SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future

SWIM-H2020 SM EFS-EG-1 & 2

Methods for classifying and assessing water uses

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Presentation Outline

- Why do we need water use information?
- Basic definitions
- Typology for water use categories
- Guidelines for the estimation of water uses
- Monitoring and reporting of water uses
- Policy-relevant assessment of water uses, Indicators
- International examples

Why do we need to know water uses?

You can't manage what you don't measure !!

- Quantifying water use per sector is an **essential component of water management** and of any Water Resources Management Plan
- 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
- Supports **proper water allocation**, the design of adequate **Programmes of Measures**, and helps prioritize water **demand management** efforts
- Pave the way towards the development of a **National Water Use Information System (NWUIS)** where water use data are monitored and estimated at a suitable decentralized scale, following **common harmonized definitions and procedures**
- 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**

Basic Definitions

It is often observed that stakeholders do not necessarily have a common understanding of the basic definitions of water use related components and use the different terms interchangeably.

- **Water Demand:** 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.
- **Water Supply:** the delivery of water from various sources (conventional and non-conventional) to the final users in order to satisfy the water demand. The water can be delivered 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):** the **process of taking water from a natural** hydrological regime (ground or surface water body), either temporarily or permanently, and conveyed to a place of use.
- **Water Use**: 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**: water abstracted which is no longer available for use because it has evaporated, incorporated into products and crops, consumed by man or livestock, etc. 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 are excluded because they may return to the system (e.g. leakage losses).

Basic Definitions (cont.)

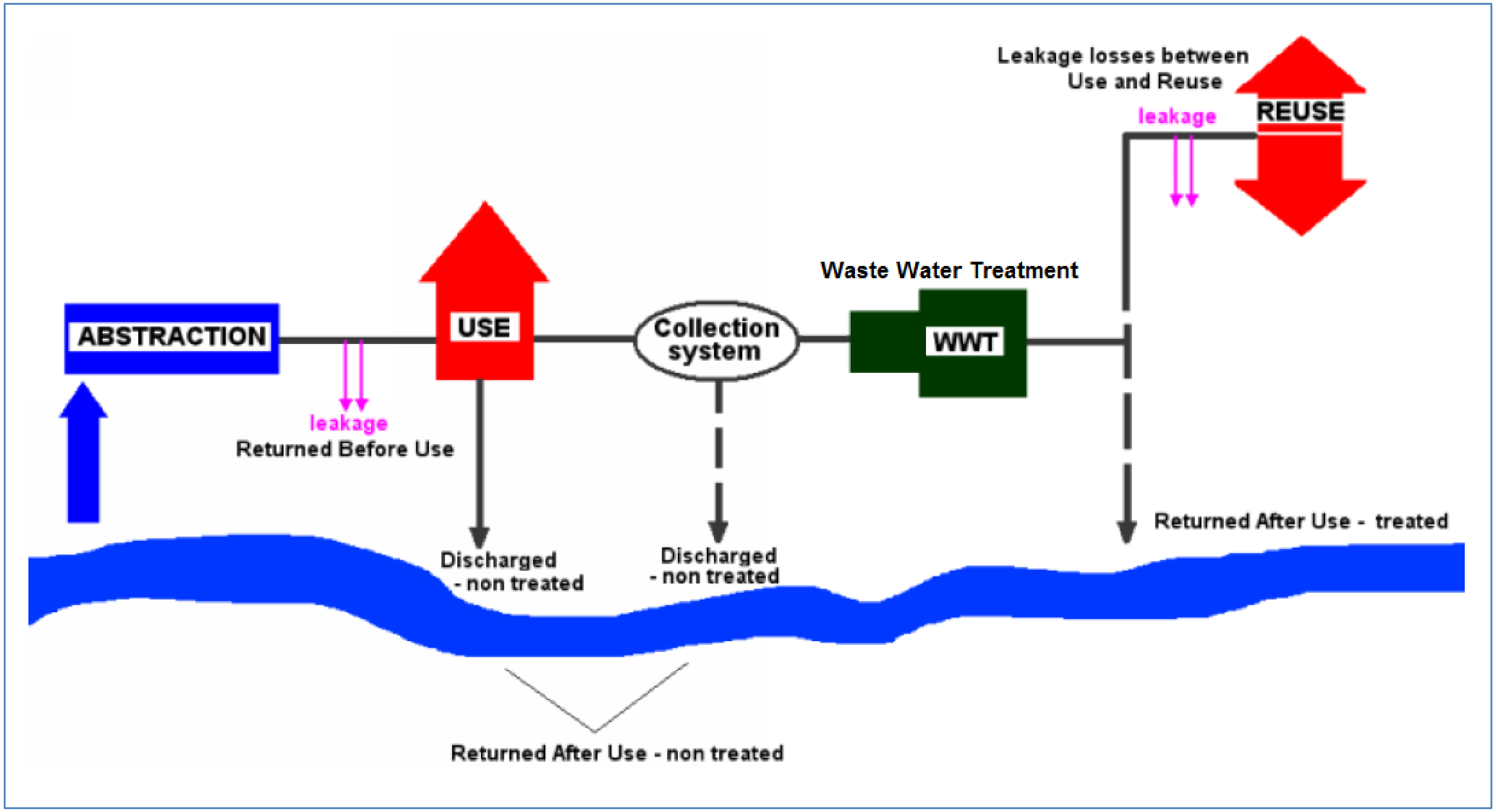
Water Demand > Water Use **Water Demand > Water Supply**	Unmet demand, water stress
Water Demand < Water Use	Wastage of water (e.g. over-irrigation)
Water Abstraction > Water Demand	Over-abstraction
Water Supply > Water Demand **Water Supply > Water Use**	Losses (e.g. leakage)

Basic Definitions (cont.)

- **Returned water**: 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 (leakage losses) or after use (as treated effluent or as non-treated)**. Discharges to the sea are not included.
- **Reused water:** water that **has undergone wastewater treatment and is delivered to a user as reclaimed wastewater**. Wastewater discharged into a watercourse and used again downstream is excluded (i.e. this is considered returned water).
- **Recycled water**: 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'70s. 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). The reused quantity amounts to more than 13.5 billion m3/yr in 2017

Basic Definitions (cont.)

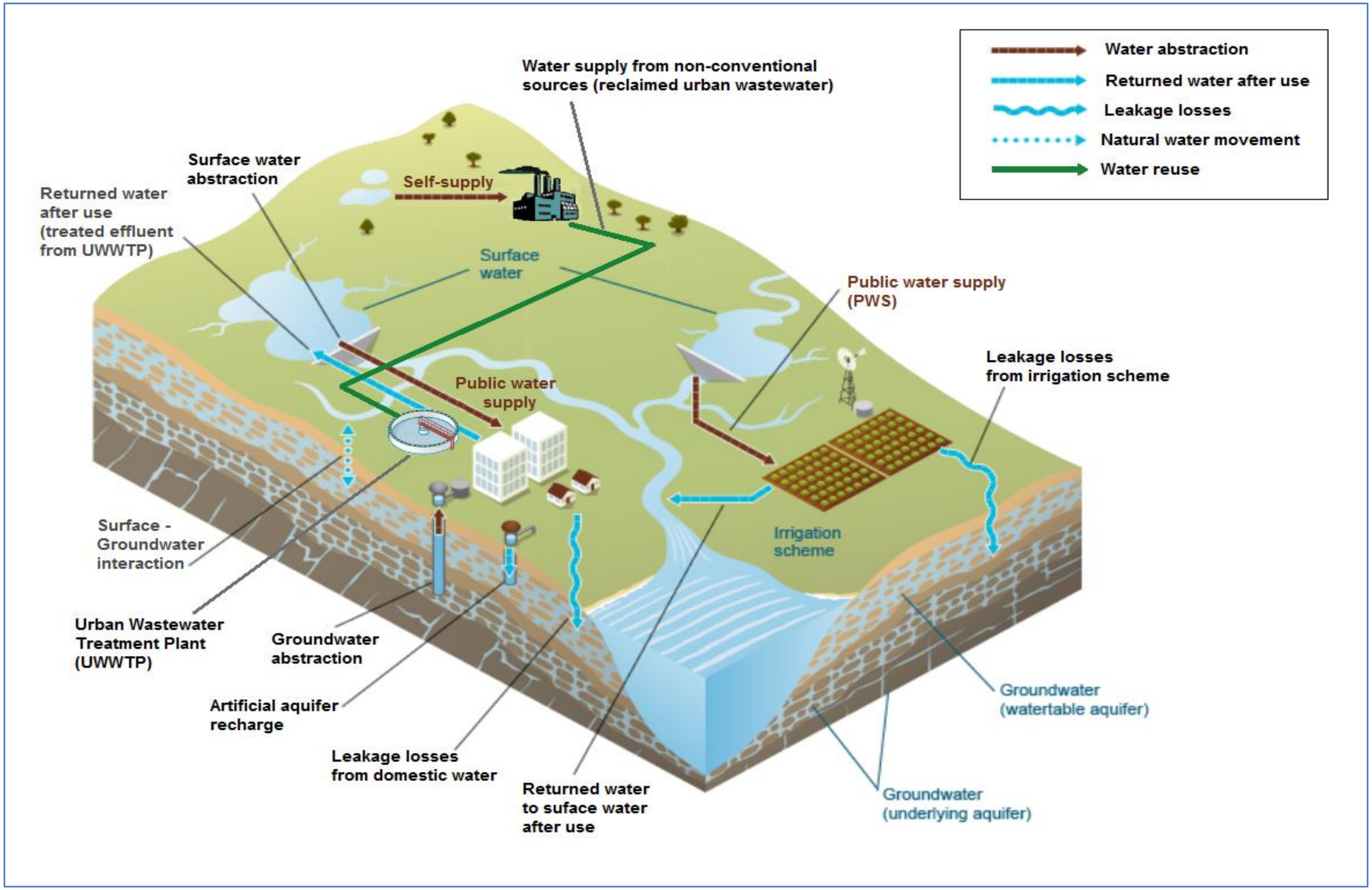
Conceptual flowchart of the “returned water” components



Basic Definitions (cont.)

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

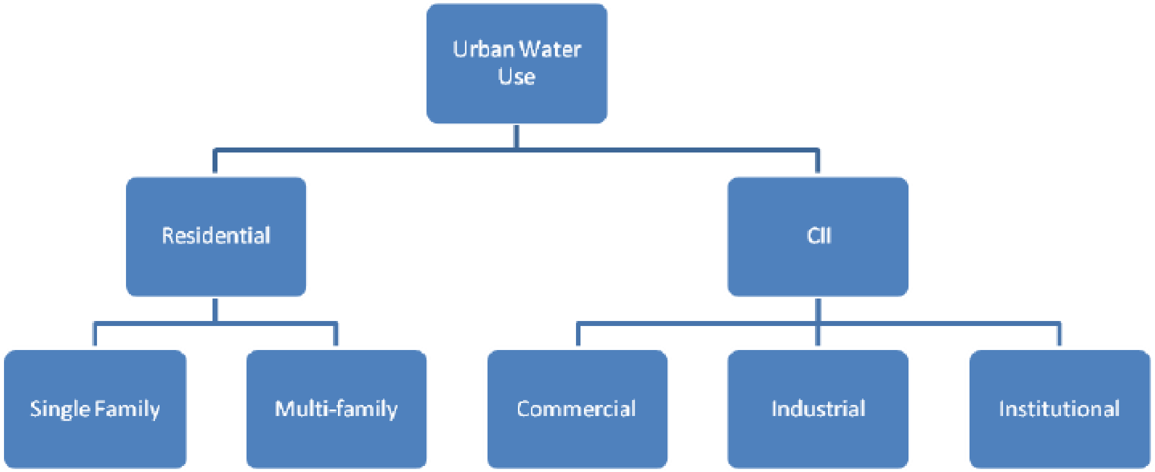


Typology of water uses

This typology can 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.*

Typology (cont.)



Domestic water use	water used for **indoor and outdoor household purposes.** It may be delivered from a public supplier (PWSS), withdrawn from a private source such as a well (self-supply), or captured as rainwater in a cistern (also a self-supply).
Commercial water use	water used for **commercial purposes and services** (e.g. tourism). It includes water used in hotels, restaurants, office buildings, commercial buildings (e.g. shopping centers, sports centers), other commercial facilities (e.g. car washers, laundromats), institutions and services (golf-courses). - **Tourism water use** (hotels, motels, etc.)
Public water use	water supplied from a 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

Typology (cont.)

water use for **Agriculture, forestry, fishing, fish farms**	water used for 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
- **Irrigation** water use	water that is applied by an irrigation system to sustain growth in agricultural and horticultural vegetation. 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.
- **Aquaculture** (fish-farming) 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.

Typology (cont.)

water use for **Mining & Quarrying**	water used for the **extraction of naturally occurring minerals** including solids (e.g. coal, sand, gravel), liquids (e.g. crude petroleum), and gases (e.g. natural gas). Also includes uses associated with **quarrying, milling and other preparations** done at the mine site, and other operations associated with mining. Does not include water associated with dewatering of the aquifer. Also does not include water used in processing, such as smelting, refining petroleum, etc.
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. The water source may be freshwater or reclaimed wastewater (so need to account for that). 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; Textiles; Paper and paper products; Chemicals, refined petroleum, etc. - Potential separation between water used **for Cooling purposes** (Cooling water: Water which is used to absorb and remove heat).

Typology (cont.)

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

Guidelines for estimating water use

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***

- The **availability**, **completeness** and most recent **year** of data can **vary** among sites, Governorates, sectors
- The **difficulty of accessing the data** for estimating water use can **vary** (from requesting them from relevant agencies to designing a survey to collect the data)
- 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 and water-use coefficients**. The coefficients represents a unit-use water requirement and number of units such as population served, number of employees, acres of cropland, or number of golf courses, etc.
- If water-use coefficients are not available, **coefficients can be developed from a representative sample** of typical users that are more pertinent to a specific facility, site, Governorate.
- All data **sources** must be well **documented**
- Site-specific water-use data are more commonly available for public-supply, industrial, and thermoelectric-power facilities, ≠ less commonly available for self-supplied domestic, irrigation, aquaculture, livestock, and mining water-use sites.

Estimating Domestic water use

Pubic Water Suppliers (PWSs) often serve mixed users (domestic, commercial, industrial)

- Masterlist of PWSs (names, location, districts served, population served, sources of raw water)
- More details for the PWSs: total withdrawal and per source, metering points (e.g. before treatment, @ delivery), purchase or sell information, number of active service connections per type (residential, commercial, industrial), delivery estimates

- **Water meters, billing records of residential water sold**

Proxies:
- 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*
- Preferably, the coefficient is derived from PWSS of similar size, customer base, rate structures, demographic and socioeconomic characteristics, climatic and geographic settings. **Exploratory sampling**
- Total public-supply per capita use coefficients are generally larger for systems that serve industrial and commercial users or have large losses
- **Multiply with** population served, or number of housing units with PS capability (billed residential connections) and average number of people per household.
- **Attention**: service-area boundaries, vacationers , dual use ares, domestic self-supply!!
- For self-supplied domestic use → use information from **WWT facilities** that set fees according to metered water use, or from **energy bills** in case of groundwater pumping

Estimating Industrial water use

Water-use-intensive industries are often self-supplied. Reclaimed WW is often a source

- Masterlist of industrial facilities (names, location, sources of water)
- Focus on the larger ones, while striving an adequate representation of the total in the area

- **Water meters, billing records of industrial water sold**

Proxies:

- A **per-employee use coefficient** (lt/employee/day) or per-unit of product (lt/product or yield) may be used to estimate total industrial water use
- Preferably, the coefficient is derived from industries of similar size, type, age, climatic and geographic settings. **Exploratory sampling – Water Auditing**
- **Multiply with** ancillary data on employment or production or annual sales
- **Attention: water recycling e.g. in cooling towers, age of facility, specific processes and water saving technologies, different water qualities for different purposes, TWW, saline water, censoring of data for privace reasons !!**
- For self-supplied industrial use → map on the watershed to determine closest water sources, use information from **permits**, or **WWT facilities** that set fees according to metered water use, or from **emission registers**, or from **energy bills** in case of groundwater pumping

Estimating Irrigation water use

Irrigation water is often self-supplied or (in some cases) illegally abstracted. Reclaimed WW is often a source

- Masterlist of industrial facilities (names, location, sources of water)
- Focus on the larger ones, while striving an adequate representation of the total in the area

- **Water meters, billing records of agricultural water sold/ delivered by the irrigation districts**
- **Individual water users or water right holders to measure and report their withdrawals and irrigated acreages for each well or surface-water diversion**

Proxies:

- Calculation of **crop water needs** using **crop water-consumption coefficients** for several crops and system types (irrigated acres by crop type coupled with irrigation system type/ method)
- **Ancillary data**: total irrigated **acres for each type of crop**, irrigation system **efficiencies**, conveyance **losses**, **climatic** variables, irrigation management **practices**
- **Key assumption**: irrigation water applied is adequate for optimal plant growth and the plants are not being irrigated with more or less water than needed.
- Preferably, the coefficients are derived from fields of similar size, crop type, irrigation method, climatic and geographic settings. **Exploratory and statistical sampling – Local surveys**

Estimating Irrigation water use

- **Attention:**
- Unknown number of irrigated acres per crop type or confusion between total vs. irrigated
- Possibility of single or multiple cropping patterns
- Multiple sources of water: surface water, ground water, reclaimed WW
- Application rates dependent on type, age, maintenance condition of irrigation system
- Seasonal irrigation needs
- Mismatch between permitted amounts vs. actual water use amounts
- Privacy of primary data, unwillingness of public authorities to provide them
- Mismatching of spatial scales and temporal incompatibilities (watershed, irrigation district, etc.) between the ancillary data needed for the estimations

- **Additional useful data**: information on crop water shortages, acres harvested and **yields by crop**, **energy sources**, water and agricultural management practices, **remote sensing** data on crops, soil moisture, etc. has been
- For self-supplied irrigation use → map irrigated areas on the watershed to determine closest water sources, use information from **WWT facilities** that may provide source water, or from **energy bills** in case of groundwater pumping

Estimating Irrigation water use

Total Irrigation water demand = SUM of crop irrigation water demand 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: ETo *[several methods: 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 *[Pe = 0.8 P - 25 if P > 75 mm/month ; else Pe = 0.6 P - 10]*

Step 5: Calculate the irrigation water need: IN = ET crop – Pe

A detailed methodology on how to calculate the crop water needs in provided by FAO in Chapter 3 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.

Estimating Thermoelectric-power water use

The predominant use of water is for cooling. Mainly self-supply.
Water use depends on whether cooling water is re-circulated (once-through /open-loop cooling vs. closed-loop /recirculation cooling)

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.

- Masterlist of power generation facilities (power-plant ownership, location, method of cooling, sources of water, average withdrawal rates, average discharge rates, operating status, and power generated)
- Focus on the larger ones, while striving an adequate representation of the total in the area

- **Water meters, billing records of water sold**

Estimating Thermoelectric-power water use

Proxies:

- 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. **Exploratory surveys – Water Auditing**

- **Multiply** this coefficient with the **amount of electricity generated** during a specified time period

- **Ancillary data**: site-specific water withdrawal and power generation data, volume discharged, data from the water permits or from other compliance requirements (emissions, WW registers, etc.)

- **Attention: water recycling in cooling towers / Cycles of Concentration, age of facility, specific processes and water saving technologies, different water qualities for different purposes, TWW, saline water, censoring of data for privace reasons !!**

Water use in Egypt

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 . <u>No separate measurements, except</u>: Banee Suief (industrial), Red Sea and South Sinai (tourism) **Facts:** The total municipal water use is about 10.7 billion m3/yr in 2017 **Responsible authority**: Holding Company for Water and Wastewater (HCWW) and its 25 subsidiary Affiliated Companies (AC) **Monitoring & recording**: Water meters for municipality , buildings, on monthly scale + estimation when there is no reading (similar users, volume of water sold per month). **T**he volume of water sold per year is calculated by the HCWW

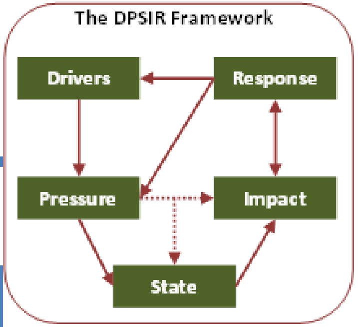
Water use in Egypt

Industrial water	**Includes**: water used both in the manufacturing process, for cooling, for cleaning the facilities, and used from the employees. In some cases industrial water use is included in the municipal (domestic) water use, and no separate measurements exist. **Facts:** Growing sector, 5.4 billion m3/yr water demand. Petroleum sub-sector 35%, food industry 24%, textile industry 13%, engineering and electrical industries 13% **Responsible authority**: Industrial water is provided through the municipal PWSS. Self-supply for industrial purposes is also applicable (e.g. in Menofia Governorate). Same as for the domestic water, the HCWW. Self-supply permits from MWRI? **Monitoring & recording**: Measured by the HCWW with water meters per factory and per month

Water use in Egypt

Irrigation water	**Includes:** 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 **Facts:** The largest user in Egypt, 85% of the total water demand, ~ 62 billion m3/yr in 2017, 9 million feddans **Responsible authority:** MWRI. This water is typically delivered from Nile system through canals (major canals → Irrigation Directorates/ branch canals/ mesqas). **Monitoring and recording:** The water flow is measured per canal (from flow readings) by the District Engineer of the MWRI.

Policy-relevant assessments – Indicators



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

Policy-relevant assessments - Indicators

Indicator	Type	Sustainability dimension	Unit	DPSIR classification
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

International examples

- USGS Water Use Data for the Nation, National Water Information System (NWIS)
- Australian Water Accounts
- Water Information System Austria (WISA)
- European Environment Agency (EEA) Water Base and Water Quantity Reporting Tool
- Eurostat / OECD Water Statistics
- FAOSTAT / Aquastat

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Thank you!

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