministry of Water Resources and Irrigation (MWRI), and will help establishing a common language among stakeholders and a harmonized approach across the Governorate Water Resources Management Plans and in relation to the monitoring, evaluation and reporting of the water uses in Egypt.

Water demand is the amount of water that is required to fully and completely satisfy a water use according to cultural, sociological, technological, meteorological conditions on a certain place in the world. For example, domestic water demand in an area is dependent on the meteorology (cold or warm climate), on the culture (frequency of bathing, etc.), on the sociology (urban areas vs. non-urban areas), on the technological means (washing machines, etc.) that define the water demand in terms of liters per capita per day. Another example is the irrigation water demand, which is a function of the specific crop water requirements in the specific region, climate and time which cannot be met by the effective rainfall.

Water supply is the delivery of water from various sources to the final users in order to satisfy the water demand. The sources of water can be withdrawals from the freshwater bodies (i.e. surface and groundwater abstraction), rainwater harvesting, water imports from other river basins and non-conventional production of water. Non-conventional sources of water include: (i) freshwater produced by desalination of brackish water or seawater; (ii) reclaimed urban or industrial wastewater (with or without treatment); (iii) collected irrigation drainage water. The non-conventional water resources are accounted for separately from the natural renewable water resources. The water can be delivered to the final users through a public water supply system (PWSS) or via self-supply (direct abstraction or non-conventional production for own final use).

Water abstraction (or water withdrawal) is the process of taking water from a natural hydrological regime (ground or surface water body) either temporarily (e.g. for cooling purpose) or permanently (e.g. for drinking water) and conveyed to a place of use. The abstracted water is used in a wide range of sectors such as agriculture, manufacturing industry, mining, electricity generation, hydropower, cooling, etc. Water abstraction from precipitation (i.e. rainwater harvesting) is included and must be identified if applicable. Water used for hydropower generation is included (although it is an in-situ water use it is considered to have a very low consumption of water due to the associated evaporation from the reservoirs) and must be identified if applicable

Water use is the utilization of water for a specific purpose, e.g. by agriculture, industry, energy production and households. It includes the in—stream uses such as fishing, recreation, transportation, identifying nevertheless that these are non-consumptive types of water use.

Water consumption can be defined as water abstracted which is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock, ejected directly into sea, or otherwise removed from freshwater resources and not returned to back. It represents the portion of water use that is not returned to the original water source after being withdrawn and is no longer available for reuse. Water losses during transport of water between the points of abstractions and points of use, or the point of use and reuse are excluded because they may return to the system (e.g. leakage losses).

Returned water is the part of the water which has been abstracted from a fresh water source and discharged/ returned into its source or into another fresh water body (surface or groundwater) either before use or after use. Discharges to the sea are not included here.

- *Returned water before use (leakage losses)*: water abstracted from any freshwater source and returned into a freshwater recipient before being uses. It basically refers to the volume of water lost during transport through leakage between a point of abstraction and a point of use, and/or in the water supply/ distribution network. Evapotranspiration losses or water losses which occurs during mining or construction activities are not included here. Artificial aquifer recharge is included here if the water is abstracted from a freshwater body and directly injected into the groundwater, and must be specified if it occurs.
- *Returned water after use*: total volume of water discharged into freshwater bodies after use as treated effluent or as non-treated (e.g. cooling water, treated wastewater, etc.). Discharges to the sea are not included here. It is important to identify the hydrological unit-recipient of this discharge since it can be different than the one where the water was originally abstracted from. Artificial aquifer recharge with treated wastewater is included here and must be specified if it occurs.
- *Leakage losses between use and reuse*: it refers to the volume of water lost through leakage during the transport between points of use and reuse, after the treated effluent leaves the wastewater treatment plant and is transported to the reclaimed water recipients.

Reclaimed wastewater is wastewater-treatment plant effluent that has been diverted for beneficial use before it reaches a natural hydrological system.

Reused water is water that has undergone wastewater treatment and is delivered to a user as reclaimed wastewater. This means the direct supply of treated effluent to the user. Wastewater discharged into a watercourse and used again downstream is excluded (i.e. this is considered returned water). Recycling is also excluded. If the reclaimed water is made available (totally or partially) for reuse to recipients who are located in a different hydrological unit (than the one where the water was originally abstracted) -in other words the water is exported for reuse elsewhere- this should be mentioned to avoid miscalculations, and the hydrological unit receiving this water should be defined if possible.

Recycled water is water that is used multiple times by the same user (either treated or non-treated) after withdrawal and before it returns to the natural hydrologic system.

Recycled drainage water: multiple reuse of drainage water in the Nile Delta has been adopted as an official policy since the late seventies. The policy calls for recycling agriculture drainage water by pumping it from main and branch drains and mixing it with fresh water in main and branch canals (CEDARE, 2014). There has been a decreasing trend in the amounts of water discharged into the sea with a significant increase in the amounts of drainage water reused recently as the reused quantity amounts to more than 13.5 billion m³/yr in 2017 (total amount in valley and delta) (MWRI). The reuse of agricultural drainage water (and of treated sewage water) cannot be considered as independent resources; however, they help augment the fresh water supply in certain regions. This recycling process of the previously used Nile freshwater improves the overall efficiency of the water distribution system (CEDARE, 2014).

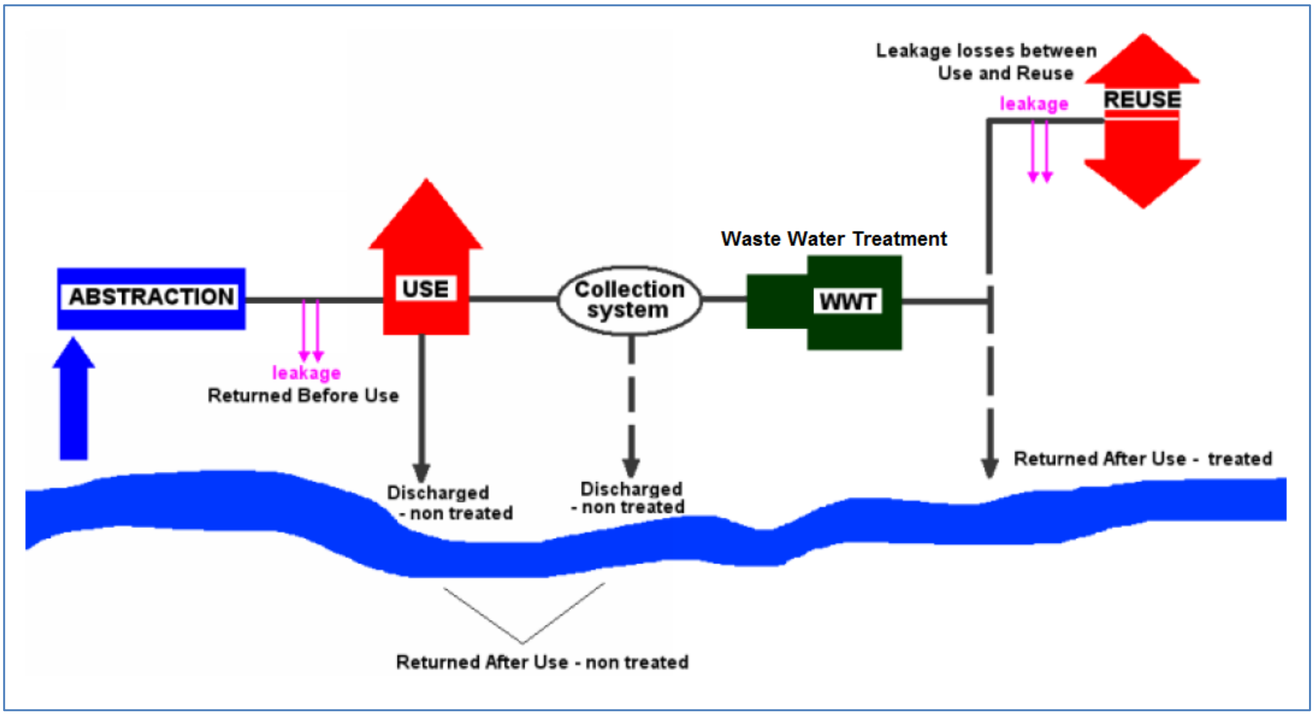


Figure 2-1: Conceptual flowchart of the "returned water" components

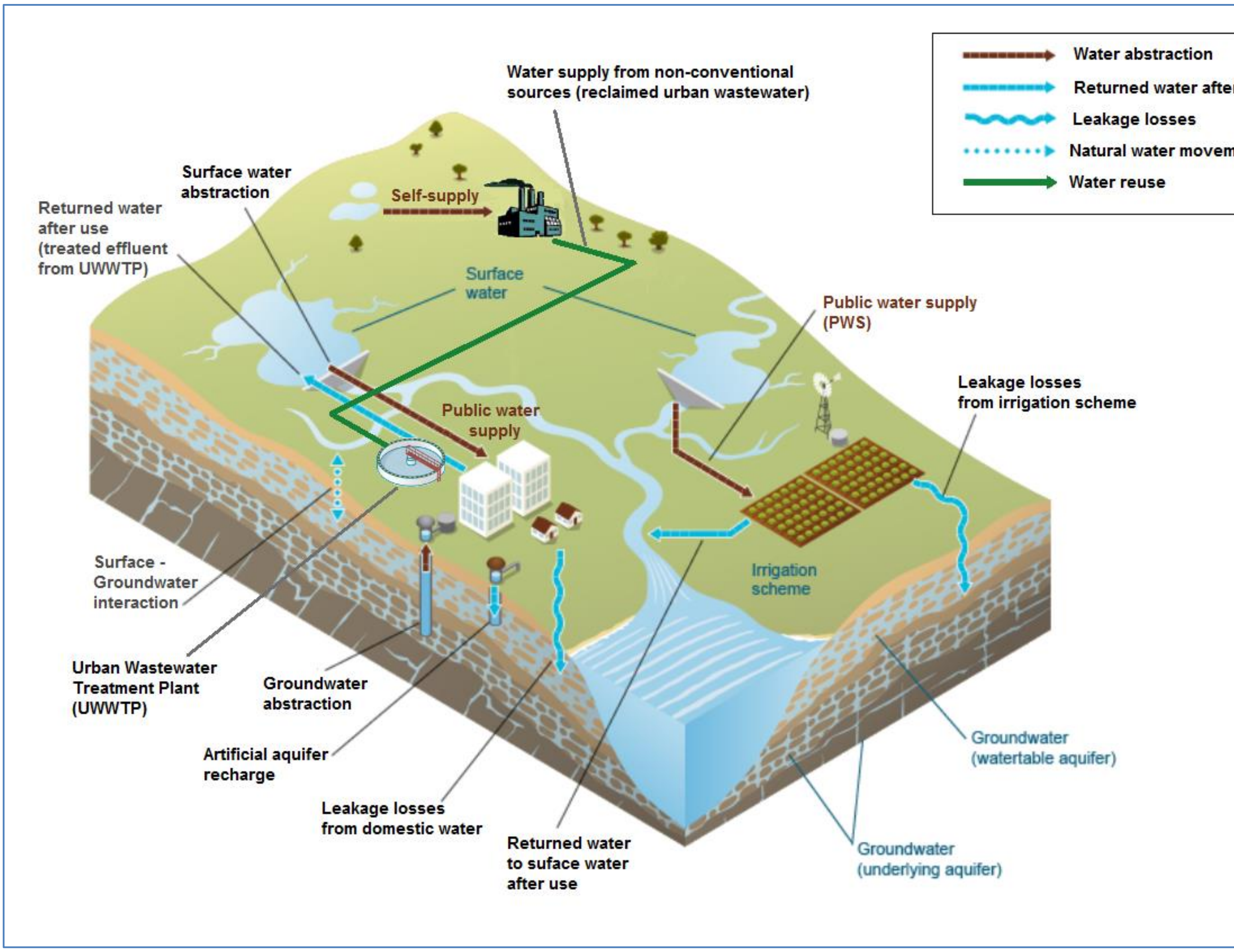


Figure 2-2: Schematic chart of the water flows and transfers in a river basin (Adopted from: Australian Government, Bureau of Meteorology, Supporting information for water accounting statements, Perth Region; http://www.bom.gov.au/water/nwa/2014/perth/notes/supportinginformationforwateraccountingstatements.shtml)

3. TYPOLOGY OF WATER USES

3.1 CLASSIFICATION OF ECONOMIC ACTIVTIES

Water use statistics are important in assessing the sustainability and productivity of the various economic sectors. In order to be able to compare or combine water use with other economic statistics and indicators, it is recommended that their classification follows international (and/or national) reference classifications of economic activities. Thus, the water use typology developed in this manual is closely linked with the ISIC classification of economic activities to allow deriving meaningful indicators for different sectors and sub-sector of the economy.

The International Standard Industrial Classification of All Economic Activities (ISIC) is the international reference classification of productive activities. It consists of a coherent and consistent classification structure of economic activities based on a set of internationally agreed concepts, definitions, principles and classification rules. Its main purpose is to provide a comprehensive framework within which economic data can be collected and reported in a format that is designed for purposes of economic analysis, decision-taking and policy-making. Since the adoption of the original version of ISIC in 1948, the majority of countries around the world have used ISIC as their national activity classification, or have developed national classifications derived from ISIC. Wide use has been made of ISIC, both nationally and internationally, in classifying data according to kind of economic activity in the fields of economic and social statistics, such as for statistics on national accounts, demography of enterprises, employment and others. In addition, ISIC is increasingly used for non-statistical purposes. The latest ISIC Rev.4 has been officially released on 11 August 2008.

In the European Union, the statistical classification of economic activities NACE (Nomenclature Statistique des Activités Economiques dans la Communauté Européenne) has been developed since 1970. NACE provides the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics (e.g. production, employment, national accounts) and in other statistical domains, and is derived from ISIC, in the sense that it is more detailed than ISIC. ISIC and NACE have exactly the same items at the highest levels, where NACE is more detailed at lower levels. In order to ensure international comparability, the definitions and the guidelines established for use of NACE within the EU are consistent with those published in the introduction to ISIC. The latest revision is NACE Rev. 2 (http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF).

In Egypt, the national classification (following the ISIC principles) is the “Classification of Economic Activities –CEA (تصنيف النشاط الاقتصادى)”. It consists of 21 tabulation categories, and was adopted in May 2007 following the international classification ISIC Rev.4 (https://unstats.un.org/unsd/cr/ctryreg/ctrydetail.asp?id=1103). The institute responsible for the development and maintenance of the classification is the CAPMAS, Head of population statistical sector-classification department (www.capmas.gov.eg).

The individual categories of ISIC Rev. 4 have been aggregated into 21sections, as presented in the Table below.

Table 3-1: International Standard Industrial Classification of All Economic Activities (ISIC, Rev. 4). (The full documentation is available at: https://unstats.un.org/unsd/cr/registry/regdntransfer.asp?f=135)

Section	Divisions	Description
A	01–03	Agriculture, forestry and fishing
B	05–09	Mining and quarrying
C	10–33	Manufacturing
D	35	Electricity, gas, steam and air conditioning supply
E	36–39	Water supply; sewerage, waste management and remediation activities
F	41–43	Construction
G	45–47	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	49–53	Transportation and storage
I	55–56	Accommodation and food service activities
J	58–63	Information and communication
K	64–66	Financial and insurance activities
L	68	Real estate activities
M	69–75	Professional, scientific and technical activities
N	77–82	Administrative and support service activities
O	84	Public administration and defence; compulsory social security
P	85	Education
Q	86–88	Human health and social work activities
R	90–93	Arts, entertainment and recreation
S	94–96	Other service activities
T	97–98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	99	Activities of extraterritorial organizations and bodies

3.2 WATER USE CATEGORIES

The following water uses have been defined for Egypt and will form the basis for monitoring, evaluation and reporting.

Domestic water use: water used for indoor and outdoor household purposes (drinking, food preparation, bathing, washing clothes and dishes, cleaning, personal hygiene, watering the yard and garden, etc.). Water for domestic use may be delivered from a public supplier (PWSS), withdrawn from a private source such as a well or spring (self-supply), or captured as rainwater in a cistern (rainwater harvesting, also a self-supply).

Water use for Agriculture, forestry, fishing, fish farms: water used during the exploitation of vegetal and animal natural resources, comprising the activities of growing of crops, raising and breeding of animals, harvesting of timber and other plants, animals or animal products from a farm or their natural habitats

Break-down between specific uses:

- Irrigation water use: water that is applied by an irrigation system to sustain growth in agricultural and horticultural vegetation and also is applied for the purposes of pre-irrigation, frost protection, weed control, field preparation, crop cooling, harvesting, dust suppression, leaching of salts from the root zone, and the application of chemicals Water may be withdrawn by the irrigator (self-supply) or delivered from irrigation companies, irrigation districts, irrigation cooperatives, or governmental entities. Irrigation/watering of commercial and public spaces (e.g. golf-courses, playgrounds, etc.) is not included here.
- Livestock water use: water used for livestock watering, feedlots, dairy operations, and other on-farm needs. Types of livestock include dairy cows and heifers, beef cattle and calves, sheep and lambs, goats, hogs and pigs, horses and poultry.
- Aquaculture water use: water use associated with the farming of finfish, shellfish, and other organisms that live in water, and off-stream water use associated with fish hatcheries.

Water use for Mining & Quarrying: water used for the extraction of naturally occurring minerals including solids (such as coal, sand, gravel, and other ores), liquids (such as crude petroleum), and gases (such as natural gas). Also includes uses associated with quarrying, milling and other preparations customarily done at the mine site, injection of water for secondary oil recovery or for unconventional oil and gas recovery (such as hydraulic fracturing), and other operations associated with mining activity. Does not include water associated with dewatering of the aquifer that is not put to beneficial use. Also does not include water used in processing, such as smelting, refining petroleum, or slurry pipeline operations. These processing uses are not included here, but they are included in industrial water use

Water use for the manufacturing industry: Water used for industrial purposes, both in the manufacturing process, for cooling, for cleaning the facilities, and used from the employees. It includes water used for purposes such as fabricating, processing, washing, diluting, or transporting a product; for cooling; incorporating water into a product (e.g. in food & beverage industry); for sanitation, maintenance, or landscaping needs of the facility. Industrial water supplies may be derived from ground water, surface water (self-supplied industrial withdrawals) or reclaimed wastewater or provided by a public-water supplier (PWS industrial deliveries). Cooling water within an industry maybe recycled several times in the cooling towers so it is essential not to double-count it.

Potential break-down per type of industry: Food processing industry; Basic metals; Transport equipment; Textiles; Paper and paper products; Chemicals, refined petroleum, etc.; Other manufacturing industry .

Potential separation between water used for Cooling purposes (Cooling water: Water which is used to absorb and remove heat).

Water use for production of Electricity: Water used in the process of generating thermoelectric power from multiple source (fossil fuels, nuclear fission, geothermal energy. Thermoelectric power plants typically. The predominant use of water he thermoelectric power plants is to cool the steam. Boiler water must be freshwater, however, cooling water may be fresh or saline.

Potential separation between water used for Cooling purposes (Cooling water: Water which is used to absorb and remove heat)

Water use for Hydropower production: the use of water in the generation of electricity at plants where the turbine generators are driven by moving water. Hydroelectric water use is most commonly an in-stream use.

Commercial water use: water used for commercial purposes and services (e.g. tourism). It includes water used in hotels, motels, restaurants, office buildings, commercial buildings (e.g. shopping centers, sports centers), other commercial facilities (e.g. car washers, laundromats), institutions and services (golf-courses). The water may be obtained from a public water supply system (PWSS) or through self-supplied.

Potential separation for water used in the Tourism sector (hotels, motels, etc.)

Public water use: water supplied from a public-water supply system (PWSS) and used for public-interest purposes, such as firefighting, street washing, municipal parks' watering, playgrounds, public buildings (e.g. schools, military camps, public hospitals) and services

Other water use: Water used for any other economic activity not included above (e.g. construction sites)

On the basis of the above definition, the water uses in Egypt have been classified into main and secondary. A sub-set of them should be monitored, evaluated and reported as mandatory in the NWUIS, while for others this can be optional, as presented in the Table below.

Table 3-2: Definition of main and secondary water uses in Egypt

Water Use category	Main	Secondary	Monitoring, evaluation and reporting in the National Water Use Information System (NWUIS) of Egypt
Domestic water use (households)	√		Mandatory

- Commercial water use (tourism is included here)	√		Mandatory
- Public water use	√		Mandatory
Water use for Agriculture, forestry, fishing, fish farms	√		Mandatory
- Irrigation	√		Mandatory
- Livestock		√	Mandatory
- Aquaculture (fish farming)		√	Mandatory
Water use for the manufacturing industry	√		Mandatory
Water use for Mining & Quarrying	√		Optional
Water use for production of Electricity	√		Mandatory
Water use for Hydropower production	√		Mandatory

4. GUIDELINE FOR PREPARING WATER USE ESTIMATES

4.1 GENERAL PRINCIPLES

It is often a problem that water use cannot be directly measured for all sectors, and thus different proxies and estimates need to be developed. To this extent it is important to:

- Define methods, techniques, and coefficients for estimating water use based on generally accepted methodologies described in the international literature and which require the least possible data but can adequately and reliably represent water use when necessary.
- Have common proxy methodologies which are also based on primary data which are feasible for the Egyptian Governorates and relatively easy to retrieve
- Compile a master list of public-supply systems containing, as a minimum, the names and locations of public- water suppliers/ distributors, the populations served, and the sources and abstraction points of the water.

When preparing water use estimated the following factors need to be considered and accounted for:

- The availability, completeness and most recent year of data can vary among sites, Governorates, sectors, etc.
- The spatial scales (unit) and temporal resolutions of data monitoring, collection, and/or estimation can be variable and not consistent, thus aggregation and/or disaggregation techniques may be required
- The difficulty of accessing the data for estimating water use can vary (from requesting them from relevant agencies to designing an extended survey to collect the data)
- The completeness and the quality of the data may vary, requiring thus the application of gap filling techniques and/or quality control checks
- Site-specific water-use data are more commonly available for public-supply, industrial, and thermoelectric-power facilities, and less commonly available for self-supplied domestic, irrigation, aquaculture, livestock, and mining water-use sites.
- Compiling an inventory of all water-use sites is very useful to identify data gaps
- When data are not readily available, water-use estimates may be determined using ancillary data (explanatory variables) and water-use coefficients. Coefficient methods estimate water use, W, as the product of a relevant explanatory variable X (number of employees, number of single-family homes, population served, acres of irrigated croplands, etc.) and a dimensionally consistent water use coefficient C (litres per employee, liters per single family home, liters per capita, etc.): $W = XC$.The coefficients represents a unit-use water requirement and the explanatory variables are the number of units. Although these indirect estimation methods can be extremely valuable when direct sample data are limited, these methods nevertheless require sufficient data to support calibration and verification.

- The water use estimates should necessarily be grounded in the local context and data records.
- Water use estimates require integrating data of mixed quality that are collected by other agencies for other purposes and that are derived from data collection protocols generally neither controlled nor modifiable by MWRI.
- The accuracy of coefficient-based estimates depends both on the water use coefficient and on the underlying activity assumed to drive water. A more robust coefficient-based model calculates water use separately for specific categories (e.g. commercial, residential, tourism). When adequate categorical data are available, these estimates can be aggregated to yield more accurate estimates of total water use.
- All data sources must be well documented
- If water-use coefficients are not available for the different categories, they should ideally be developed from a representative sample (pilot survey) of typical users that are more pertinent to a specific facility, site, Governorate, and using a stratified approach when possible
- Coefficient-based methods assume constant water use rates in each category of use. This simplification ignores trends, changes in water use due to conservation, technological change, or economic forces, and the optimal level of disaggregation of water use categories.
- For a robust indirect estimation of water use, the following elements should be available or considered on top of the activity-based water use coefficients: correlation-based models estimated with regression techniques in order to prove the relation between the water use, the coefficient and the explanatory variable, econometric models of water use behavior, materials flow models estimated from macroeconomic national accounts data, system-level models that explicitly optimize water use, indirect methods for consumptive use.

4.2 DOMESTIC WATER USE

Pubic Water Suppliers (PWSs) often serve mixed users: domestic, commercial, industrial. Thus, estimating the domestic waster use alone might not be straight forward.

Preliminary steps:

- Compile a Masterlist of PWSs (names, location, districts served, population served, sources of raw water).
- Obtain more details for the PWSs: total withdrawal and per source, metering points (e.g. before treatment, at delivery, etc.), purchase or sell information, number of active service connections per type (residential, commercial, industrial), delivery estimates.
- Install water meters and keep billing records of residential water sold.

Proxies to be used:

- A per-capita use coefficient (lt/person/day) may be used to estimate total public-supply water use or domestic deliveries from public supply (total public-supply per capita use coefficient vs.

domestic public-supply per capita use coefficient). Total public-supply per capita use coefficients are generally larger for systems that serve industrial and commercial users or have large losses.

- Preferably, the per-capita use coefficient is derived from PWSS of similar size, customer base, rate structures, demographic and socioeconomic characteristics, climatic and geographic settings. Conducting a reasonably representative sample survey is advised prior to determining the coefficient.
- To estimate the water use, multiply the per-capita use coefficient with the population served, or with the number of housing units with public supply capability (billed residential connections) and average number of people per household.

Key issues:

- The per-capita use coefficient varies considerably between different localities in Egypt, as well as the rate of losses, so using a universal country coefficient introduces bias
- A reliable estimate of population served per Governorate depends on collecting information from public-water suppliers that serve customers in that particular Governorate. “Population served” per Governorate is not the same with the “number of subscribed users” (i.e. more than 1 people are served by one subscription, depending also on the household size and number of people in the household)
- The service-area boundaries of a public supplier may not coincide with the city or Governorate limits (i.e. a public supplier may serve customers living outside a city or Governorate boundaries), and thus the population served estimates may need to be adjusted
- Vacationers and tourists in publicly supplied areas (i.e. non-residents) are not included in the population-served number because they do not reside in this area. In highly touristic areas 9e.g. Cairo, Alexandria, Red Sea, etc.) the population that is actually served is undercounted resulting in a comparatively larger per capita use coefficient. It is often difficult to differentiate the share of tourism water use from the actual domestic water use.
- Besides the domestic water supplied by PWSS, there is also the self-supplied domestic water (mainly from groundwater) which need to be accounted for. Self-supplied domestic water use is typically estimated by multiplying the “self-supplied population” by a “self-supplied domestic per capita use coefficient”. The self-supplied population can be calculated by subtracting the population served by the PWWS from the total population in the Governorate (or specific service area, city, etc.), and is of course subject to the reliability of these ancillary data.
- The self-supplied domestic per capita use coefficient needs to be considering per Governorate or service area, based on the specific characteristics of the area (demographic and socioeconomic characteristics, climatic and geographic settings). The self-supply domestic per capita use coefficient may differ from the public supply domestic per capita use coefficient, and be either higher or lower: if there is not volumetric change for the self-supplied water then the user may not have a water saving culture and use more of this freely available source; on the other-hand, if electricity costs for pumping water from private wells is high, the users may be more reluctant to water wastage and use it more rationally. In areas where public supply serves

a mix of uses together with the domestic use (i.e. touristic, industrial, etc.), the self-supply domestic water use coefficient is expected to be much lower that the public supply water use coefficient. A sampling survey is well advised prior to defining these coefficients. Self-supplied domestic water use can also be estimated from wastewater facilities and the relevant fees charged foe sewage disposal and treatment.

Example calculation:

- Per per-capita use coefficient (lt/person/day) = 237 litres of water per capita per day (including 35% leakage)
- Number of population served = 21,000
- Number of housing units served = 5,000
- Average number of people per household = 4.2
- Period = 365 days/year

➢ Annual Domestic Water Use = (Per per-capita use coefficient) × (Number of population served) × (Period) ÷ (1,000 lt/m^3) ÷ (1,000,000 m^3/billion) = 1.82 billion m^3 per year (BCB/yr)

Or,

Annual Domestic Water Use = (Per per-capita use coefficient) × (Number of housing units served) × (Average number of people per household) × (Period) ÷ (1,000 lt/m^3) ÷ (1,000,000 m^3/billion) = 1.82 billion m^3 per year (BCB/yr)

Table 4-1: Total amount of produced & sold water and wastage percentage for the year 2015/2016 (Source: CAPMAS 2018 - Drinking water and drainage statistics Bulletin, Issued April 2018, https://www.capmas.gov.eg/Pages/Publications.aspx?page_id=5104&Year=23382)

Quantity by million m3				
Governorate/Item	**Quantity of produced pure water**	**Quantity of sold water**	**loss %**	**No. of subscriptions**
Cairo	2,098.3	1,399.6	33.3	1,150,070
Alexandria	1,056.3	753.2	28.7	1,535,155
Port Said	9.7	4.1	57.7	8,606
Suez	18.8	8	57.4	25,855
Damietta	188	142.9	24.0	321,018
Dakahlia	528.7	396.5	25.0	1,130,855
Sharkia	371.5	285.3	23.2	952,076
Kaliobeya	214.6	159.9	25.5	597,473
Kafr El_Sheikh	287.5	201.8	29.8	492,116
Gharbia	336	273.8	18.5	913,984
Monoufia	326.2	259.3	20.5	834,027
Behera	488.4	349.2	28.5	839,444
Ismailia	139.8	59.3	57.6	134,855
Giza	1,234.9	825	33.2	972,388
Beni Suef	203	143.1	29.5	492,407

Fayoum	249.14	179.2	28.1	535,384
Menia	287.7	186.7	35.1	842,099
Asyout	224.8	185.3	17.6	654,996
Suhag	270.7	207.9	23.2	742,515
Qena	202.6	141.6	30.1	463,967
Aswan	119.1	88.1	26.0	318,130
Luxor	104	62.7	39.7	237,639
Red Sea	40.9	31	24.2	82,597
El_Wadi El_Gadid	46.5	38.3	17.6	33,644
Matrouh	66.3	31.6	52.3	102,081
North Sinai	69.4	44.9	35.3	76,691
South Sinai	24.6	15.9	35.4	31,250
Total	9,207.4	6,474.2	29.7	14,521,322
Bulletin Name: Refining and distribution of water – CAPMAS				

Box 1. Domestic Water Use Survey

1. How many people live in your household? (average) - *you can assume basic use of 40 lt/person for hand washing, face washing, brushing teeth, drinking, cooking*
2. How many showers total are taken per week in your household?
3. What is the average length of each shower? (in minutes) – *you can use 8 minutes as an average duration*
4. What is the flow rate of your showerhead? (litre per minute) – *you can use 20 lt/min for standard, or 9 lt/min for low flow showerheads*
5. How many baths are taken each week in your household? – *you can assume a use of 23 lt per bath*
6. How many flushes total per week in your household?
7. How many gallons does your toilet use per flush? – *you can use 10 lt/flush for standard toilet, 4 lt/flash for low flow WCs*
8. How many times are dishes washed by hand each week in your household?
9. How long does the water run each time wash the dishes? (minutes)
10. What is the flow rate of your sink faucet? (litres per minute) – *you can use 13 lt/min for standard, and 4 lt/min for for low flow faucets*
11. How many times is the dishwashing machine run each week? - *the average dishwashing machine uses 40 litres per load, if you have a water-efficient machine, enter the gallons used by your machine (efficient dishwashers use around 7-19 lt/load)*
12. How many loads of laundry are done in your household each week? - *the average washing machine uses 80 litres per load, if you have a water-efficient machine, enter the gallons used by your machine (efficient washing machines use around 40 lt/load)*
13. Do you have any outdoor water use? It is assumed that outdoor water use occurs during the summer months from May to September
14. How many times do you irrigate you lawn each week in the summer?
15. How long is the lawn irrigated for? (minutes)
16. How much time is spent each week on miscellaneous watering such as washing cars, pets, watering garden? (minutes)

To calculate the domestic per water use coefficient (lt/person/day) sum up all the uses and then divide by 7.

Example calculation of daily and weekly domestic water use per capita coefficient:

	Unit	Rate	Duration	Daily use (lt/day)	Weekly use (lt/week)
Number of people in the household	1	40 lt/day		40 lt/day	280 lt/week
Showers per week	5 per week	20 lt/min	8 min	114.3 lt/day	800 lt/week

Baths per week	2 per week	23 lt/bath		6.6 lt/day	46 lt/week
Toilet flushes per day	6 per day	10 lt/flush		60 lt/day	420 lt/week
Dishes washed by hand each week	3 per week	13 lt/min	4 min	22.3 lt/day	156 lt/week
Use of dishwasher each week	1 per week	40 lt/load		5.7 lt/day	40 lt/week
Use of washing machine each week	1 per week	80 lt/load		11.4 lt/dy	80 lt/week
Outdoor water use	n/a				
TOTAL				**260.3 lt/day**	**1,822 lt/week**

4.3 INDUSTRIAL WATER USE

Industrial water use may be provided by the Public Water Systems which often serves additional user (mixed system), i.e. domestic, commercial, tourism. Thus, in this case, estimating industrial water use alone might not be straight forward. Water-use-intensive industries are often self-supplied. Reclaimed wastewater is often a source.

Preliminary steps:

- Compile a Masterlist of industrial facilities (names, location, type of industry, sources of water, estimated annual quantity of product produced, number of employees).
- For the water self-supplied industries, map them on the watershed to determine the closest water sources, and retrieve information from the water permits, or the WWT facilities.
- Focus on the larger ones, while striving an adequate representation of the total in the area
- Install water meters and keep billing records of industrial water sold.

Proxies to be used:

- A per-employee use coefficient (lt/employee/day), or a per-unit of product use coefficient (lt/tons of product or yield), or a per-$ of annual sales use coefficient (lt/1000 dollars of sale), or a per-working hour use coefficient (lt/100 working hrs) may be used to estimate total industrial water use.
- Preferably, the use coefficient is derived from industries of similar size, type, age, climatic and geographic settings. Conducting a reasonably representative sample survey is advised prior to determining the coefficient.
- To estimate the water use, multiply with ancillary data on employment or production or annual sales with the respective use coefficient(s).
- For the water self-supplied industries, use information from the water abstraction permits, or the WWT facilities that set fees according to metered water use, or from emission registers, or from energy bills in case of groundwater pumping.

Key issues:

- The use coefficients varies considerably between different types of industries, between different localities in Egypt, as well as the rate of losses, so using a universal country coefficient introduces bias
- Water use rate may also vary within the same type of industries, as a function of the age of the facility, the maintenance conditions of the machinery, the operation of the cooling towers, the specific processes uses, the water saving technologies in place, the management practices, the employees' water saving culture, etc. Thus, the water use coefficients vary even within the same type of industries, so further investigation and benchmarking are important.
- Water use in industries covers many aspects and processes, both manufacturing processes as well as cooling purposes, cleaning of facilities and water used by employees. Thus, accurately estimate the total volume it needs to be broken down by components, since the use rates in the manufacturing process are very wide and fifer of course from the lavatory user rates of the employees. Water leakage in the facilities may also be significant. Water auditing is thus an essential aspect for accurately defining the water use across the various processes and better capturing the reality.
- The use of reclaimed wastewater is often in industries. This volume is of course part of the total water used by the industry, but has to clearly be differentiated since it does not originate from a direct freshwater abstraction. The same applies in the case of use of desalinated water or saline water.
- Water recycling in industries, within the cooling towers or across processes is often encountered in industries. It is thus important to identify this and not double-count the water used. The potential for water recycling depends on the manufacturing processes, the operation of the cooling towers, the water quality requirements across the different processes and stages.
- Different water qualities may fit different purposes in industries. Thus, some facilities may be using a mix of water resources of higher and lower water quality, recycle part of the water, etc. These practices require a more thorough estimation of water use per type of water resource. Water auditing and benchmarking are once again essential.

Example calculations:

- Example 1

Production level (tons/day) = 1,000 tons/day

Average per unit of output use coefficient (m^3/ton) = 0.54 m3/ton

Working days = 250 days/year

- Annual Industrial Water Use = (Per unit of output use coefficient) × (Production level) × (Working days) = 135,000 m^3 per year

- Example 2

Number of Employees = 165 employees

Average per employee use coefficient (litres per employee per day - lped) = 1,500 lped

Working days = 250 days/year

➢ Annual Industrial Water Use = (Per employee use coefficient) × (Number of employees) × (Working days) = 22,500,000 m^3 per year

- Example 3

Factory floor area (m2) = 50,000 m^2

Average per factory floor area use coefficient (m^3/m^2 of factory floor) = 1,950 m^3/m^2

➢ Annual Industrial Water Use = (Per factory floor area use coefficient) × (Factory floor area) = 97,500,000 m^3 per year

- Example 4

Factory floor area (m2) = 20,000 m^2

Average per factory floor area use coefficient (m^3/day/m^2 of factory floor) = 0.0055 m^3/day/m^2

Working days = 250 days/year

➢ Annual Industrial Water Use = (Per factory floor area use coefficient) × (Factory floor area) × (Working days) = 27,500 m^3 per year

Box 2. Industrial Water Use Survey and Empirical Evidence

A country-wide cross-sectional survey was conducted in Bahrain to investigate the water demand characteristics in industry, and develop appropriate demand functions. The sample included 135 industrial firms (representing all types of industrial activities and all levels of manufacturing), while a set of demand determinants were hypothesized to influence industrial water use namely the production level/ output, the number of employees, the factory floor area.

The average water use based on the sample data was estimated to be around 315 m^3/day (with a high standard deviation of 1,307 m^3/day), of which approximately 84% was used in production, 11% for staff hygiene, and the remaining 5% for other purpose (i.e. landscaping, floor washing, facility cleaning, etc.). The re-cycling factor was not considered in these calculations. A benchmarking was also performed according to Standard Industrial Classification (SIC) categories to assess their key consumption values as presented in the Table below (Source: Mubarak A. Al-Noaimi, 2014):

SIC Category	Industrial activity	Average Consumption m^3/day	Per employee water use (lt/emp/day)	Water use per unit of output (m^3/ton/day)	Water use per factory floor area m^3/m^2
No. 31	Manufacture of food, beverages and tobacco	463.4	8,197	1.08	0.036
No. 32	Textile wearing apparel & leather industries	133.4	221	9.52	0.15
No. 33	Manufacture of wood and wood products including furniture	11.8	103	7.9	0.0021

No. 34	Manufacture of paper and paper products, printing and publishing	103.8	1,753	7.6	0.0051
No. 35	Manufacture of chemicals, and of chemical, petroleum, coal, rubber and plastic products	610.1	4,032	0.33	0.0069
No. 36	Manufacture of non-metallic products, except products of petroleum and coal	147.0	1,569	0.13	0.0048
No. 37	Basic metal industries	930.3	1,478	0.31	0.0042
No. 38	Manufacture of fabricated metal products, machinery and equipment	12.5	134	0.35	0.0007
No. 39	Other manufacturing industries	372.1	723	--	0.002

The empirical evidence suggested that average industrial water use is positively responsive to changes in the variables factory floor area, number of employee, and output level. Available data on water price were insufficient to investigate price-quantity relationship. The log-linear models that reated water use (dependent variable) to the three selected determinants (i.e. production level/ output, number of employees, factory floor area) exhibited statistical superiority over the linear functions, and demonstrated good correlations. A key finding is that the number of persons employed and the SIC Categories are important determinants of industrial water use.

4.4 IRRIGATION WATER USE

Irrigation water may be self-supplied or delivered from irrigation companies, irrigation districts, users' associations and/or public supply governmental scheme s (canals, drains, etc.). Illegal abstractions may also occur (mostly from groundwater wells). The irrigation efficiency varies from one area to another, depending on the conveyance efficiency and the field application efficiency. Different conveyance networks are applicable, i.e. opens canals versus closed pipes systems, resulting in different conveyance efficiencies. The losses from the open canals are higher, and thus these systems have lower efficiencies. Different irrigation methods and systems can be used, i.e. surface (furrow) irrigation, sprinklers, drip irrigation, resulting in different application efficiencies. The surface irrigation is the least efficient method, while drip irrigation is the most efficient. Reclaimed wastewater is also often is used for irrigation, as well as saline water in some cases. Drainage water recycling (mixing of agricultural drainage water with fresh water in the main and branch canals) is also widely practiced in Egypt. Thus, in this case, estimating irrigation water use alone might not be straight forward.

Preliminary steps:

- Compile a Masterlist of the main irrigation areas and schemes (location, area covered, number of farms, crop type(s), type(s) of irrigation method, sources of water, estimated annual yields per crop type).

- Map the main irrigation area on the watershed to determine the closest water sources, and retrieve information from the water permits and the irrigation networks/ schemes.
- Focus on the larger irrigation areas, while strive an adequate representation of the total in the study area.
- Install water meters and keep billing records of agricultural water sold/ delivered by the irrigation districts.

Proxies to be used:

- A crop water-consumption coefficient for several crops and system types (irrigated acres by crop type coupled with irrigation system type/ method) can be used to calculate crop water needs.
- To derive crop water needs (ETcrop) literature default values can be used, or alternatively, they can be calculated based on more sophisticated/ customized methods incorporating the growing season length and the growth stages to calculate the needed crop factor (Kc), and the reference crop evapotranspiration (ETo) using known methods (pan method, Blaney-Criddle methos, etc.). In the latter case, ETcrop = ETo x Kc.
- Preferably, the crop water needs (ETcrop) or Kc values are derived from fields of similar size, crop type, irrigation method, climatic and geographic settings. Conducting a reasonably representative local sample survey is advised prior to determining these coefficients.
- Once crop water needs have been obtain, the crop irrigation water demand in a specific unit area (IrrD_crop) can be estimated by subtracting the amount of rainfed irrigation (effective precipitation - Pe) and multiplying by the number of irrigated hecatres in this unit area (for each specific crop): IrrD_crop = [ETcrop - Pe] x [irrigated hectares]. In cases where there is no rainfall at all during the growing season, all water has to be supplied by irrigation. Consequently, the irrigation water demand (IrrD) equals the crop water need (ETcrop): IrrD = ETcrop x irrigated heacted.
- The term effective rainfall (Pe) is used to define this fraction of the total amount of rainwater useful for meeting the water need of the crops. It is related to the rainfall (P) and calculated based on the following formulas: Pe = (0.8 x P) – 25, if P > 75 mm/month; or Pe = (0.6 x P) – 10, if P < 75 mm/month,
- The sum of all the crop irrigation water demands in the area provides an estimate of the total irrigation water use in the area: IrrD_total = SUM (IrrD_crop)
- Key assumption in these proxies: the irrigation water applied is adequate for optimal plant growth and the plants are not being irrigated with more or less water than needed
- The aforementioned irrigation water can come from freshwater, reclaimed wastewater or drainage water. Thus, a breakdown of the water use per source is necessary in order to obtain a clear picture
- The necessary ancillary data include: total irrigated acres for each type of crop, irrigation system efficiencies, conveyance losses, climatic variables (precipitation, evapotranspiration, temperature, etc.), irrigation management practices

- Additional useful data: information on crop water shortages, acres harvested and yields by crop, energy sources, remote sensing data on crops, soil moisture, etc. has been
- For the water self-supplied irrigation, use information from the water abstraction permits, from WWT facilities that may provide source water, or from energy bills in case of groundwater pumping

Key issues:

- The crop water need mainly depends on the climate (in a sunny and hot climate crops need more water per day than in a cloudy and cool climate), the crop type (crops like maize or sugarcane need more water than crops like millet or sorghum), the growth stage of the crop (fully grown crops need more water than crops that have just been planted). Thus, the use of universal crop water need values (ETcrop) or crop factor (Kc) values may hinder the filed reality.
- Farmer may practice some crop rotation or multiple cropping patterns which may complicate the process
- The irrigation efficiency is an important factor in the volume of water that is used in total. Conveyance losses result in a higher water use since the necessary volume reaching the farmer was subject to unaccounted losses. The same applies for the different irrigation techniques, since the final irrigation application rates are dependent on the type, age, maintenance condition of irrigation system. Thus, although we may assume that crop irrigation demand equals the irrigation water use, the latter might in fact be much higher due to water wastage.
- The number of irrigated hectares per crop type may be unknown (lack of farm survey data) or there may be a confusion between the total versus the irrigated agricultural areas. These challenges the calculation of the total irrigation demand
- Unexpected seasonal irrigation needs, such as frost protection or harvesting, are often unaccounted for and can obscure the reality
- Iirrigation water can come from multiple sources and a combination of them: surface water, groundwater, reclaimed wastewater or drainage water. Drainage water is in fact a form of water recycling, where it is mixed with freshwater in the canals. This mixing of sources complicates the process, as double-counting can be an issue. a breakdown of the water use per source is thus necessary in order to obtain a clear picture
- The spatial scales of the agricultural management units (AMUs) related to irrigation (i.e. boundaries of service areas supplied by a system such as mesqas and branch canals, irrigation district boundaries, watershed boundaries, governorate boundaries) differ and this adds extra complexity. The spatial scales of the primary source of data compared to the needed Governorate-scale data for the compilation do not coincide. Additionally, there may be mismatches in the permitted amounts compared to use amounts, also due to illegal abstraction practices.
- Data privacy issues may apply, which, combined with an unwillingness of public authorities to provide them, makes the process of estimating irrigation water use harder.

Example calculations:

Generic example:

- **Total Irrigation water demand (IrrD_total) = SUM of crop irrigation water demand (IrrD_crop)** of all crops in the study unit (e.g. feddan) in m^3
- In most cases, part of the crop water need is supplied by rainfall and the remaining part by irrigation. In such cases the irrigation water demand is the difference between the crop water need (ETcrop) and that part of the rainfall which is effectively used by the plants (Pe). In formula:

  Crop irrigation water demand (in m^3) = (Crop water needs – Effective Rainfall, in m) x Area occupied by the crop (in m^2)
- The following steps must be applied:
  - **Step 1**: Determine the reference crop evapotranspiration[5]: ETo *[several methods: Pan method, Blaney-Criddle, Penman, Hargreaves, etc.]*
  - **Step 2**: Determine the crop factor: Kc *[Kc ~ type of crop, growth stage of the crop, climate]*
  - **Step 3**: Calculate the crop water need: ET crop = ETo × Kc
  - **Step 4**: Determine the effective rainfall: Pe = (0.8 x P) - 25 if P > 75 mm/month ; else Pe = (0.6 x P) - 10]
  - **Step 5**: Calculate the irrigation water demand: IrrD_crop = ET crop – Pe
- A detailed methodology on how to calculate the crop water needs in provided by FAO in Chapters 3 and 4 of: FAO (1986). Irrigation Water Management: Irrigation Water Needs. Training manual no. 3. Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy (available online: http://www.fao.org/3/S2022E/s2022e00.htm#Contents)

Specific example:

- Calculation of the Reference crop evapotranspiration (ETo) using the of the Blaney-Criddle formula: ETo = p × (0.46 × Tmean + 8),

  where: p is the mean daily percentage of annual daytime hours for different latitudes, Tmean is the mean daily temperature for a specific month

  For example for the month of April in Kafr Elsheikh (latitude 30^0): p = 0.29, Tmean = 21.5°C the ETo is calculated as follows:

  ETo = 0.29 × (0.46 × 21.5 + 8) = 0.29 × (9.89 + 8) = 0.29 × 17.89 = 5.2 mm/day
- Calculation of the Crop water need (ETcrop) using the formula: ETcrop = Kc × ETo,

  where: ETcrop is the crop evapotranspiration or crop water need (mm/day), ETo is the reference evapotranspiration (mm/day), Kc is the crops factor. Kc average values for the various crops and growth stages can be obtained from the Table below, or can be calculated analytically.

Table 4-2: Values of the crop factor (Kc) for various crops and growth stages (Source: FAO, 1986)

[5] Reference crop evapotranspiration (ETo) is the rate of evapotranspiration from a large area, covered by green grass, 8 to 15 cm tall, which grows actively, completely shades the ground and which is not short of water (FAO, 1986).

Crop	Initial stage	Crop dev. stage	Mid-season stage	Late season stage
Barley/Oats/Wheat	0.35	0.75	1.15	0.45
Bean, green	0.35	0.7	1.1	0.9
Bean, dry	0.35	0.7	1.1	0.3
Cabbage/Carrot	0.45	0.75	1.05	0.9
Cotton/Flax	0.45	0.75	1.15	0.75
Cucumber/Squash	0.45	0.7	0.9	0.75
Eggplant/Tomato	0.45	0.75	1.15	0.8
Grain/small	0.35	0.75	1.1	0.65
Lentil/Pulses	0.45	0.75	1.1	0.5
Lettuce/Spinach	0.45	0.6	1	0.9
Maize, sweet	0.4	0.8	1.15	1
Maize, grain	0.4	0.8	1.15	0.7
Melon	0.45	0.75	1	0.75
Millet	0.35	0.7	1.1	0.65
Onion, green	0.5	0.7	1	1
Onion, dry	0.5	0.75	1.05	0.85
Peanut/Groundnut	0.45	0.75	1.05	0.7
Pea, fresh	0.45	0.8	1.15	1.05
Pepper, fresh	0.35	0.7	1.05	0.9
Potato	0.45	0.75	1.15	0.85
Radish	0.45	0.6	0.9	0.9
Sorghum	0.35	0.75	1.1	0.65
Soybean	0.35	0.75	1.1	0.6
Sugarbeet	0.45	0.8	1.15	0.8
Sunflower	0.35	0.75	1.15	0.55
Tobacco	0.35	0.75	1.1	0.9

Table 4-3: Tomato crop growing period and growth stages (Source: FAO, 1986)

Crop parameters: TOMATOE	Total growing period	Initial stage	Crop dev. stage	Mid-season stage	Late season stage
Growing Period	1 Feb-30Jun	1 Feb-5 Mar	6 Mar-15 Apr	16 Apr-5 Jun	6 Jun-30 Jun
Days within the period	150	35	40	50	25
Kc		0.45	0.75	1.15	0.8

Table 4-4: Estimated values of tomato crop water needs for various growth stages

Crop parameters: TOMATO	February	March	April	May	June
ETo (mm/day)	5.0	5.8	6.0	6.8	7.1
Growing stage	Initial	Initial + Crop dev.	Crop dev. + Mid-season	Mid-season	Mid-season + Late season
Kc	0.45	0.70	0.95	1.15	0.85

		Initial stage (5 days): 0.45 *Crop dev. Stage (25 days): 0.75* *Kc = 5/30 × 0.45) + (25/30 × 0.75) = 0.70*	*Crop dev. Stage (15 days): 0.45* *Mid-season Stage (15 days): 0.75* *Kc = 15/30 × 0.75) + (15/30 × 1.15) = 0.95*		*Mid-season Stage (5 days): 0.45* *Late season Stage (25 days): 0.75* *Kc = 5/30 × 1.15) + (25/30 × 0.8) = 0.85*
ETcrop (mm/day)	2.25	4.06	5.70	7.82	6.04
ETcrop (mm/month)	67.5	121.8	171	234.6	181.05
ETcrop (mm/year)	**776 mm/year**				

- Alternatively, Crop water need (ETcrop) estimates for the total growing period of various important field crops can be directly obtained from literature, as presented in the Table below (Source: FAO, 1986). The values indicated in the table provide a rough estimate and should only be used if the crop water needs cannot be calculated more accurately due to lack of data. As the crop water needs depend heavily on the duration of the total growing period, the maximum value should be used in the case of a long total growing period and the minimum value should be used when the total growing period is short. An average value is to be used with a medium total growing period. In addition, the Table provides an indication of the sensitivity of the various crops to water shortages or drought. If the sensitivity is high it means that the crop cannot withstand water shortages very well and such shortages should be avoided. If the sensitivity is low it means that the crop is relatively drought resistant and can withstand water shortages fairly well.

Table 4-5: Indicative values of crop water needs and sensitivity to drought (Source: FAO, 1986)

Crop	Crop water need (mm/total growing period)	Sensitivity to drought
Alfalfa	800-1600	low-medium
Banana	1200-2200	high
Barley/Oats/Wheat	450-650	low-medium
Bean	300-500	medium-high
Cabbage	350-500	medium-high
Citrus	900-1200	low-medium
Cotton	700-1300	low
Maize	500-800	medium-high
Melon	400-600	medium-high
Onion	350-550	medium-high
Peanut	500-700	low-medium
Pea	350-500	medium-high
Pepper	600-900	medium-high
Potato	500-700	high
Rice (paddy)	450-700	high
Sorghum/Millet	450-650	low
Soybean	450-700	low-medium
Sugarbeet	550-750	low-medium

Sugarcane	1500-2500	high
Sunflower	600-1000	low-medium
Tomato	400-800	medium-high

- Calculation of the Effective Rainfall (Pe) using the formula: Pe = (0.8 × P) – 25, if P > 75 mm/month or Pe = (0.6 × P) – 10, if P < 75 mm/month

  where: P is the monthly average rainfall (mm/month)
- Calculation of the Crop irrigation water demand (IrrD_crop) in mm/month) using the formula: = IrrD_crop = Etcrop – Pe
- Multiply by the number of irrigated hectares to obtain the total crop irrigation water demand (IrrD_Crop) in m^3/month in the area using the formula: IrrD_total = IrrD_crop × hectates, and sum up all the months to obtain the annual total crop irrigation water demand in m^3/year

Table 4-6: Estimated values of tomato irrigation water needs per month (within the growing season)

Month	P (mm/month)	Pe (mm/month)	ETcrop (mm/month)	IrrD_crop (mm/month)
February	17	0.2	67.5	67.3
March	13	0	121.8	121.8
April	6	0	171	171
May	4	0	234.6	234.6
June	0	0	181.05	181.05
Total for the growing period (mm/year)				**775.75**

4.5 ENERGY GENERATION (TERMOELECTRIC POWER) USE

Thermoelectric power plants typically generate electricity with a boiler, where water is heated to turn it into steam. The steam then is used to turn turbines, which generate electricity. After that, the steam is condensed to water by cooling it in a heat exchanger. The condensed water then is routed back to the boiler, where the cycle begins again. The predominant use of water is thus for cooling purposes, and it depends on whether cooling water is re-circulated (once-through/ open-loop cooling versus closed-loop /recirculation cooling). The water is usually mainly self-supplied and based on governmental permits.

Preliminary steps:

- Compile a Masterlist of power generation facilities (power-plant ownership, location, method of cooling, sources of water, average withdrawal/intake rates, average discharge rates, operating status, amount of power generated).
- For the water self-supplied industries, map them on the watershed to determine the closest water sources, and retrieve information from the water permits, or the WWT facilities.

- Focus on the larger ones, while striving an adequate representation of the total in the area.
- Install water meters and keep billing records of the water sold, or keep records of the licenses for each station and their subsequent modifications if applicable.

Proxies to be used:

- Power-generation data can be used to estimate the water withdrawals. A coefficient to estimate the m3 of water used per unit-hour of electricity generated is calculated using information from plants of similar age, design, and cooling methods. Conducting a reasonably representative sample survey is advised prior to determining the coefficient.
- Multiply this coefficient with the amount of electricity generated during a specified time period
- Ancillary data needed: site-specific water withdrawal and power generation data, volume discharged, data from the water permits or from other compliance requirements (emissions, WW registers, etc.)

Key issues:

- The use coefficients varies considerably between different types of plants, between different localities in Egypt, as well as the rate of losses, depending of the age of the facilities, the specific process and technologies implemented, etc., so using a universal country coefficient introduces bias
- Water use rate may highly vary within the same type of plants depending on the water recycling practices applied in the cooling towers. The higher the number of Cycles of Concentration under which a cooling towers operates, the higher the expected water saving. Further investigation and benchmarking are thus important to avoid double-counting. Water auditing and benchmarking are important.
- Water leakage in the facilities may also be significant. Water auditing is thus an essential aspect for accurately defining the water use across the various processes and better capturing the reality.
- Different water qualities may fit different purposes in the facilities. Thus, some facilities may be using a mix of water resources of higher and lower water quality, recycle part of the water, etc. These practices require a more thorough estimation of water use per type of water resource. Water auditing and benchmarking are once again essential.

5. NATIONAL MONITORING AND REPORTING OF WATER USE

5.1 THE CURRENT SITUATION

In Egypt there is no unified national water database compiling all information on water resources, drinking water, wastewater, irrigation, environment, etc. Each Ministry involved in water management, each National Agency, and each company has its own measuring stations network, its own sampling programs, its own database and its own management criteria without real consultation between operators. The tools used for the various databases are very different among them, from the data on paper to the use of GIS. This results in a significant challenge to obtain an overview of the situation. At the moment the multiplication of the databases, the differences in format and in geographical scales do not allow easy communication and exchange of data between organizations. Additionally, some of these data are only accessible within the organization itself and are not public.

Similarly, there is no national structured framework for monitoring, evaluation and reporting of water uses in Egypt (CAPMAS, 2014). This is done on a case-by-case. Different entities monitor and collect data which are directly or indirectly related to water use, implementing different methods and approaches. However, the NWRP (National Water Resources Planning) Unit of the MWRI chaired the coordination platform (CP) for monitoring and evaluation of the NWRP-2017 within the premises of the MWRI. The NWRP-CP was formed to assist the various functional actors involved in NWRP implementation at central and non-central level with getting the planning and decision making process effectively on the ground, which is needed for the efficient and timely implementation of the NWRP (CAPMAS, 2014). Some of the main entities currently involved in the monitoring, collection and analysis of water use-related data are listed hereof:

- The Central Agency for Public Mobilization & Statistics (CAPMAS) :is considered, according to the presidential decree no. 2915/ 1964, the official source for providing, preparing and publishing statistical data, information and reports for all organizations, universities, research centres and international organizations that help in planning, developing and evaluating policies formulation and decision-making. Information about (CEDARE, 2014), CAPMAS can be accessed at: www.capmas.gov.eg
- The Egyptian Meteorological Authority (EMA) has regional centres for weather and seasonal forecasts and Climate Change and has approximately 200 meteorological stations to serve the Ministries of Defence, Civil Aviation and Agriculture & Land Reclamation (CEDARE, 2014)
- The MWRI with its different departments, units and information centers. For example, the Public Authority for Drainage projects maintains a drains database, the Water Resources Research Institute maintains a climatic stations database and a groundwater analyses database, the Strategic Research Unit maintains a database of water quality and its different use, the Groundwater Sector maintains a database of hydrology and licenses, etc. Yet, these are databases are piecemeal and not interactive and among them (Source: Egypt EMWIS, http://emwis.mwri.gov.eg/data%20management%20-%20information%20center.htm

- The Holding Company for Water and Wastewater (HCWW) operates a Monitoring Analysis and Reporting System (MARS), and collects water supply and sanitation information and water quality data for storage, calculates performance indicators and provides annual reports. The MARS has been established to link all the subsidiary companies of the HCWW providing a comprehensive database on pre-approved set of water related indicators including those of the MDGs and on financial and other indicators as well
- The Ministry of Housing, Utilities and Urban Communities (MOHHUUC) collects water quality data along the River Niles its branches, and on major canal with special interest in drinking water intakes (CAPMAS, 2014)
- The Ministry of Agriculture and Land Reclamation (MALR) is the government agency responsible for monitoring any information related to the agriculture sector. MALR records indicators on crops (e.g. total area of field and vegetable crops), total of cropped area, total area of winter crops, total area of summer crops, etc...), agricultural area, yield and production (e.g. yield and production of summer field crops), average cost of production (e.g. average cost of production per feddan for field crops inside the valley, average cost of production per feddan for vegetable crops inside the valley, etc.); and average net return (CAPMAS, 2014). MALR's Economic affairs section conducts data gathering, processing, and reporting and produces an annual report

5.2 SUGGESTIONS FOR A DATA FLOW SCHEME

The development of a National Water Use Information System (NWUIS) for Egypt, where water use data are monitored and estimated at a suitable decentralized scale, following common harmonized definitions and procedures, and reported to the NWUIS is a difficult process, which requires significant time, and a coordinated effort within the Country. In this section, some preliminary data flow schemes are suggested, as discussed and drafted during the relevant participatory exercise conducted during the Closing Workshop[6] organised on 22/01/2019 in Cairo, aiming to initiate the process.

5.2.1 DOMESTIC WATER USE

Which is the appropriate/ meaningful disaggregated scale(s) of the data collection process (DCP) that you want to design? Of course, you have to compromise here the high resolutions with the data availability

	Preference 1	Preference 2
Spatial scale	building	Governorate

[6] The SWIM-H2020 SM project, in cooperation with Ministry of Water Resources and Irrigation (MWRI) has conducted a full-day workshop on water demand management, planning and infrastructure development on 22/01/2019 in Cairo, Egypt. The purpose of this workshop was to present the outputs of the activities undertaken in relation to the developed classification for water uses and the guidelines for their estimation and assessment, the methods for assessing water balances at the Governorate level and the different demand management options in the domestic sector, and the methods for planning and infrastructure development. The workshop aimed as well to facilitate a participatory discussion on issues related to water use and water balance assessment, constraints, etc., and engage the participants into hands-on collaborative exercises to further build their capacity

Temporal scale	Monthly	annually

What type of data do you need for your DCP?

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) quantity (volumes of domestic water use)	HCWW	Monthly	HCWW	For the whole city, not for every building
b) quality	HCWW	Monthly	HCWW	For the whole city, not for every building

What type of ancillary data (e.g. population, irrigated acres per crop, etc.) do you need for your DCP? These are important in case you want to use proxies to estimate the water use.

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) population	MoHP (Ministry of Health and Population)	Yearly – or more (census data)	CAPMAS (Central Agency for Public Mobilization and Statistics)	Governorate, Urban Area/ Yearly

Briefly describe a suggested data collection and reporting schema (*e.g. X entity collects and quality checks the data every month, and sends them to X entity, who aggregates them at X level and sends them to the MWRI, CAPMAS, etc….)*

HCWW collects and send this data to the Ministry of Housing, Utilities and Urban Communities (MOHHUUC) who does any necessary aggregations statistics and conveys them to the CAPMAS. HCWW also sends the data to a NWUIS at the MWRI

Briefly describe the main constraints, expected problems, etc., that you think you will confront in the Data Collection Process (DCP). List any ideas how to overcome them.

- not accurate data
- not available most of the time
- not easily accessible

Please suggest a pilot area where a pilot Data Collection Process (DCP) could be tested. This area may be a significant water user of this category, or an area where some good infrastructure already exists, or an area with low complexity, etc. Please justify why have you selected this pilot area?

New Cairo City

5.2.2 INDUSTRIAL WATER USE

Which is the appropriate/ meaningful disaggregated scale(s) of the data collection process (DCP) that you want to design? Of course, you have to compromise here the high resolutions with the data availability

	Preference 1	Preference 2
Spatial scale	factory	industrial zone
Temporal scale	weekly	Monthly, annually

What type of data do you need for your DCP?

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) Volume of water used	MWRI	Yearly	MWRI and CAPMAS (Central Agency for Public Mobilization and Statistics)	Governmental level / Yearly
b) Water quality parameters (Temperature, EC, pH, Hardness, Salinity, etc.)	MWRI	Yearly	MWRI	Governmental level / Yearly
c) Energy use/ Power consumption	MEE (Ministry of Electricity and Renewable Energy)	Monthly	MEE	Governmental level / Yearly

What type of ancillary data (e.g. population, irrigated acres per crop, etc.) do you need for your DCP? These are important in case you want to use proxies to estimate the water use.

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) number of employees	Owners and Investors	Variable (maybe every 6 months)	many entities	Governmental level
b) Working hours	Owners and Investors	Variable (maybe every 6 months)	many entities	Governmental level
c) Mass production	Owners and Investors	Variable (maybe every 6 months)	many entities	Governmental level
d) Type/ category of industries	Owners and Investors	Once in few years	many entities, MWRI	Governmental level

Briefly describe a suggested data collection and reporting schema (e.*g. X entity collects and quality checks the data every month, and sends them to X entity, who aggregates them at X level and sends them to the MWRI, CAPMAS, etc….*)

The entity (factory) will be responsible to collect and quality-check the data, and send it to the MWRI. The MWRI will review the data and aggregate them per industrial sector/ category, and import them into the NWUIS. The MOHUUC (Ministry of Housing, Utilities and Urban Communities) could also contribute to the review and aggregation process. It is important here to identify the most water consuming industrial sectors (e.g. textile industry, food & beverage, etc.).

Briefly describe the main constraints, expected problems, etc., that you think you will confront in the Data Collection Process (DCP). List any ideas how to overcome them.

Collaboration across entities and Ministries

Please suggest a pilot area where a pilot Data Collection Process (DCP) could be tested. This area may be a significant water user of this category, or an area where some good infrastructure already exists, or an area with low complexity, etc. Please justify why have you selected this pilot area?

Badr City (near New Cairo, far from river)

Any remarks, comments?

- The pre-paid meters are a new trend now in Egypt. There is an ongoing effort to expand their use in order to eliminate miss-use of water. - Regarding the industrial surface water abstraction from Nile, this is for the Governmental factories and usually for cooling purposes. There are gates to measure these abstractions. - It is a necessity to develop, install and implement a system for data collection, since there are factories that take water from the Nile, and a thorough monitoring is essential. It would be beneficial to have thus a national system in this respect.

5.2.3 IRRIGATION WATER USE

Which is the appropriate/ meaningful disaggregated scale(s) of the data collection process (DCP) that you want to design? Of course, you have to compromise here the high resolutions with the data availability

	Preference 1	Preference 2	Preference 3
Spatial scale	Branch canal	Main canal	Meska
Temporal scale	Hourly, daily, or weekly (as required by the spatial scale and the remote measurements)		

What type of data do you need for your DCP?

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) Water level (in the main and branch canals)	Human and Remote sensing	Hourly, Daily	MWRI	Main canal, branch canal / Daily
b) Water discharge (in the main and branch canals) / estimates of drainage water	Human and Remote sensing	Daily, Weekly, 15-days	MWRI MARL?	Main canal, branch canal / Daily
c) volume of water used	MWRI, MALR?			Irrigation district, irrigation directorate, Governorate
d) Water quality	Human and Remote sensing	Real-time, 5-days	MWRI	Main canal, branch canal / Daily

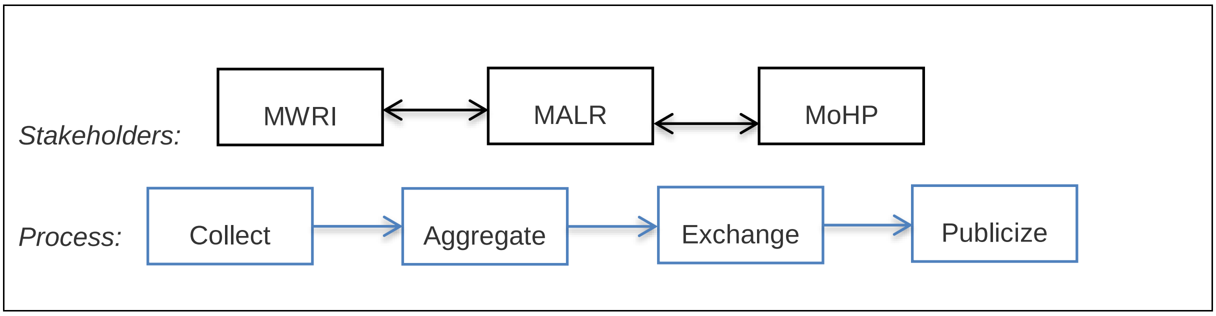
What type of ancillary data (e.g. population, irrigated acres per crop, etc.) do you need for your DCP? These are important in case you want to use proxies to estimate the water use.

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) irrigated hectares per crop	MALR (Ministry of Agriculture and Land Reclamation)	15-days	MALR should be coordinated with MWRI	Irrigation District / 15-days
b) irrigation system/ method	MALR (Ministry of Agriculture and Land Reclamation)	4-months	MALR should be coordinated with MWRI	Irrigation District / 4-months

Briefly describe a suggested data collection and reporting schema (*e.g. X entity collects and quality checks the data every month, and sends them to X entity, who aggregates them at X level and sends them to the MWRI, CAPMAS, etc….)*

Data about water levels, discharge and water quality to be measured/collected every week at each district (by the district engineer of MWRI). MWRI to aggregate these data by irrigation district and directorate and import them into the NWUIS. The volume of water sold per year is calculated by the HCWW and send to the MWRI to the NWUIS.

The MWRI, MALR and MoHP (Ministry of Health and Population) should coordinate among them and exchange ancillary data.



Briefly describe the main constraints, expected problems, etc., that you think you will confront in the Data Collection Process (DCP). List any ideas how to overcome them.

- Irrigation efficiency differs across areas - Financial resources limitations

Please suggest a pilot area where a pilot Data Collection Process (DCP) could be tested. This area may be a significant water user of this category, or an area where some good infrastructure already exists, or an area with low complexity, etc. Please justify why have you selected this pilot area?

Sinai – El Mahsama Drain (transmits water from MR to Sinai)

5.2.4 THERMOELECTIRC POWER WATER USE

Which is the appropriate/ meaningful disaggregated scale(s) of the data collection process (DCP) that you want to design? Of course, you have to compromise here the high resolutions with the data availability

	Preference 1	Preference 2	Preference 3
Spatial scale	Factory (all the openings/ intakes that supply the factory)		
Temporal scale	Once when built, and updated annually		

What type of data do you need for your DCP?

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) data related to the license of the water intake	MWRI	Yearly	MWRI	By intake / Yearly or when there is a change in the intake
b) Water quantity (volume of water used)	MWRI	Yearly	MWRI	By intake / Yearly or when there is a change in the intake

What type of ancillary data (e.g. population, irrigated acres per crop, etc.) do you need for your DCP? These are important in case you want to use proxies to estimate the water use.

Data category	Who collects these data?	How often are these data collected?	Who holds these data? Is it the same entity that collects them?	At what scale (spatial / temporal) are these data currently available?
a) number of factories and their location	MoTI (Ministry of Trade and Industry) ?	?	MoTI ?	?

Briefly describe a suggested data collection and reporting schema (*e.g. X entity collects and quality checks the data every month, and sends them to X entity, who aggregates them at X level and sends them to the MWRI, CAPMAS, etc….*)

The district engineer can collect the data, send it to the General Directorate and then to the MWRI to import them into the NWUIS. The MOEE (Ministry of Electricity and Renewable Energy) to send/ exchange information and data about new plans to the MWRI.

Briefly describe the main constraints, expected problems, etc., that you think you will confront in the Data Collection Process (DCP). List any ideas how to overcome them.

- Problems with the accuracy of the data
- Limitations in the continuity of the data
- Limited staff for data collection, analysis and aggregation (lack of human resources)
- This type of data collection is not simple and direct, and different entities are involved which need to be adequately coordinated (lack of coordination across stakeholders)
- Pollution related data are lacking

Please suggest a pilot area where a pilot Data Collection Process (DCP) could be tested. This area may be a significant water user of this category, or an area where some good infrastructure already exists, or an area with low complexity, etc. Please justify why have you selected this pilot area?

Cairo industrial areas

Any remarks, comments?

The installation of pre-paid meters is a new trend in Egypt now, and very important to minimize the miss-use of water.

5.2.5 RECOMMENDATIONS AND REMARKS

As previously mentioned, there is no unified national water database in Egypt compiling all information on water resources, drinking water, wastewater, irrigation, environment, etc. Similarly, an integrated framework for data collection, identifying the data and useful indicators, the roles and work allocation (who collects what among sectors), the data flow and analysis methods, does not exist as such, minimizing consequently the full potential of use in decision making (CAPMAS, 2014).The development of a National Water Use Information System (NWUIS) for Egypt, where water use data are reported at a suitable decentralized scale, following common harmonized definitions and procedures, is essential. This requires of course significant time, and a coordinated effort within the Country. The following key elements in this direction have been identified at the planning level:

- Define which parameters need to be monitored and which indicators need to be reported into the NWUIS. The parameters identified in this Manual can serve as a good starting point, yet more specifications are needed in a collaborative work with stakeholders.
- Define data collection and reporting procedures (how often, whom to whom, format, protocol, metadata/ documentation), and develop a though and clear documentation. The documentation should include for example information on the coefficients and proxies to be used if applicable. The MWRI will have a significant input here in defining the governance aspects (i.e. responsible agencies, dataflow frequency, format, and protocol).
- Suggest some quality assurance and quality control procedures (QA/QC). It has to be noticed that this is a very important aspect, yet it needs to be fully elaborated once the NWUIS has been established (further work will be needed once the system is operational).
- Design the NWUIS architecture
- Updating and gap filling of local databases: the various ministries, agencies and companies must update their databases, make them compatible to the NWUIS and improve the management these databases. Coordination has to be created between the data managers to structure effective data monitoring, acquisition and exchange networks and data, maximizing the information flow, avoid duplication and optimize costs.
- Train qualified personnel for data collection, analysis, and reporting. Financial resources to be identified and mobilised.

6. ASSESSMENT OF WATER USE

A key driving force of each reform and paradigm change is the underlying policy question, which in this case is “Why do we need to know our water use?”. There are many answers to this question, among which the following have been identified as crucial in the case of Egypt:

- Quantifying water use per sector is an essential component of water management and of any Water Resources Management Plan
- The analysis of water use is an indispensable input for the drafting of the Governorates Water Resources Management Plans
- Water use statistics are important in assessing the sustainability, water efficiency and productivity of the various economic sectors
- The knowledge of the water used within each sectors allows for rge proper water allocation, the design of adequate Programmes of Measures, and helps prioritize water demand management efforts
- The organization of water use data and the development of a National Water Use Information System (NWUIS), following common harmonized definitions and procedures, allows for the calculation of additional policy-relevant indicator, combining water use, environmental and socio-economic data, which further allow the identification of progress towards international targets (e.g. SDGs)
- Contributes to better governance at the decentralized water management level, initiating a better coordination between stakeholders at the local level when it comes to the monitoring of water use, the definition of water saving targets, and the design of mitigation measures

6.1 PROPOSED INDICATORS FOR WATER USE ANALYSIS

In relation to policy-making, environmental indicators are used for three major purposes (EEA, 1998):

- to supply information on environmental problems, in order to enable policy-makers to value their seriousness;
- to support policy development and priority setting, by identifying key factors that cause pressure on the environment;
- to monitor the effects of policy responses.

The Driver-Pressure-State-Impact-Response methodological framework. has often been used to provide a thinking framework for the development and categorisation of indicators (see Figure below). DPSIR provides a cyclical representation where a driver results in a pressure which adversely changes the state, or can cause a direct impact. Changes in state have impacts which call for responses. Responses can mitigate an impact, or can be a alleviate the pressures, or can even change the driving force.

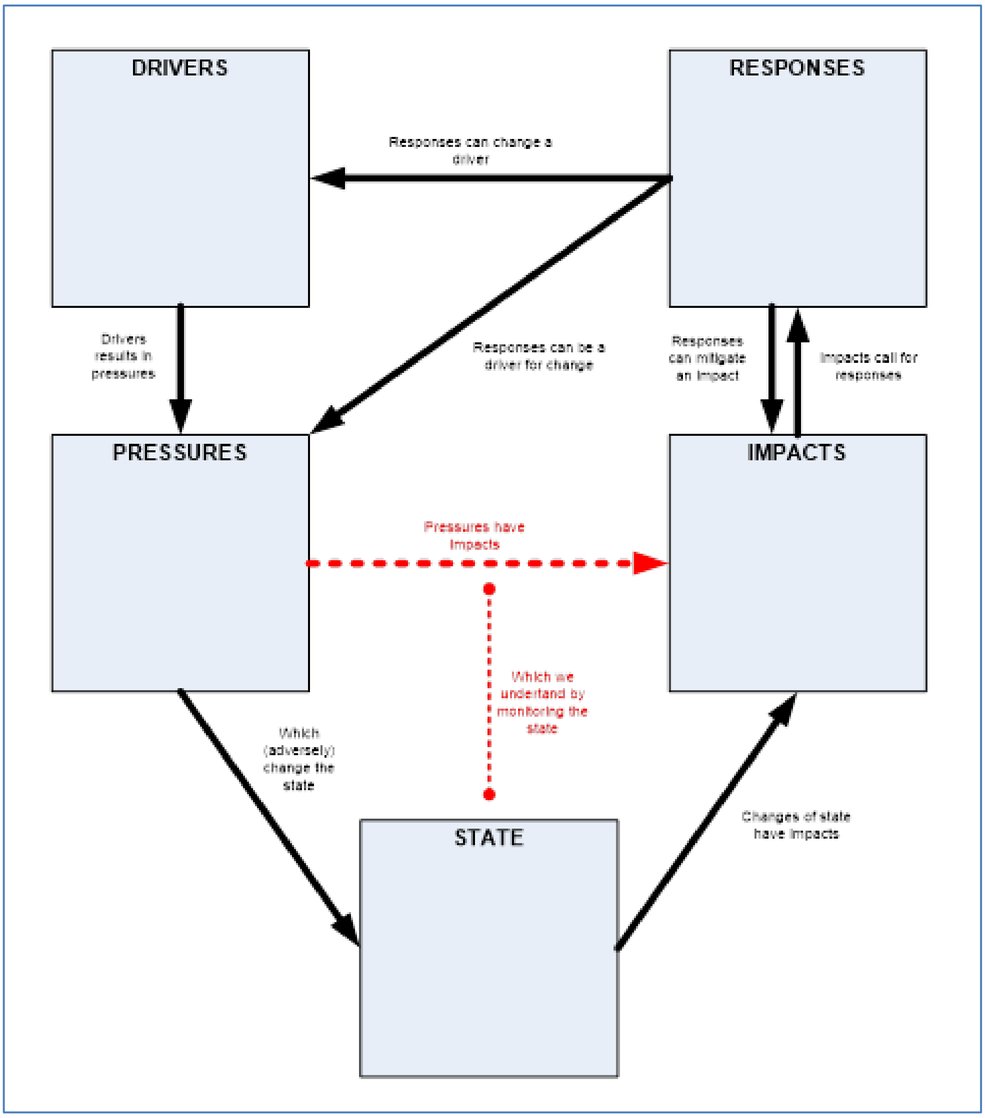


Table 6-1: The Driver-Pressure-State-Impact-Response (DPSIR) methodological framework (Source: Kossida, 2009)

The following definitions have been used in the EEA (1999) report "Environmental Indicators: Typology and overview" and serve as the basis for categorization:

- **Indicators for driving forces** describe the social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patterns. Primary driving forces are population growth and developments in the needs and activities of individuals. These primary driving forces provoke changes in the overall levels of production and consumption. Through these changes in production and consumption, the driving forces exert pressure on the environment
- **Pressure indicators** describe developments in release of substances (emissions), physical and biological agents, the use of resources and the use of land. The pressures exerted by society are transported and transformed in a variety of natural processes to manifest themselves in changes in environmental conditions. Examples of pressure indicators are CO2-emissions per sector, the use of rock, gravel and sand for construction and the amount of land used for roads.

- **State indicators** give a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks) and chemical phenomena (such as atmospheric CO2-concentrations) in a certain area. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosporous and sulphur in lakes, or the level of noise in the neighborhood of airports.
- **Response indicators** refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment. Some societal responses may be regarded as negative driving forces, since they aim at redirecting prevailing trends in consumption and production patterns. Other responses aim at raising the efficiency of products and processes, through stimulating the development and penetration of clean technologies. Examples of response indicators are the relative amount of cars with catalytic converters and recycling rates of domestic waste. An often used overall response indicator is an indicator describing environmental expenditures.

Environmental indicators can also be classified into 4 simple groups which address the following questions (EEA, 1999):

What is happening to the environment and to humans?' (Type A or Descriptive Indicators)

Does it matter? (Type B or Performance indicators)

Are we improving? (Type C or Efficiency indicators)

Are we on the whole better off? (Type D or Total Welfare indicators)

- The **descriptive indicators** describe the actual situation with regard to the main environmental issues, such as climate change, acidification, toxic contamination and wastes in relation to the geographical levels at which these issues manifest themselves.
- The **performance indicators** compare actual conditions with a specific set of reference conditions. They measure the distance between the current environmental situation and the desired situation (target), i.e. "distance to target" assessment.
- The **efficiency indicators** express the relation between separate elements of the causal chain. Most relevant for policy-making are the indicators that relate environmental pressures to human activities. These indicators provide insight in the efficiency of products and processes, in terms of the resources used, the emissions and waste generated per unit of desired output.
- The **total welfare indicators** measure the total sustainability

6.2 PROPOSED INDICATORS FOR WATER USE ANALYSIS

Based on the DPSIR framework the following indicators related to water use have been identified as policy relevant. For each indicator, its definition, type, sustainability dimension and DPSIR classification are provided in the Table below:

Table 6-2: Water-use related indicators for policy-relevant analysis

Indicator	Type	Sustainability dimension	Unit	DPSIR classification
Water Use per sector / per capita	performance	Environmental-Developmental	MCM, %	pressure
Water Consumption	performance	Environmental-Developmental	MCM, %	pressure
% of (change in amount/volume) of freshwater used per sector	performance	Environmental-Developmental	%	pressure
Water reuse	performance	Environmental-Developmental-Economical	MCM, %	Response
Water re-cycling	performance	Environmental-Developmental-Economical	MCM, %	response
Water Exploitation Index (WEI)	performance	Environmental-Developmental	%	pressure
Economic Water Productivity of irrigated crops	efficiency	Environmental-Developmental-Social-Economical	€/m3 (economic output produced per cubic meter of fresh water used)	impact
Water efficiency per sector	efficiency	Environmental-Developmental-Social-Economical	Value added in €/m3 (value added per volume of water used by a given economic activity over time)	impact
Water use intensity by economic activity	efficiency	Environmental-Developmental-Economical	m3/m2 or person or GDP	pressure
Water tariff	performance	Social-Developmental-Economical	EGP/m3 per use	response
Cost Recovery	performance	Environmental-Developmental-Social-Economical	Cost recovery rate per Municipality and service percentage (%)	response

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8. ANNEX: DETAILED STRUCTURE OF THE ISIC CATEGORIES

Section	Description	Divisions	
A	Agriculture, forestry and fishing	01:	Crop and animal production, hunting and related service activities
		02:	Forestry and logging
		03:	Fishing and aquaculture
B	Mining and quarrying	05:	Mining of coal and lignite
		06:	Extraction of crude petroleum and natural gas
		07:	Mining of metal ores
		08:	Other mining and quarrying
		09:	Mining support service activities
C	Manufacturing	10:	Manufacture of food products
		11:	Manufacture of beverages
		12:	Manufacture of tobacco products
		13:	Manufacture of textiles
		14:	Manufacture of wearing apparel
		15:	Manufacture of leather and related products
		16:	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
		17:	Manufacture of paper and paper products
		18:	Printing and reproduction of recorded media
		19:	Manufacture of coke and refined petroleum products
		20:	Manufacture of chemicals and chemical products
		21:	Manufacture of pharmaceuticals, medicinal chemical and botanical products
		22:	Manufacture of rubber and plastic products
		23:	Manufacture of other non-metallic mineral products
		24:	Manufacture of basic metals
		25:	Manufacture of fabricated metal products, except machinery and equipment
		26:	Manufacture of computer, electronic and optical products
		27:	Manufacture of electrical equipment
		28:	Manufacture of machinery and equipment n.e.c.
		29:	Manufacture of motor vehicles, trailers and semi-trailers
		30:	Manufacture of other transport equipment
		31:	Manufacture of furniture
		32:	Other manufacturing
		33:	Repair and installation of machinery and equipment
D	Electricity, gas, steam and air conditioning supply	35	
E	Water supply; sewerage, waste management and remediation activities	36–39	
F	Construction	41–43	
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	45–47	
H	Transportation and storage	49–53	
I	Accommodation and food service activities	55–56	
J	Information and communication	58–63	
K	Financial and insurance activities	64–66	
L	Real estate activities	68	
M	Professional, scientific and technical activities	69–75	
N	Administrative and support service activities	77–82	

O	Public administration and defence; compulsory social security	84
P	Education	85
Q	Human health and social work activities	86–88
R	Arts, entertainment and recreation	90–93
S	Other service activities	94–96
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	97–98
U	Activities of extraterritorial organizations and bodies	99

Manufacture of rubber and plastic products
Manufacture of other non-metallic mineral products
Manufacture of basic metals
Manufacture of fabricated metal products, except machinery and equipment
Manufacture of computer, electronic and optical products
Manufacture of electrical equipment
Manufacture of machinery and equipment n.e.c.
Manufacture of motor vehicles, trailers and semi-trailers
Manufacture of other transport equipment
Manufacture of furniture
Other manufacturing
Repair and installation of machinery and equipment