إدارة الثروة المائية
بناء على سطح مائع

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WATER MANAGEMENT
BUILDING ON FLUID AVAILABILITY

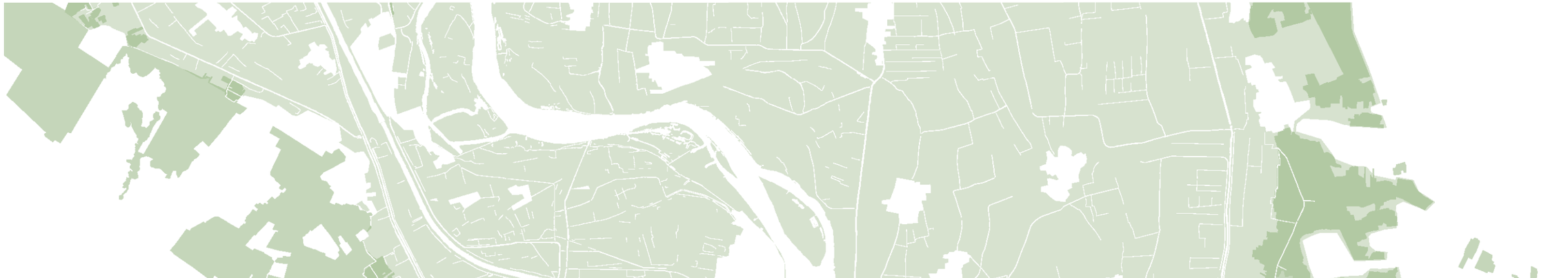
WATER MANAGEMENT

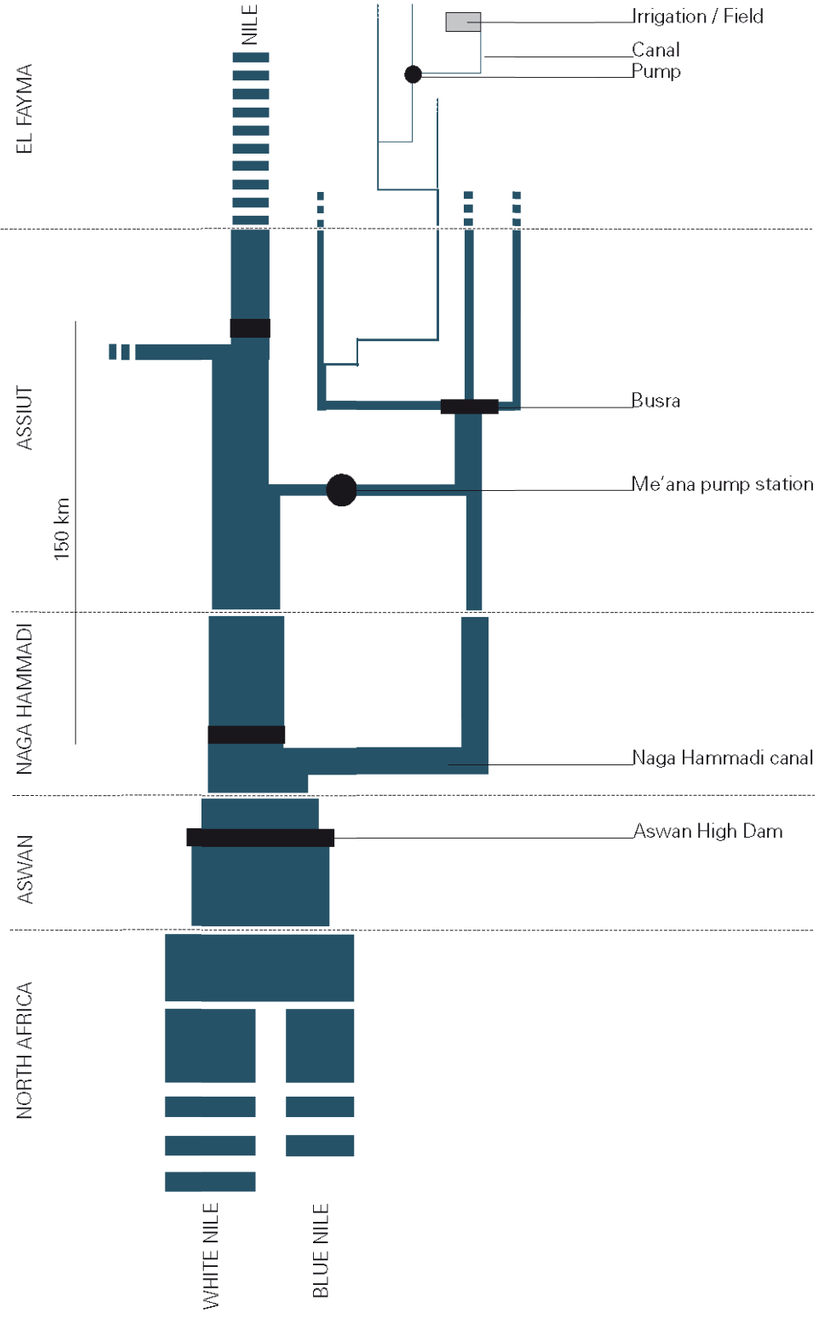
BUILDING ON FLUID AVAILABILITY

The dry climate of the Nile Valley makes civilization dependent on the availability of water. It has nourished society, agriculture, and industry for millennia. Structures built to distribute the water shape the landscape from the banks of the Nile to the desert, influencing all major practices connected to water use. The distribution of Egypt's water resources are administered on the state level while its actual use in the field occurs practically unsupervised. The growing population and expanding use of water puts the system under pressure, and projects on different scales seek to realize maximum potential.

IRRIGATION

Typical for Egypt, Assiut has one day of rain per year; thus, any vegetation must be sustained by irrigation. With agriculture consuming 95% of water resources, the control of irrigation water is of great importance. The State successfully makes water available free or charge to farmers. The Aswan High Dam marks the point in the Nile's course below which the Egyptian government has complete control over the Nile water, which it allots dependent on demand and the natural inflow into Lake Nasser.





A Maze of Branching Points

A Pump Owner's Work

"... I own 4 pumps in the surroundings of El Fayma. With my big Nile water pump, which is 50 years old, I deliver water to 10 farmers. They pay me 10 pounds per feddan [1 feddan = 4200 m²] ... The machine runs nearly every day from 8 am to 4 pm. My own feddans are cultivates by paid workers ...The big pump irrigates 40 feddans, the other 2 medium pumps 10 and the smallest only 3 feddans ..."
Yusif Khalaf, El Fayma

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1. The great majority of fields (92-95%) is irrigated by the traditional method of surface irrigation, i.e. flooding of the fields every 5 to 20 days, depending on the crop and the season. Its efficiency (water actually used by the plant divided by total water applied) is 65-70%.

2. + 3. In reclaimed lands, only sprinkler and drip irrigation are allowed because of their higher efficiency (80-85% and 95%, respectively); they require, however, a greater initial investment.

The Art of Irrigation

Bringing the water to the plants is done in several ways. Before the Aswan High Dam, the Nile rose every spring, covering the fields and depositing fertile mud. The ability nowadays to irrigate year-round demands a greater effort of water control but theoretically makes complete use of Nile water possible. The water needed for irrigation is the amount that the plant absorbs and gives off to the air through evapotranspiration, plus an additional amount that seeps or drains to maintain normal salinity of the soil. In cooperation with the Ministry of Water Resources and Irrigation, the universities' research improve irrigation methods and offer free lectures of efficient water use to farmers.

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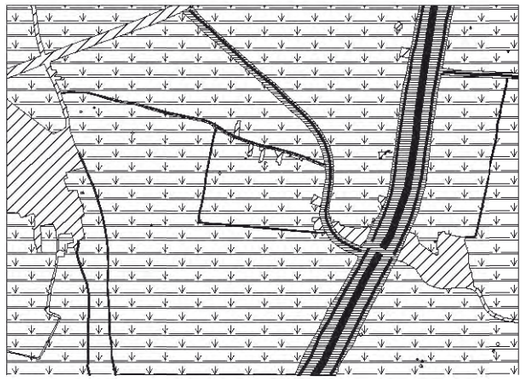

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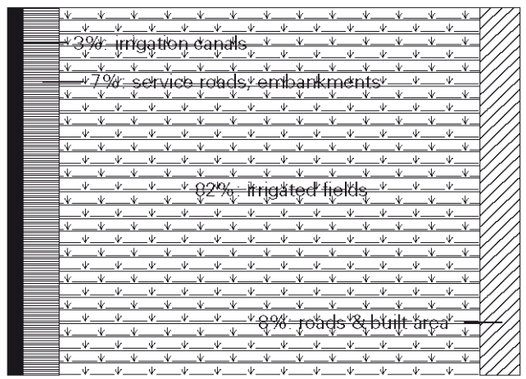

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Sacrificing Land for Canals

Through the choice of open canals for transporting the irrigation water, a sizable part of agricultural land is given up for canals. In the above area selected from the fields around Assiut (1,2), roughly one tenth of the surface area is taken up by irrigation canals and the maintenance space they require (3).

Canal Structures and Pump Systems

The private canals from farmers' pumps to the field strongly influence the appearance of the agricultural landscape. The farmers choose how they construct these waterways. To guide the water through the canal labyrinth to the appropriate field, they plug up or unplug openings in their canal with mud or stones. The pumps were often bought second-hand and imported from India, Europe or neighboring countries, sometimes almost a century ago; they run on gasoline or diesel.

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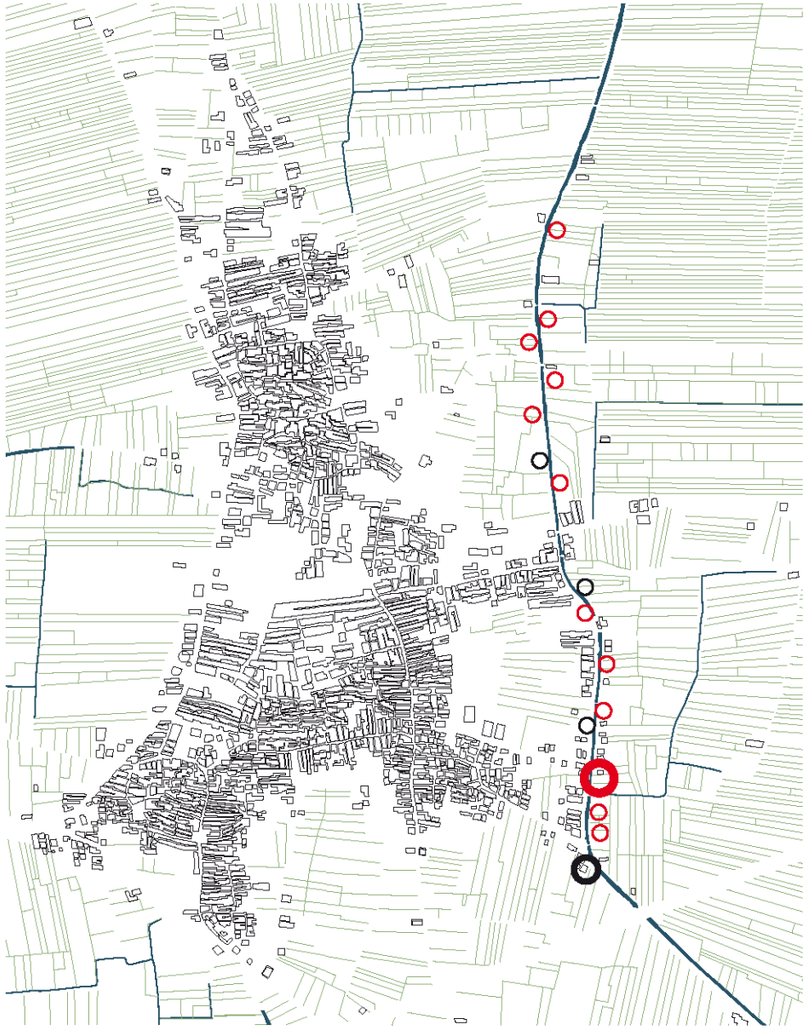
Material Variation

1. Concrete canal
2. Earth canal
3. Stone canal



Mobile pump
Fixed pump
Shared groundwater pump
Shared Nile water pump

A Mix of Pumps in El Fayma

Irrigation pumps draw water from the canals or from groundwater wells; they can be fixed, or mobile if the owner's fields are dispersed. Large pumps are often shared in their use. The pumps gush water into stone troughs from where the water flows to the fields.

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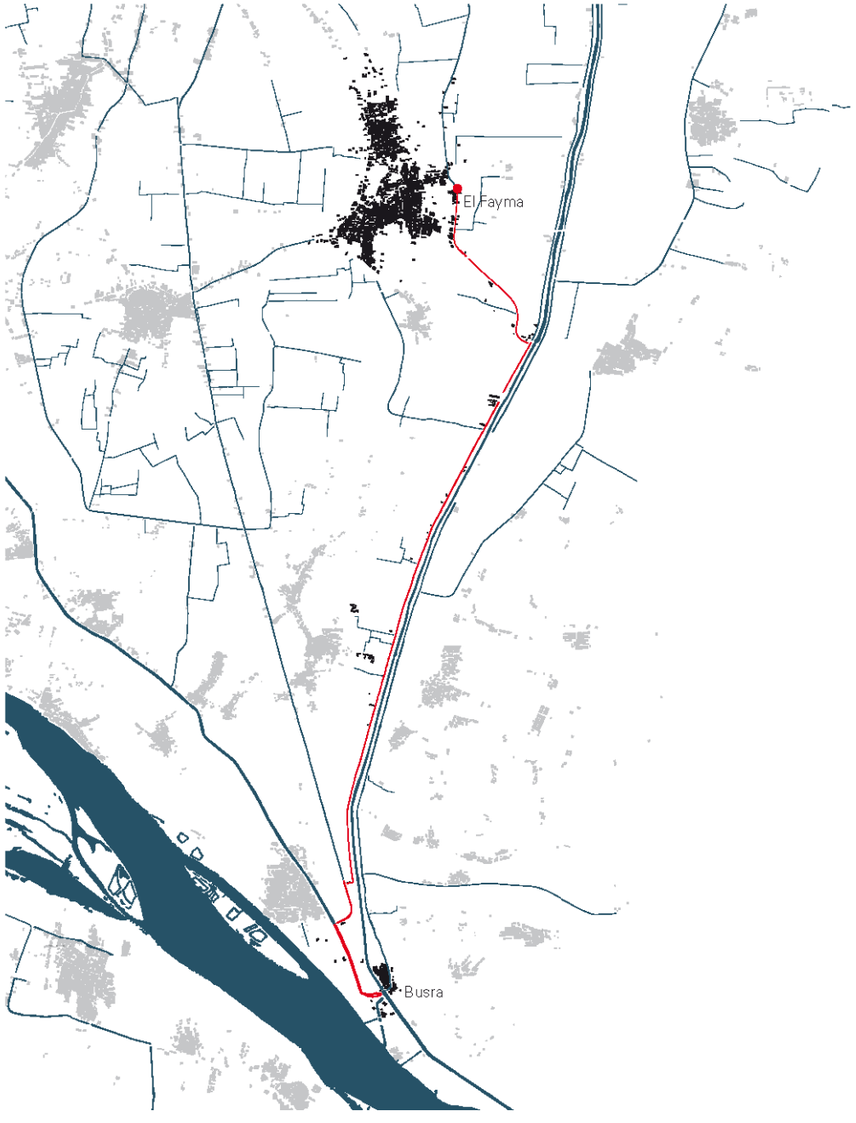
Menagerie of Machines

1. Groundwater pump: Anyone is allowed to drill for water on his land. The depth of the water source varies from 30 to 80 m. Because of the high cost of construction, large groundwater pumps are often shared by family members.
2. Farmers with few feddans often use fixed shared pumps.
3. Mobile private pump: The farmers move their small machines between their fields in different locations.
4. Fixed individual pump: This pump always irrigates the same set of fields; the capacity is comparable to that of mobile private pumps.

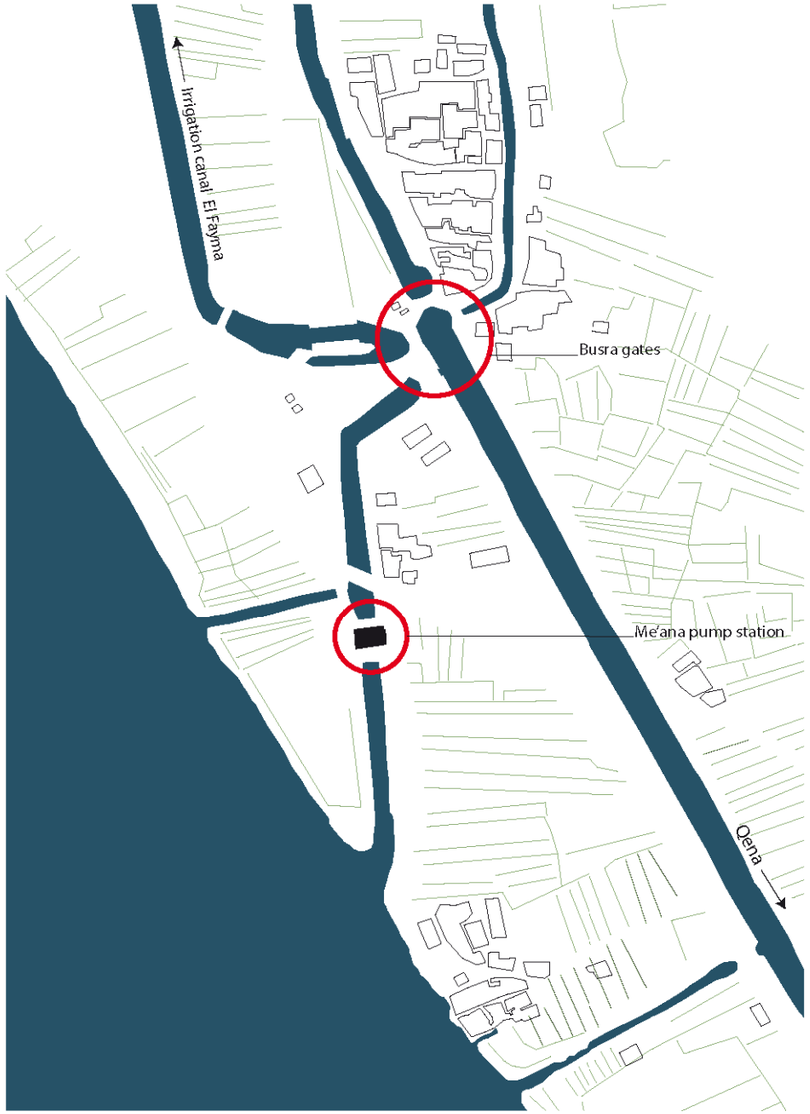


Tracing the Origin of the Water

The nearest major control point to the fields in El Fayma is the distribution point in Busra. The Eastern Naga Hammadi canal brings water diverted from the Nile 150 km upstream; the Me'ana pump station adds more water from the Nile before the canal parts into three directions.

Three Hierarchies

Carrier canals transport water over long distances and, like the Nile, must not be used as a source of irrigation water. Farmers are only permitted to take water from branch (or distribution) canals and mesqa canals (the lowest level canal that brings the water from the branch canals to the fields).



A Regional Control Point

Being one of three stations in Assiut Governorate, the Me'ana pump station pushes Nile water about 3m up into the Naga Hammadi Canal with five electrical units with a capacity of 5m³/s each (only one or two are usually running at any time). It was built in 1994 by Italian design and is operated under the direction of the Ministry Water Resources and Irrigation in Assiut. At Busra, three gate workers control the flow of the Naga Hammadi Canal splitting into three directions, manually opening and closing the gates according to schedule.

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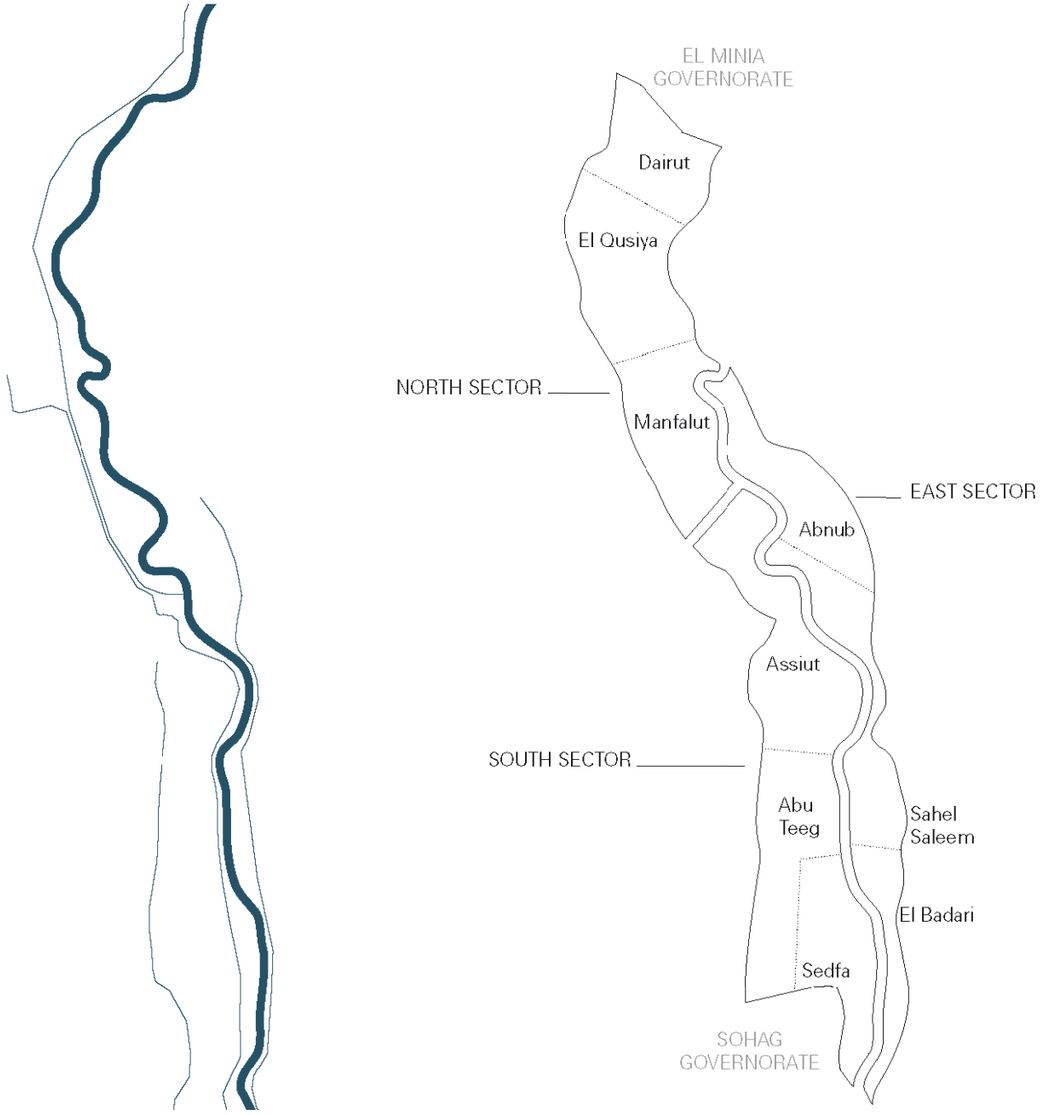
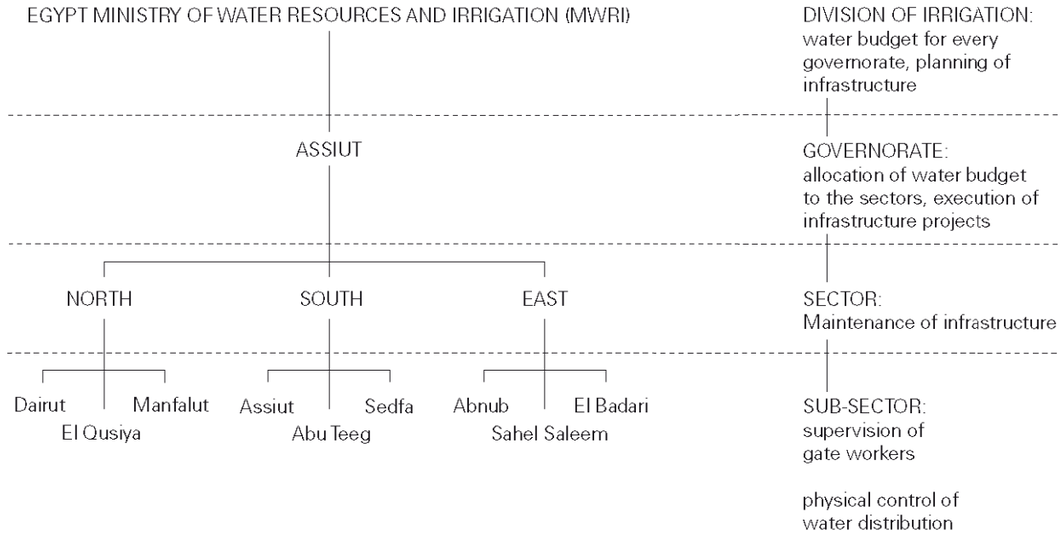
The Control Systems

1. The national standard for measuring water use is meters above sea level. So-called Nilometers located on both sides of the gates allow an estimate of flow.
2. Electronic Nilometers transmit directly to the Ministry of Water Resources and Irrigation in Cairo.
3. Two gates control the incoming Nile water flow, supporting the irrigation canal coming from Qena.



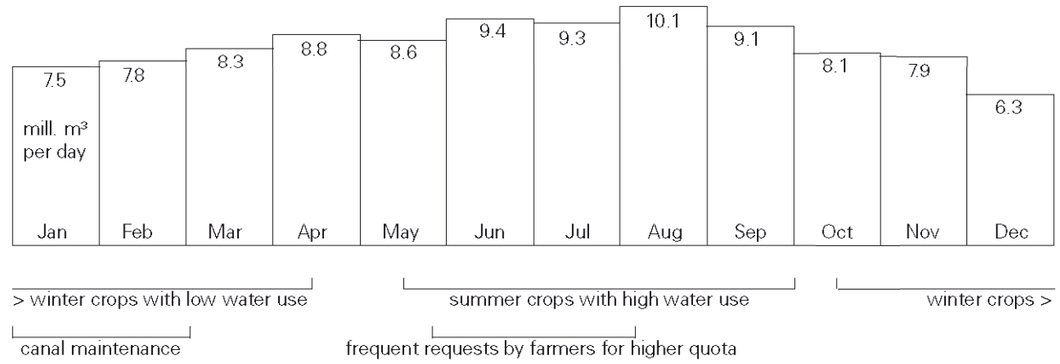
An Interconnected Strip, Segmented

The supply of irrigation water flows through the carrier canals that run along the Nile for hundreds of kilometers, passing through several governorates. Roughly 75% of the 328,000 feddans of agricultural land in Assiut governorate receive water that left the Nile in Sohag governorate or above. The actual distribution of water through 1800 km of canals is then administered in three sectors with three sub-sectors each.



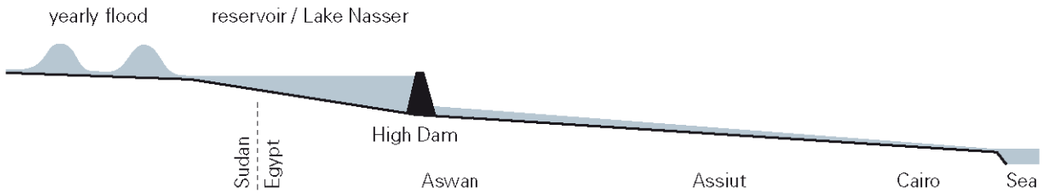
Division of Competencies

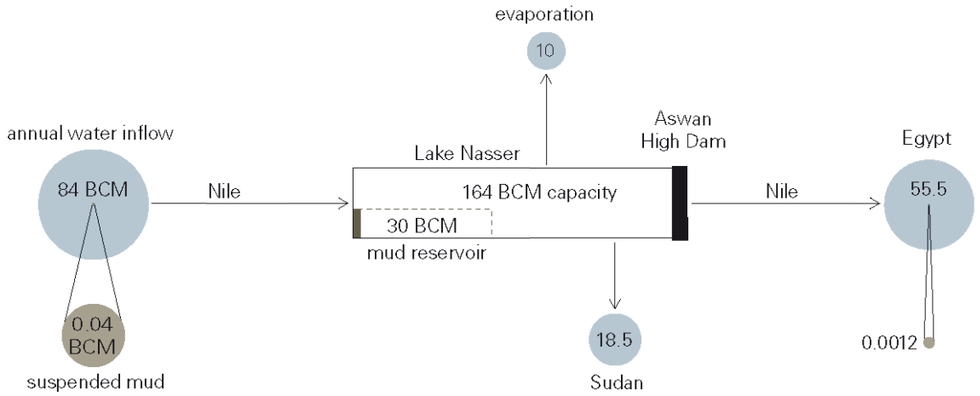
The power of planning water infrastructure and allotting quotas resides with the national ministry in Cairo (MWRI). The ministries in the governorates are merely the representatives of the national authority on site.



Daily Budgets

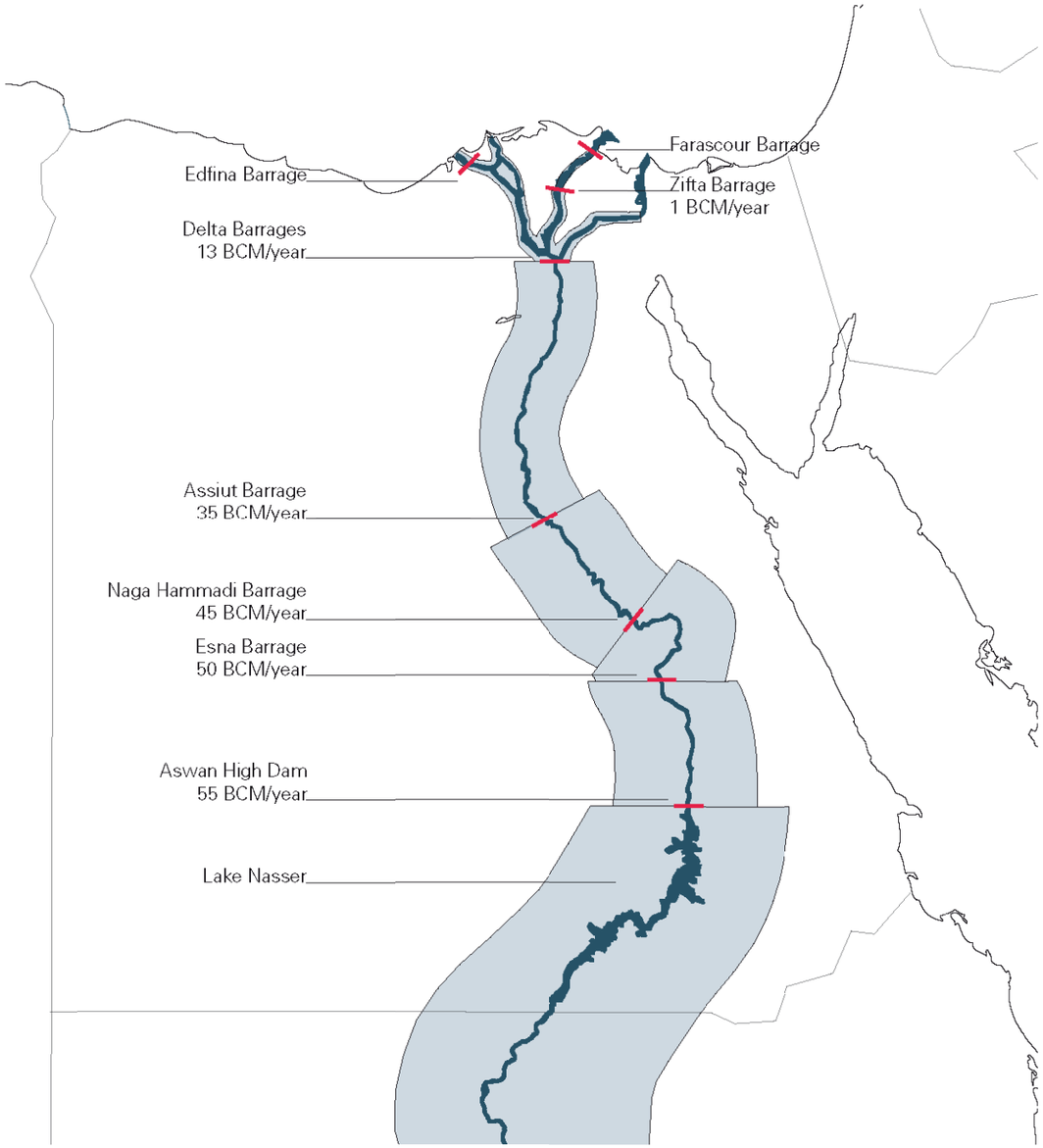
The Ministry of Water Resources and Irrigation in Cairo fixes a daily water quota for every governorate; Assiut is allotted 2.8 BCM (billion cubic meters) per year. The quota can fluctuate widely, however, as the figures above (here for 2006/07) add up to 3.1 BCM per year.





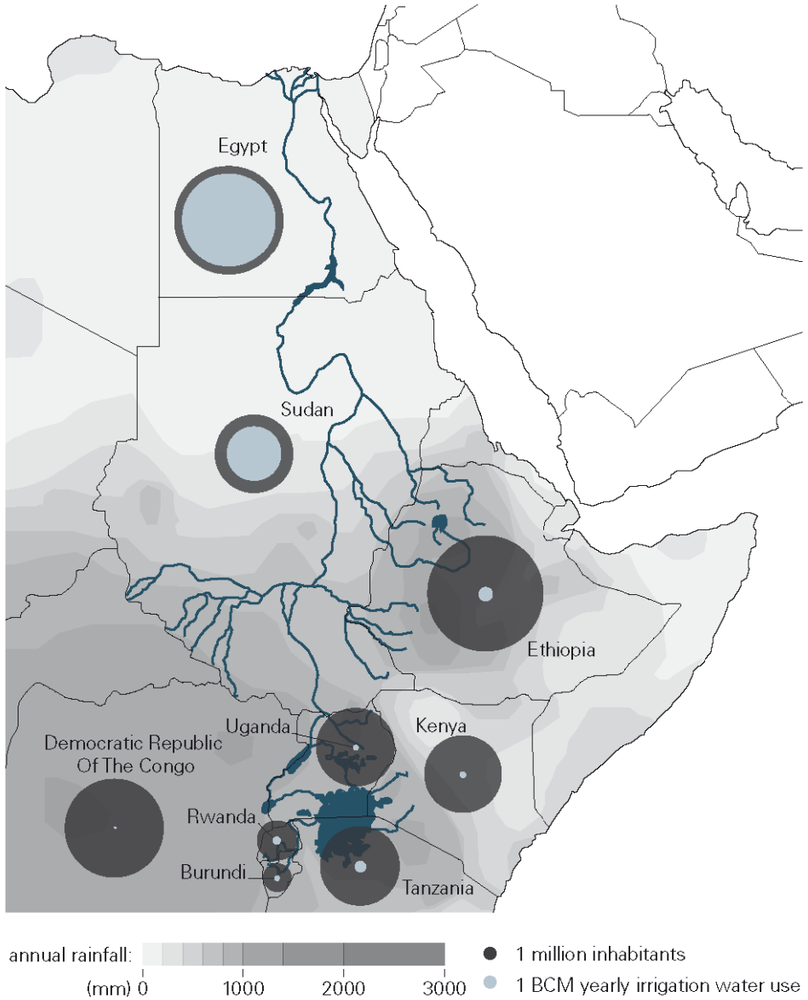
An International Chain of Water Users

Egypt is the last in a line of ten countries that share the Nile, and, since it has almost no rainfall, acutely depends on the Nile for water. The Aswan High Dam represents the nexus between Egypt and the upstream riparian states. Built from 1960 to 1970, it allows complete regulation of the Nile's waters. By enabling multiple planting cycles per year, this forceful act upon the river produced a paradigmatic shift in Nile water use.



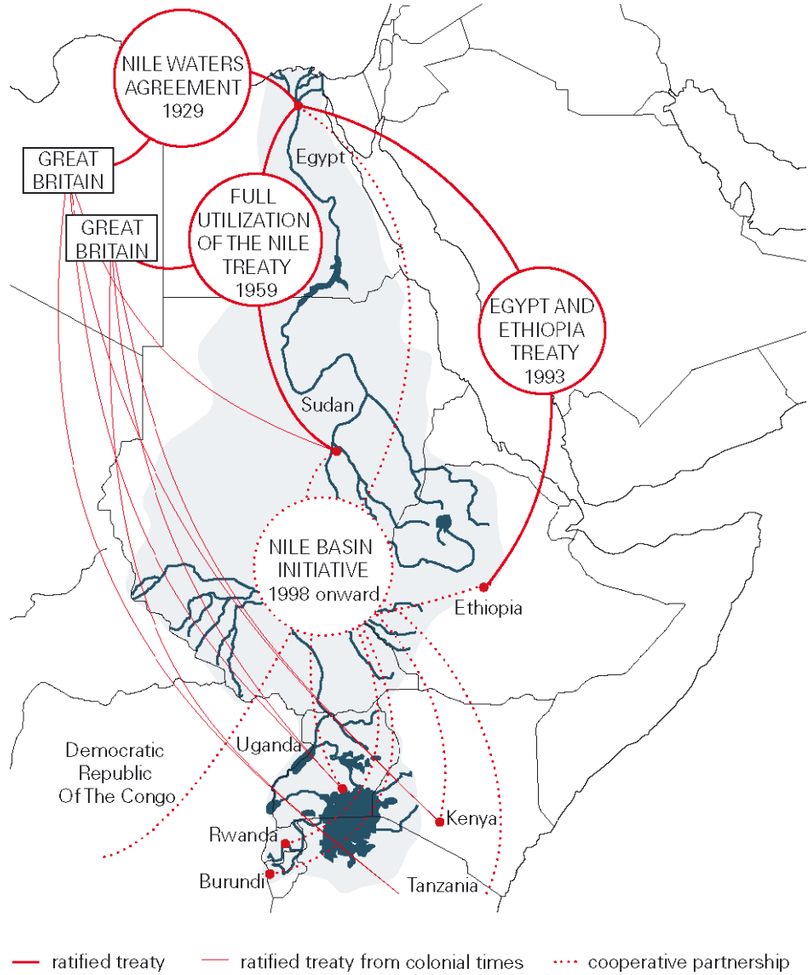
Reduced to a Trickle

The amount of water flowing in the Nile from the Aswan High Dam downward is systematically diminished at several dams along the Nile where carrier canals divert irrigation water, which is fully utilized by agriculture.



Farming by Rain vs. Irrigation

High rainfall in the tropical zone of Ethiopian highlands and the Equatorial Lakes permits rain-based agriculture and produces the abundant water that is drained by the Nile. Thousands of kilometers north, this water is used for irrigation in Sudan and Egypt, where the dry climate demands artificial watering.

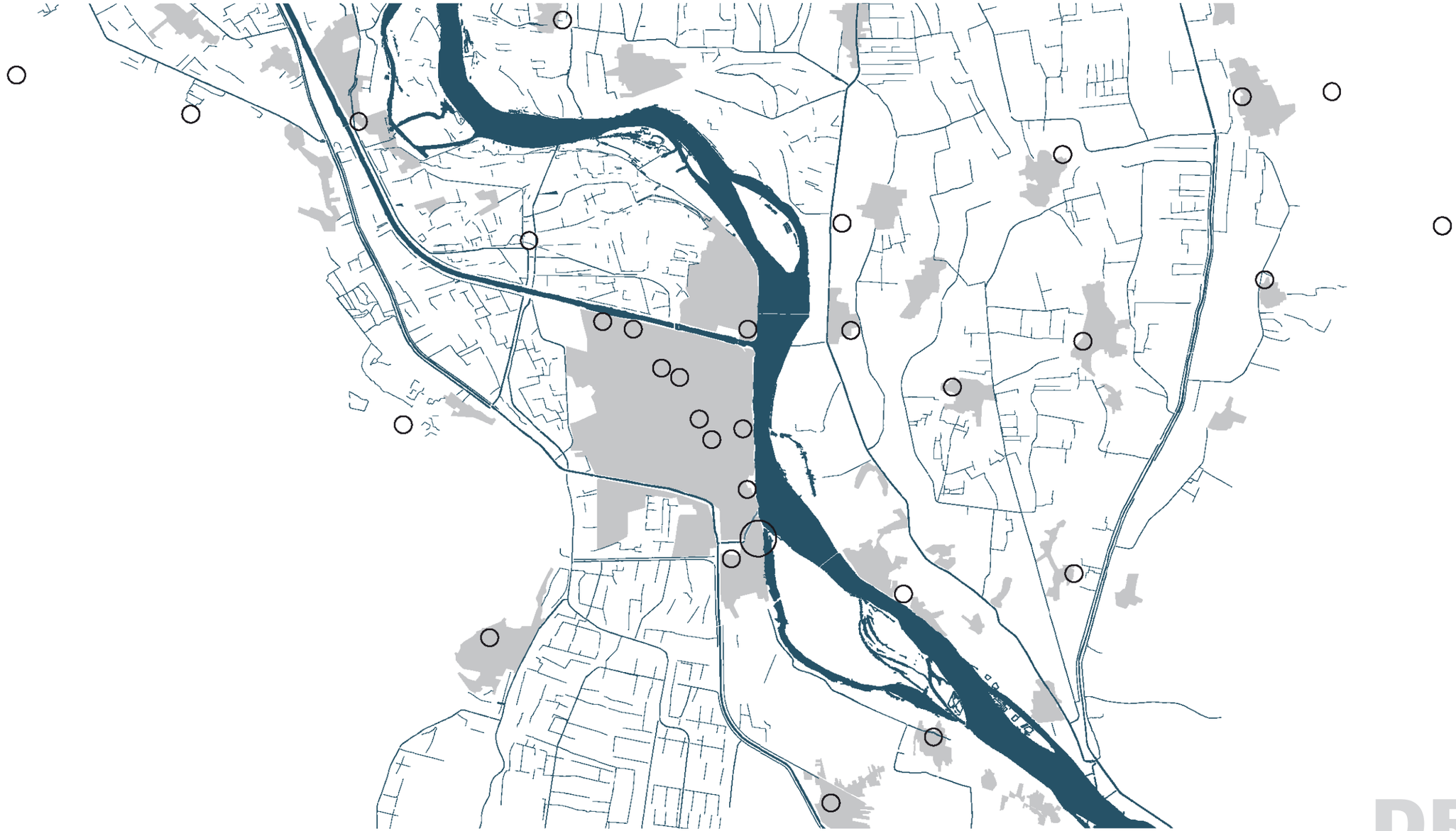


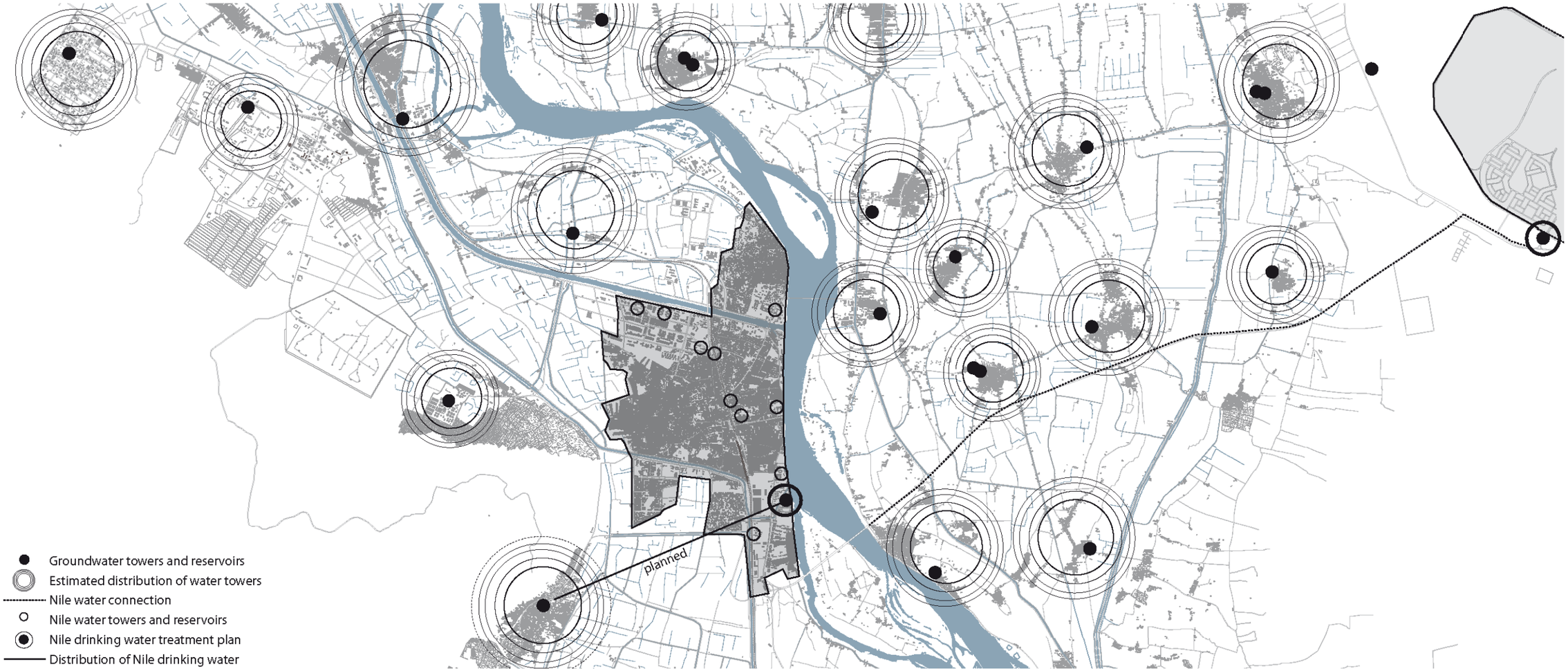
Nile Water Treaties

As the region's dominant power, Egypt has aggressively secured water rights from upstream riparian countries. The 1959 treaty grants Egypt the right to veto any upriver project that would reduce the water arriving at Aswan. The Nile Basin Initiative seeks to establish a cooperative approach to solving the challenges of the Nile Basin.

DRINKING WATER

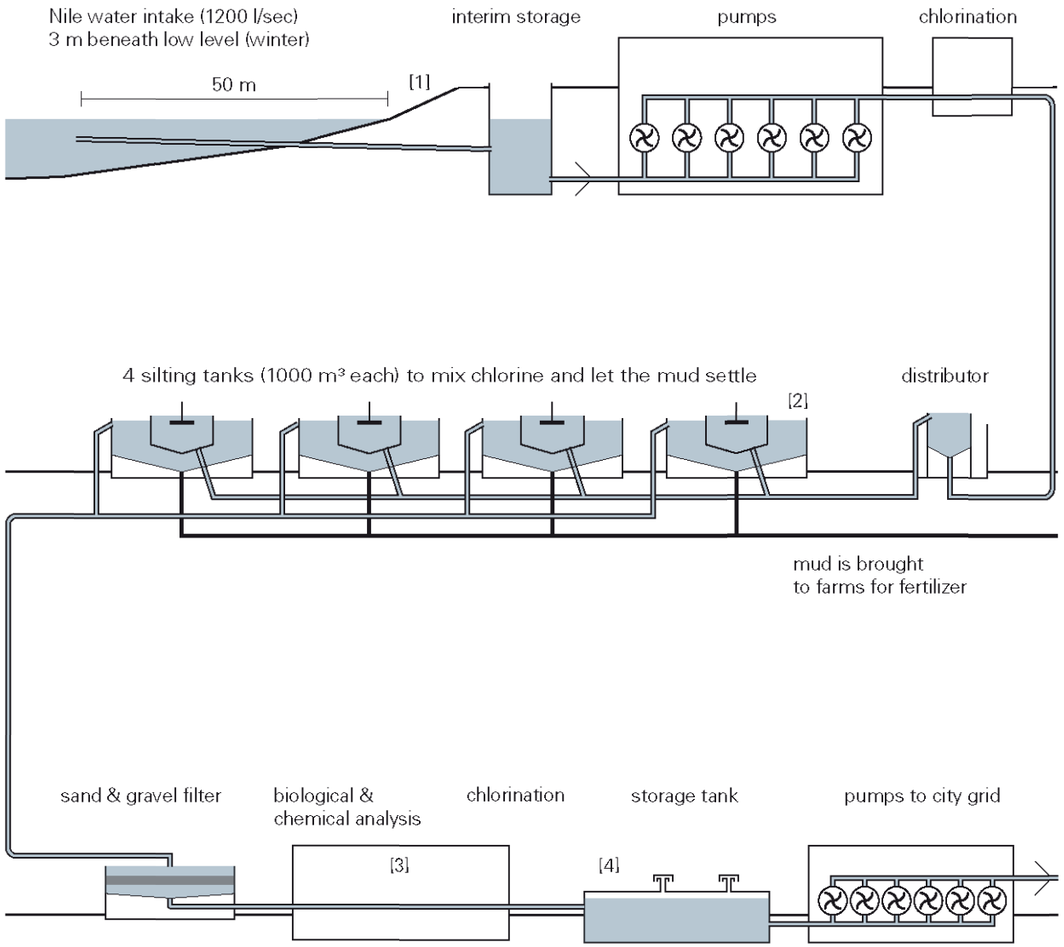
Autonomous networks of production and distribution ensure the availability of drinking water. Extracted groundwater is the most common source of drinking water in the villages. Because of its scale, the city of Assiut responds to its needs by tapping the Nile directly and converting it into drinking water through an industrial process.





The Water Supply in Assiut

Assiut City is supplied with drinking water by an extensive network of pipes from its Nile water treatment plant. In the villages, however, groundwater is pumped to municipal water towers by a system of pipes often subject to informal extensions. Some houses pump their own groundwater.



The Nile Becomes Potable

Assiut's current drinking water station was built in 2002 (expanded in 2008) and converts 100,000 m³ of Nile water into drinking water per day. Located just upriver from Assiut, it takes in the cleanest water possible.

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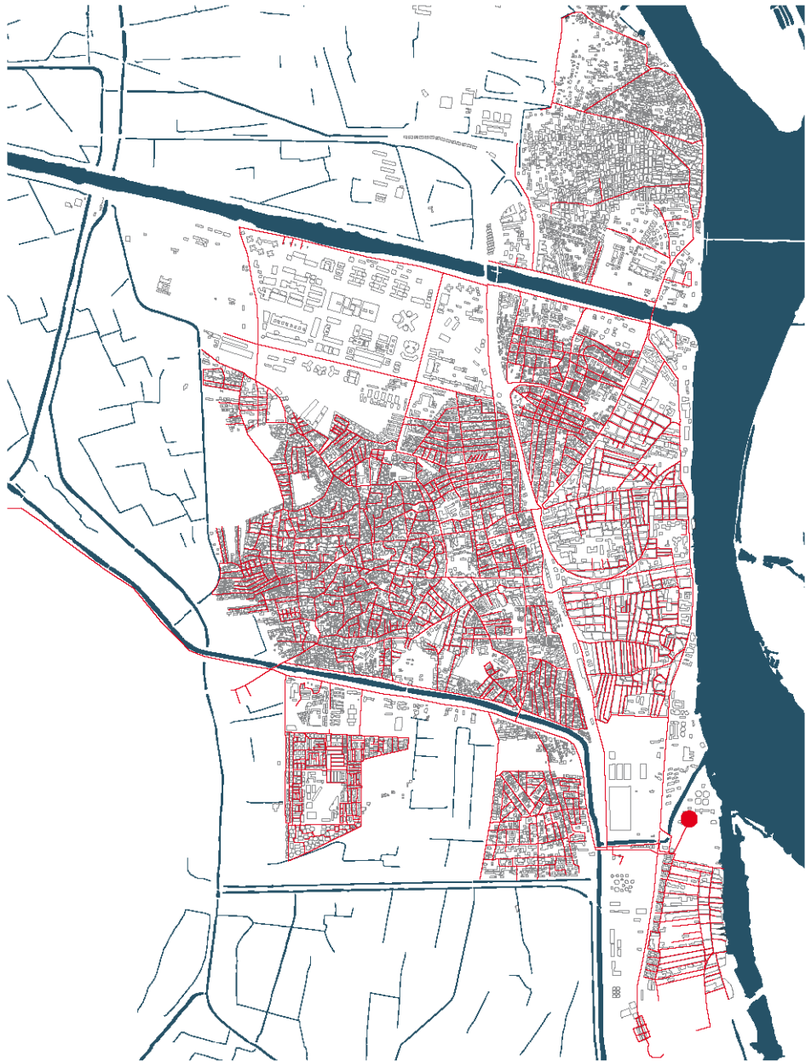
Scenes from the Treatment Plant

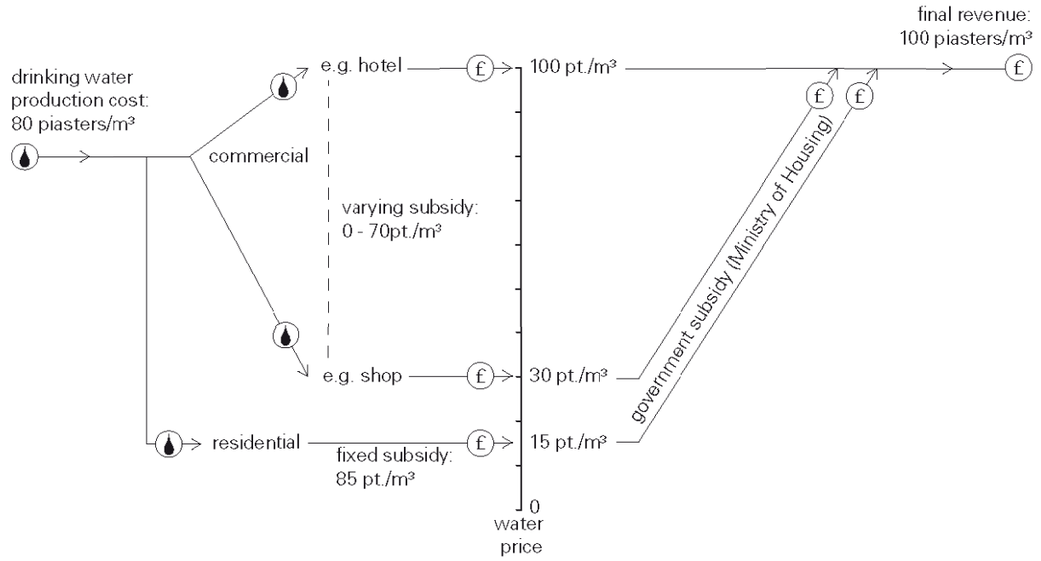
1. Nile water intake with maintenance boats
2. Silting tanks
3. Filter control room
4. Ventilated final storage tanks



drinking water treatment plant
underground pipes

A Dense Web of Municipal Pipes

Drinking water pipes run underneath the streets of Assiut City. The diameter of the pipes varies from 1200 mm (at the water treatment plant) to 25 mm (distribution to households).



A Diversity of Water Prices

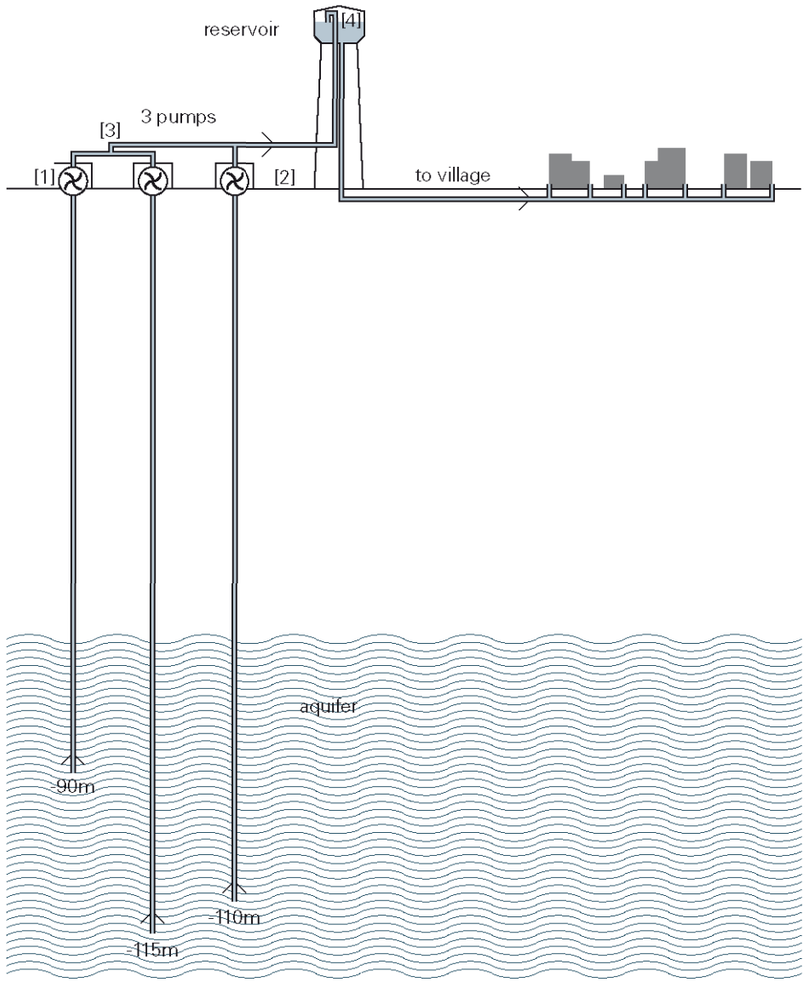
The Assiut drinking water company offers its water at different prices. In Assiut City, roughly 80,000 water meters in half a million households measure water use in the network connected to the drinking water facility. Every two months the users pay their bill, subsidized to varying degree by the government. (100 piasters = 1 LE)

Nile Extension to New Assiut

The new desert city is served by a supply system isolated from its surroundings. A station at the Nile pumps water to the treatment plant just outside of New Assiut. Where it crosses an irrigation canal, the pipe emerges above ground.

A Water Tower for Every Village

Extracting groundwater is the most frequent method of rural supply. Autonomous systems of groundwater wells connected to a water tower exist for nearly every village.



Village Drinking Water Distribution

The three wells of this 7-year old station west of Assiut pumps groundwater from different depths to the elevated reservoir, alternating for two hours each. The extraction per day reaches 200 – 300 m³. From the water tower, the water flows to the c. 5000 water meters in the distribution network. The same company that operates the treatment plant in Assiut owns this station and all others in Assiut governorate.

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Water Tower Treatment

1. One of the three electrical pumps
2. Pump house
3. Y–connector of two pipes leading to tower
4. Outlet into the tank in the top of the tower

Private Groundwater Pumps

Some households use their individual groundwater pump for drinking water. The reason is not always due to lack of infrastructure, but often an old habit.

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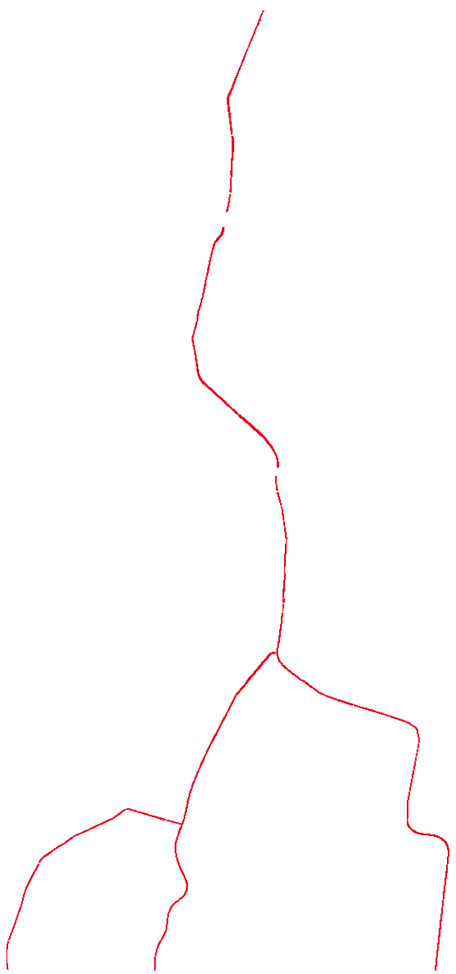
Old and New Water Dispensers

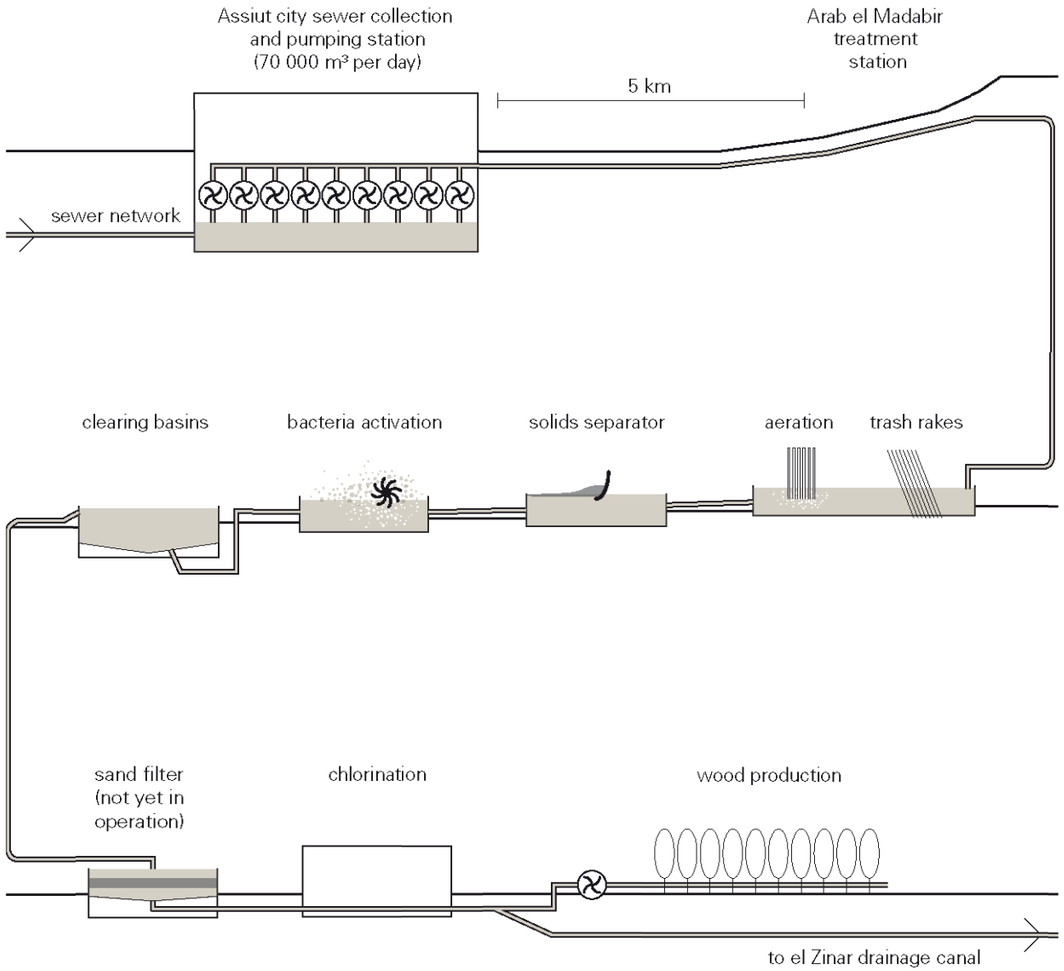
In villages and on the fields, drinking water is offered by different methods.

1. The Ziir are old Egyptian clay pots to clean drinking water and offer it to passers-by.
2. A modern interpretation of the Ziir are these "fridges."
3. Drinking water enters a dwelling on the outside wall.

WASTE WATER MEETS DRAINAGE

Generally, waste water from the villages reaches a treatment station or a dump by donkey cart. Only Assiut City and the industrial area to the west have comprehensive systems of waste water collection and treatment. Yet, they are not entirely closed circuits, and, in the canals that drain the fields from excess irrigation water, different kinds of effluents and waste come together.





Waste Water: Turning into a Resource

Waste water was formerly pumped out into the desert to prevent it from polluting the inhabited areas. Nowadays, treatment facilities extract water for irrigation from sewage. By law, treated waste water can only be used for irrigating trees. Ironically, New Assiut disposes of its waste water the old way, pumping it out to disappear into the sand.

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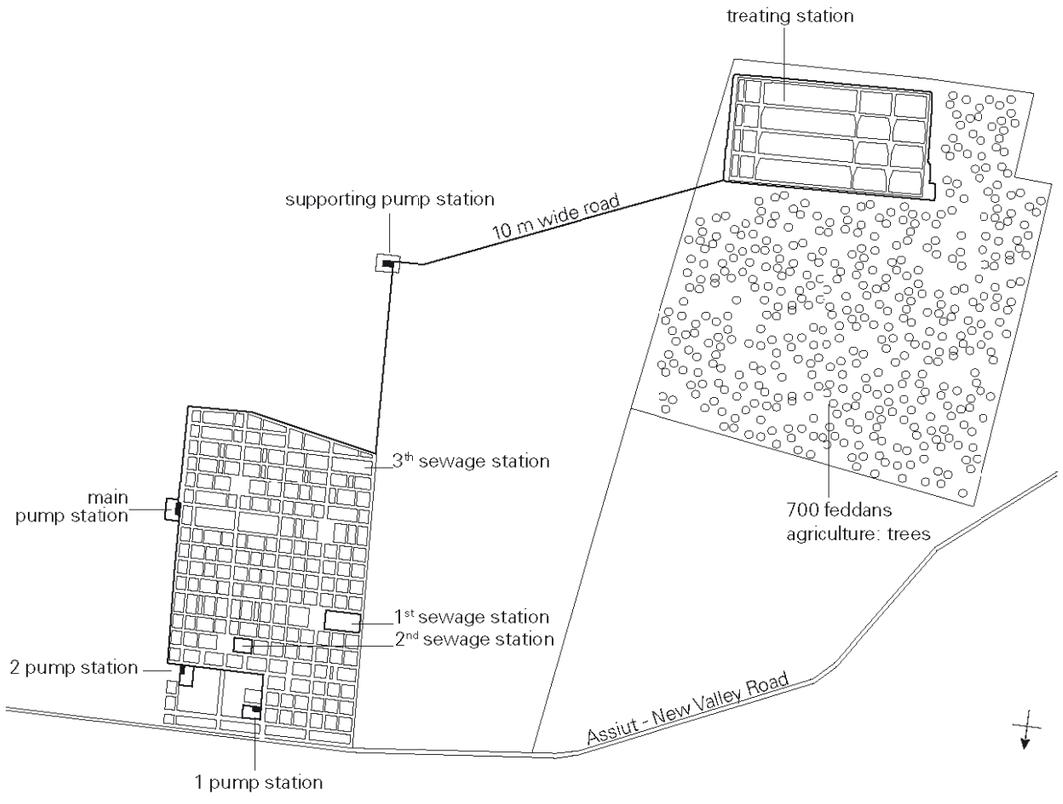
Treatment in Arab el Madabir

Collecting from two subsidiary pumps, the central waste water station (built in 1960 and expanded in 1990) pumps 70000 m³ of sewage daily to the mountainside treatment plant in Arab el Madabir. After treatment, a portion of the waste water is used to irrigate a tree grove of 75 feddans for wood production; the rest is channeled into the Zinar drainage canal, where it reaches the Nile.

1. Conveyor belt for solid waste removal
2. Distributing pool for the 4 clearing basins
3. Fan-weels mix the liquid with air to accelerate decomposition of organic substances by bacteria
4. The sand filters, the last step, will be operational in a few months



Industrial Waste Water Wood

At the Bani Ghalib industrial area, a waste water treatment plant is under construction. Four pumps will transport sewage to the treatment plant, located 7 km into the desert. Construction began in 2003 and the start of operation is expected for 2010. The waste water will be treated in four separate circuits of 5 basins each, open to air and sun. The plant occupies an area of 200 feddans. After passing 1 ½ km of cleaning steps in 2 to 3 days, the water will irrigate a tree grove of 700 feddans for wood production.

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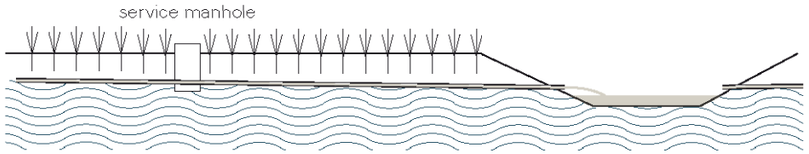
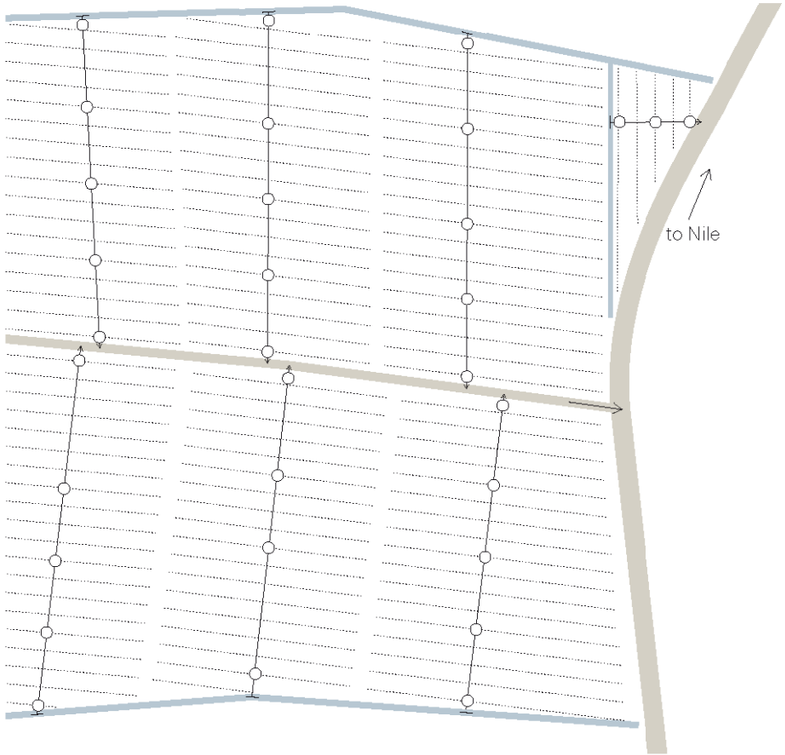
An Immense Site in the Desert

Pipes about ½ m in diameter carry sewage to the plant.
1. One of 4 large stone-lined basins under construction
2. Formwork for the supporting pump station

Drainage

Year-round irrigation made possible by the Aswan High Dam caused the groundwater table to rise into the root zone of cultivated crops, making drainage of the fields necessary. Construction of a drainage system for the agricultural areas started in the mid 1970's and will be completed where needed in the next 5 years. The drainage canals flow into the Nile, usually downstream of cities.





A Rational Layout

The underground network of drainage pipes runs in a quasi-orthogonal arrangement irrespective of the property lines that divide the fields. Farmers pay 2200 LE per feddan for the installation of the drainage system and are compensated for land given up for the open drains.
Evenly spaced and perforated lateral pipes, 80 mm in diameter, lie 1.2 to 2 m under the ground and 30 to 60 m apart. Collectors, 20 to 45 cm in diameter, connect the laterals to an open drain. The open canals have 3 hierarchical levels.

Drainage Collector Outlet

The largest part of the drainage system lies buried under the surface of the earth, accessible for maintenance through manholes. The visible components of the drainage system are the open canals.

Mouth of El Zinar Drainage Canal

Completed in 1976 and 22.5 km long, El Zinar canal drains nearly 37,000 feddans of agricultural land. As an unofficial recipient of trash and sewage, it reaches the Nile brownish and filthy. Nonetheless, irrigation pumps draw water from it all the way to the outlet of the drainage canal.

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Secondary Environments

The appearance of El Zinar drainage canal changes distinctly as it passes fields and human settlements. Surprisingly, birds find food in every stretch of the canal, indicating that the water manages to stay alive despite the pollution.

1. Fertilizer runoff causes thick growth in some sections
2. The outlet into the Nile is at the same time a trash dump
3. Along the way, a pair of sewage dumpers pour waste from rural homes onto the embankment
4. Unconcerned by trash, fishermen check their nets

Irrigation Water Crossing Drainage

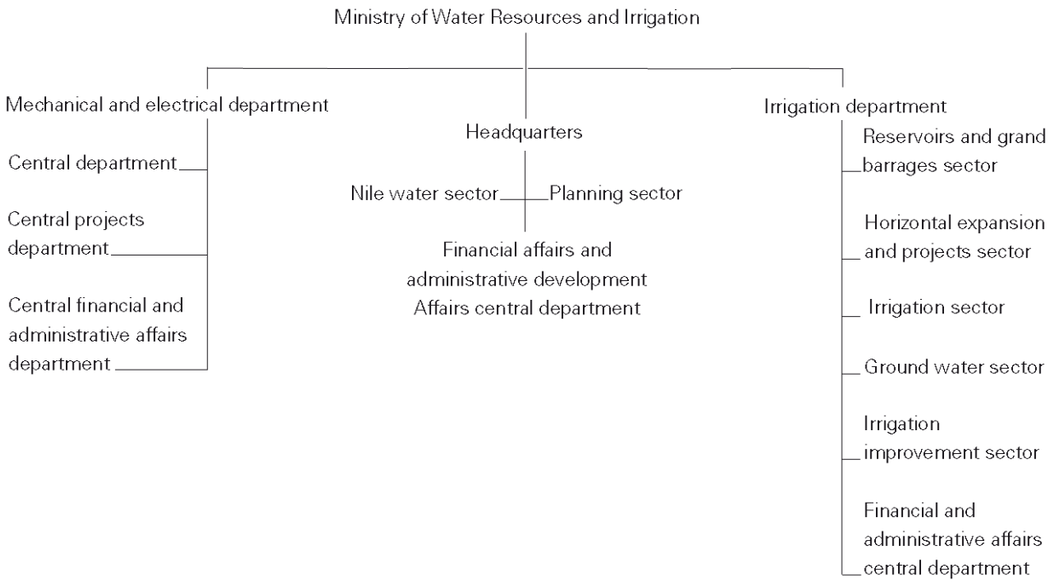
Officially, it is not allowed to use drainage water for irrigation. Irrigation canals that were severed by the construction of the drainage canal are restored with steel pipe siphons that cross the drainage canal to make irrigation water available on the other side.

Waste Water Meets Drainage

West of Assiut, 2.3 km before El Zinar canal drains into the Nile, foamy waste water enters the canal. A sequence of large siphons along the drainage canal pointing to the mountains suggests that it is excess waste water from the treatment plant in Arab el Madabir where the grove only requires a fraction of treated water. Instead, the water travels nearly 3.7 km under ground till it reaches the drainage canal. The farmers complain about the deterioration of the water quality and its negative effect on fish. They sent a representative to the Ministry to complain about the situation, but he was dismissed.

A SHRINKING MARGIN OF STABILITY

The continued existence of civilization in the Nile Valley depends crucially on successful handling of water resources. So far, enormous government efforts have built up a mechanism of complete control in delivering the national resource to the population. However, the practices of its use, for the most part, have hardly evolved. How have these two ways of dealing with water coexisted without friction?



Passing the Resource through a Control Vacuum

The system of irrigation is determined by the actions of two completely different entities. On the distribution side, the government allocates water to governorates, irrigation sectors, sub-sectors, and individual canals in a top down fashion. On the usage side, farmers take the amount that is appropriate for their fields. The two sides have no means of directly influencing each other. However, the established water use by farmers tacitly influences the quotas that the government dictates for every area, and the government, theoretically, has the power to shut off the supply.

"It is not a problem if I accidentally irrigate a few hours more than necessary."

"I take as much water from the irrigation canal as I need."

"No one told me about lectures to increase my production."

"My water comes from the pump station 5 km from here."

Diverging Perceptions

Many farmers we spoke to seemed unaware of the major national effort of making water available on the fields. Has the government stepped into the role of a distant Nature, providing water steadily but ultimately not within the farmer's sphere of influence?

Finding a New Balance

As it stands, the government effectively implements a regime controlling all flows from Aswan to the Mediterranean Sea. This control, however, governs merely the distribution of water into the network of canals that sustains the land. On the other hand, actual usage hinges solely upon users' decision to consume water to fulfill their needs. The logic of use operates independently of the logic of supply.

There exists no convention, legal or otherwise, that authorizes the government to influence agricultural water use. Naturally, agriculture's aim is not simply to use water but to apply it to plants in sensible amounts, and so, the usage has remained within a range of predictability. So far, the two systems have coexisted peacefully thanks to an oversupply of water that permits ad hoc adjustments of the top-down quota due to bottom-up demands.

Reclamation projects are expanding the area of irrigated land; exploration is making new water resources accessible; research and new technologies are pushing irrigation efficiency ever farther. Meanwhile, the yearly water supply disposable at Aswan remains unchanged. For all technical development, curiously, nobody has initiated comprehensive improvements in the use of water by Egypt's biggest consumer, agriculture—so far goes the indifference for controlling usage that the government doesn't even demand a price for the irrigation water.

The premise underlying the rapidly growing Egyptian society seems that agriculture is its natural livelihood; as a rule, more farming will mean more water use. The two autonomous systems, of distribution and of consumption, are creeping towards each other; will there come a moment of scarcity that reveals their mutual incompatibility? The enormous efforts of the past keep Egypt alive. The future will tell whether or not the current system is poised for adaptation.

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IMAGE CREDITS

All graphics and photos by Isabelle Maassen and Samuel P. Smith, except where noted.

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P. 151. figs. 1, 3, 4
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