Redeker, C. (2014)
The Nile Delta - water insensitive?
Revista M, 11(1): 66-81
https://doi.org/10.15332/rev.m.v11i1.953

Recibido: 03 febrero 2014
Aprobado: 07 abril 2014

THE NILE DELTA – ¿WATER INSENSITIVE?*

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The Nile
Source: *NASA http://eoimages.gsfc.nasa.gov/images/imagerecords/68000/68269/Egypt.A2003235.0845.250m.jpg.*

ABSTRACT

The Nile Delta is considered one of the deltas most vulnerable to climate change worldwide. Apart from the immediate threat of sea level rise it is additionally facing water scarcity, agricultural and ecological degradation in parallel to an unprecedented population increase and the vast urbanization of scarce agricultural land. The urbanization of the Nile Delta, which may be considered an even bigger threat than climate change, is dominated by informal building processes mainly for the lower income sector while the formal sector is planning new cities in the desert. To overcome the pressure of land scarcity in the Nile Valley and Delta, which make up only 4% of the country, the ongoing governmental strategy since the 1970s also for the delta's fringes has been land reclamation in the desert, for both agricultural, industrial and settlement purposes. Yet, up until today "New Urban Communities" have not been able to attract the designated number of inhabitants as they fail to meet the needs of a large part of the population. Instead they have become market-steered recluses to a growing middle class that longs for a suburban life style and can afford it. Apart from offering a privileged lifestyle, desert developments are investment objects for the private sector. In the formally organized planning processes, sustainable design remains vanguard. As low-rise, high-density and mixed-use neighborhoods, informal developments evolving along canals and transportation nodes in the delta, meet a number of sustainability criteria. While these neighborhoods often lack proper infrastructure and safe accessibility internally, it is their location on scarce agricultural land that proves to be their main deficiency in the light of an increasing geographic vulnerability of the delta. In summary, currently both formal, market-steered developments on reclaimed desert land and informal developments in the Nile Valley and Delta lack ecological awareness. To become more resilient, how can ecological intelligence of people and places be incorporated in this spectrum of formal and informal settlement processes? Water scarcity and quality stand at the top of the list when looking at Egypt today. An overview of current social and spatial conditions in the Nile Delta region and of planning practice in Egypt today depicts a highly complex condition. This paper proposes Water Sensitive Urban Design as a tool for both formal and informal urban developments to negotiate between social and topographical extremes to increase resilience of the Nile Delta and its adjoining desert developments.

KEYWORDS

Nile, delta urbanization, design guidelines, ecological awareness.

* This text is a revised version from the author of the published article "The Nile Delta – Urbanizing on Diminishing Resources", published in Built Environment, Delta urbanism: New Challenges for Planning and Design in Urbanized Deltas, Vol. 40 No. 2, Alexandrine Press.

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DELTA DEL NILO: ¿(IN) SENSIBLE AL AGUA?

The Nile
Source: *NASA http://eoimages.gsfc.nasa.gov/images/imagrecords/68000/68269/Egypt.A2003235.0845.250m.jpg.*

RESUMEN

El delta del Nilo es considerado uno de los deltas más vulnerables al cambio climático en todo el mundo. Además de enfrentarse a la amenaza inmediata del aumento del nivel del mar, debe hacer frente a la escasez de agua, la degradación de la agricultura ecológica y al aumento de población sin precedentes, impulsado por la urbanización de tierras agrícolas. La urbanización del delta del Nilo, que puede ser considerada una amenaza aún más grande que el cambio climático, está dominada por los procesos de construcción informal (principalmente en el valle y el delta, orientado al sector de menores ingresos), y formal (orientada a la planificación de nuevas ciudades en el desierto). Para superar la presión de la escasez de tierras en el valle del Nilo y el delta, que representan solo el 4% del territorio nacional, la estrategia gubernamental desde la década de 1970 ha sido la recuperación de tierras en el desierto tanto para agricultura como para la industria y residencia. Sin embargo, hasta hoy las *nuevas comunidades urbanas* no han sido capaces de atraer el número deseado de habitantes, ya que no son capaces de satisfacer las necesidades de una gran parte de la población. En la actualidad, ambos desarrollos, sean los formales, dirigidos al mercado en tierra desértica recuperada y los informales en el valle del Nilo y el delta, carecen de conciencia ecológica. Para incrementar la resiliencia ¿cómo puede la inteligencia ecológica de las personas y los lugares incorporarse como una solución en este espectro de procesos formales e informales? La escasez de agua y la calidad se sitúan en la parte superior de la lista cuando se mira en el Egipto de hoy. Una visión general de las actuales condiciones sociales y espaciales en la región del delta del Nilo y de la planificación de la práctica en Egipto hoy en día representa una condición muy compleja. En este trabajo se propone el *Water Sensitive Urban Design* como herramienta para el desarrollo urbano, tanto de los desarrollos formales como informales, para negociar entre los extremos sociales y topográficos y para aumentar la capacidad de recuperación del delta del Nilo y sus desarrollos desérticos.

PALABRAS CLAVE

Delta del Nilo, deltas urbanos, lineamientos de diseño, conciencia ecológica.

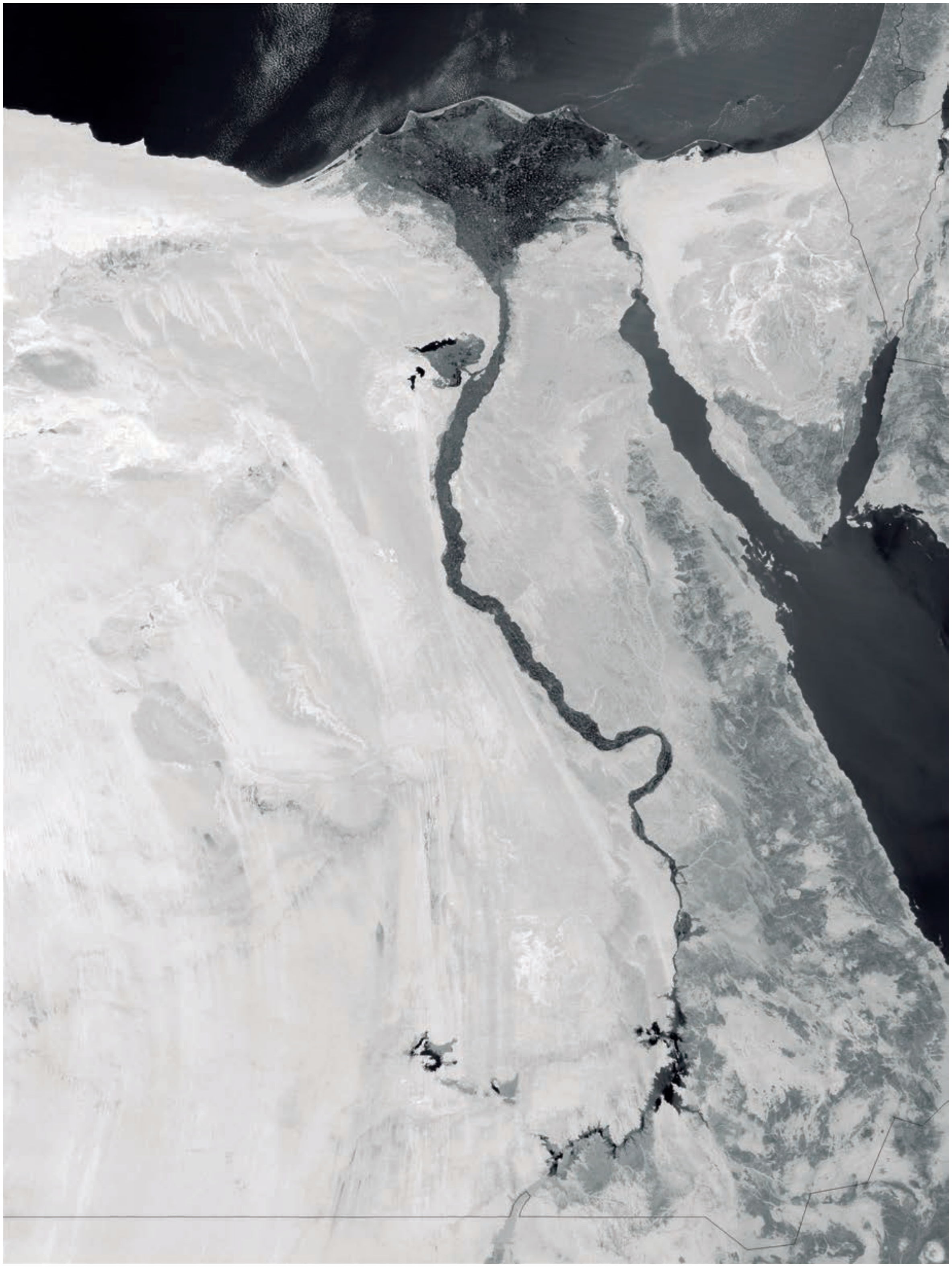

Figure 1. *The Nile*
Source: *NASA http://eoimages.gsfc.nasa.gov/images/imagerecords/68000/68269/Egypt.A2003235.0845.250m.jpg*.

Climate change and sea level rise

Climate change is likely to increase the current stress on resources, especially in the developing world. Most systems are sensitive to both the magnitude and the rate of climate change (e.g. Gleick, 1998). The vulnerability of a system to change depends on the overall resilience to cope with different risks. Most developing countries, such as Egypt, are generally more vulnerable and less able to adapt (El-Din, 2013). From Alexandria in the west to Port Said in the east the Nile Delta covers 240 km of Mediterranean coastline. From north to south the delta is approximately 160 km in length starting 20 km downriver from Cairo. It is one of the world's largest river deltas and remains the most important source of ecosystem goods and services for Egypt.

The Nile Delta testifies to the consequences of past, and more urgently, present climate change, anthropogenic transformations, and the socio-ecological dimensions associated with each. It is shaped by an interplay of urbanization processes and agricultural and industrial land uses that are coupled with multiple urgencies defined by water scarcity and pollution, sea level rise, desertification and population increase. For example, the North Coast, as one of Egypt's major national and international tourist destinations and a site of immense cultural heritage, is the site most vulnerable to sea level rise. According to one of a number of studies that were evaluated by the Met Office Hadley Centre in 2011, the impact of a 1.0 m SLR for 84 developing countries, Egypt was ranked second of those countries seriously impacted with respect to the coastal population affected and fifth highest for the proportion of urban areas affected (see El Dhin, 2013). An assessment of Alexandria alone suggests that a rise of 50 cm would demand the evacuation of more than 2 million people (see GOPP, UN, 2009).

More people on less land - urbanization and desertification

The Egyptian situation is further framed by land and water scarcity for a growing poulation. The contested agricultural land makes up only 4% of the country see fig. 1). About 95% of the people (84 million in 2012) actually live on the scarce agricultural land in the Nile Valley and Delta in a country that is otherwise a desert. With a population density of 1500 inhabitants per square kilometer when including the capital (Tamburelli et al, 2013), the Nile Delta is one of the most densely populated delta in the world and after Cairo also its main economic region with industries, agricultural production, natural resources and tourism. While shrinking in size, an estimated population increase from 48 million in 2010 to 75 million by 2050 will require more jobs, housing and food production. In the absence of enforcement following the 2011 revolution, informal urbanization, a phenomenon that arose in the 1970s has reached an unprecedented dynamic. While the delta fills with informal urban development, its fringes are suffering from desertification (Egypt, UNDP, 2011). According to the UN Convention to Combat Desertification, Egypt stands at the forefront of those countries threatened by desertification with 34 hectares per day lost (Metawali, 2011).

Water scarcity and quality

Water resources in Egypt are the Nile, rainfall, deep groundwater, and desalinated water complimented by shallow groundwater in the Nile delta and both re-used agricultural drainage and treated waste water as non-conventional water resources (El Dhin, 2013). 86% of that water comes from the Nile and around 11% from undergound sources, 2% is recycled (CAPMAS, 2012) often 3-4 times. Desalinated water only makes up 0.1% of water resources and will rely on more economic techniques to make it affordable (Attia,

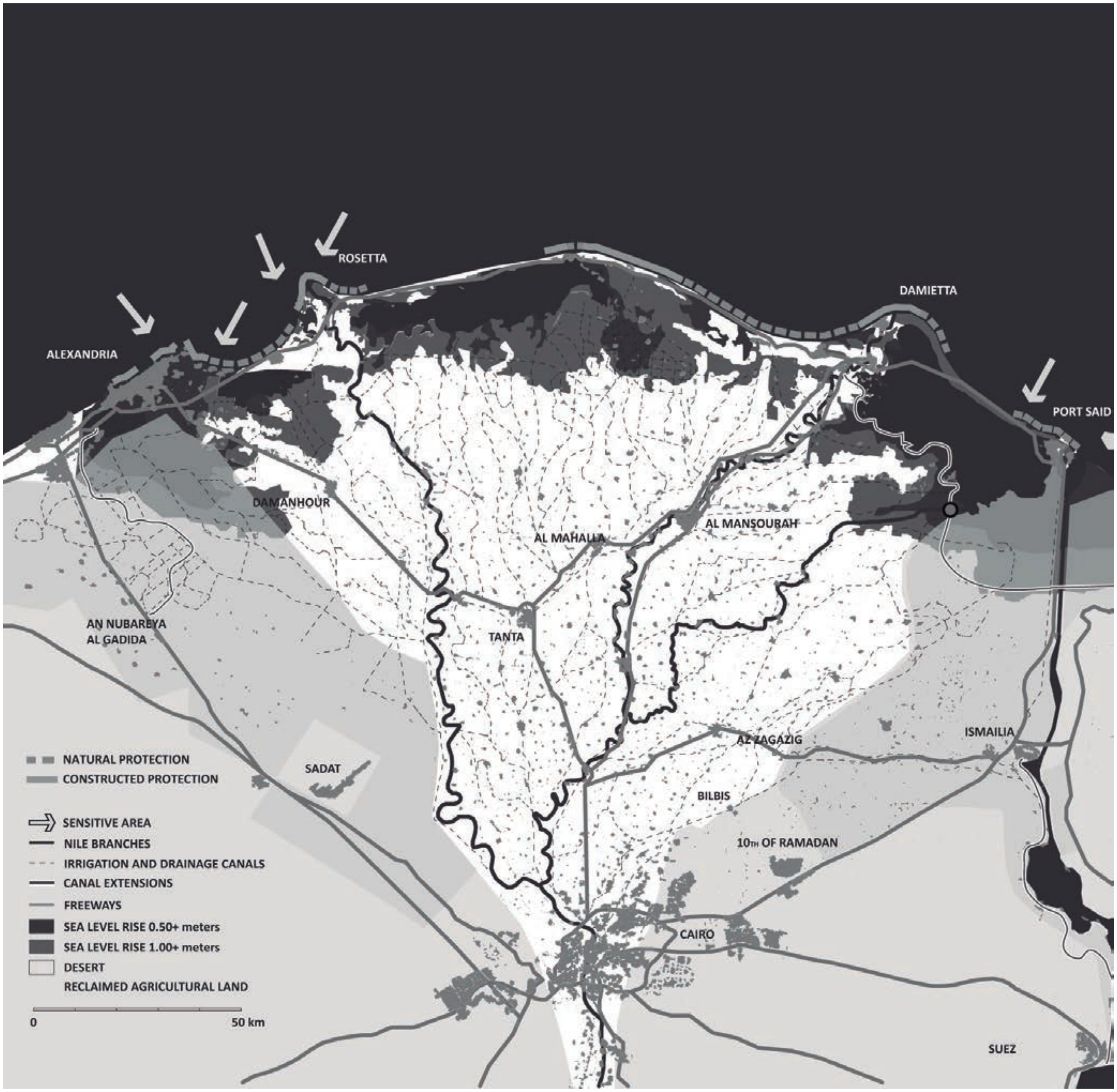

Figure 2. *Nile Delta*
Source: *map by Hassan EL Ghayesh based on Simonett a.o., suministrated by author.*

2014). 86% of all water is used for irrigation of which, unfortunately, surface irrigation accounts for more than 85% of the total volume of water used for irrigation in the Nile Delta.

Nearly 100 m thick, the porous Prenile River's sand and gravel layer covered by a clay cap of about 50 meters serves as a fresh water reservoir. As the second source, the Prenile aquifer with 300 billion cubic meters, or the equivalent of 3.5 years of total Nile flow is replenished by seepage from the Nile and irrigation channels. As the water passes through the sand, some pollutants are filtered. However, the reservoir has already been heavily tapped leading to seawater penetrating from the north and now extending at least 35 km inland (Sampsell, 2003). It provides about 85% of total groundwater abstractions in Egypt. In addition, the Moghra aquifer is located in the North western desert and groundwater is directed towards the Qattara Depression. It is recharged by rainfall and lateral inflow from the Nile aquifer. It contains fresh groundwater only with salinity increases towards the North and West. Yet, the water quality of this aquifer is currently at risk due to the rapid development of land reclamation in this area (El-Din, 2013).

Large hydro-structures have freed the Egyptian Nile Valley and Delta from floods, but also dramatically confine sediment transport and water availability. Since the 1960s, the Egyptian Nile is completely controlled by the Aswan High Dam and a series of barrages along its course to the Mediterranean Sea. Dams in Ethiopia, Sudan and South Sudan are currently being planned or are already under construction. These dams, most prominently the Renaissance Dam in Ethiopia, will put additional pressure on the territory (Kantoush, 2013). The severity of its impact produces enough pressure to consider declaring a war against Ethiopia content for presidential campaigns of upcoming elections (Egypt Independent, April 8, 2014). Lacking sediment and water supply lead to local water and mineral extraction. This increases subsidence and enables salt-water intrusion into wetlands and reservoirs. In turn, the destruction of wetland habitat has diminished water quality and reduced biodiversity while urbanization is hindering inland migration of the coastal wetland zones. With the completion of the Aswan High Dam the Nile was not only freed from its annual floods, but also from silt depositions to fertilize the fields of the flood plain. Without annual floods also the erosion process along the Mediterranean coast is no longer counter-balanced by river sediment which has led to a considerable retreat of the coastline. Regulating the floods via the dam has also depleted the annual flush of pollutants out of the Nile system and into the Mediterranean. Further a decrease in precipitation in Eastern Africa has reduced discharge by up to 25%. Of the 55 million cubic meters discharge at Aswan per year (ECIDSC, UNDP, 2011) only 8 percent reach the delta (Ministry of Water and Irrigation, 2004) with the Rosetta branch carrying 70-80% of the water while the Damietta branch would silt up if not dredged. Further water is lost by evaporation and will increasingly do so with the expected rise in temperature. In summary, engineering interventions may delay, but are unlikely to prevent the destruction of the Nile delta as we know it in the coming decades.

ECONOMIES UNDER MULTIPLE PRESSURES

Agriculture

The above named pressures of urbanization, population increase, sea level rise and desertification, very limited water reserves and poor water quality are the major challenges facing sustainable agricultural development in Egypt, a country that up until 60 years ago was more or less self-sufficient in almost all agricultural commodities with the exception of cereals, oils and sugar. With the rise of 1° C the evapo-transpiration rate may increase by up to 5%. A rise in temperatures by 3° C would triple this (Eid, 2001). If Egypt's agricultural sector is consuming 41 billion cubic meters, an increase of 1° C would lead to additional amount of about 2 billion cubic meters to maintain the same level of productivity. It would also have a negative effect on groundwater recharge (Eid et.al, 2006). All crops except for cotton would be negatively affected (El Dhin, 2013).

Water released from the Aswan High Dam is distributed throughout the valley and delta in a diverse network of canals. This extensive irrigation network delivers water mainly by gravity diversion and pumping stations. The irrigation system distributes water among main canals and regions based on volumetric quota defined according to served area, soil and climate conditions and cropping patterns. Yet, control over branch canals is mainly by levels, which leads to mismatching allocated supplies from the upstream side with demands from the downstream resulting in unequal water distribution. This forces downstream users to lift water from the nearest drains to irrigate their lands. Reusing agricultural drainage water in the Nile Delta has been official practice since the late seventies. The policy defines the recycling of agricultural drainage water by pumping it from drains and mixing it with fresh water in canals. There has been a decrease in the amount of water pumped into the sea with a significant increase in the amounts of drainage water recently reused both officially and unofficially (El Dhin, 2013). The increased need for recycling, already today the water is used 3-4 times (Attia, 2014), necessitates stronger legislations and enforcement to protect the water bodies. The same accounts for the effect on water quality in the canals from domestic and industrial discharge by a vastly growing population.

Today, changing perennial into drip irrigation is supposed to increase the efficiency of water use, as is the improved drainage of fields.

Aquaculture

In the last three decades, Egypt has redeveloped a number of lagoons and lakes along the northeastern coast of the delta for fish production to compensate for the reduction in fish catches induced by land reclamation, industrial and nutrient pollution, and an overgrowth by water hyacinth (Ghobrial, 2007). A network of artificial structures, mainly short dikes enclosing hundreds of aquaculture ponds, occupies the Musalla lagoon shores directly south of Port Said almost entirely. The total area devoted to fish production in the lagoon is estimated to be 8,000 hectares - more than half of Egypt's aquaculture production. The intense aquaculture in the Nile Delta was born out of the impacts of the Aswan High Dam leading to such severe drops in nutrient supply that fishery in the lakes and lagoons in the mid-1960s came down to about 3 percent of pre-dam values. The aquaculture program throughout Egypt during the last 30 years has partially compensated for this loss, yet consumption has doubled in the meantime and export never fully recovered (http://earthobservatory.nasa.gov/IOTD/view.php?id=7070).

Tourism and energy production

Beyond agriculture and aquaculture, two further economic sectors will be severely affected by climate change: tourism and energy production (TearFund, 2010). Tourism is reliant on the beaches of the Mediterranean North Coast which may be lost due to sea level rise. Reviving tourism, which has experienced a severe downfall after the revolution, also demands for reliable water supply, proper wastewater treatment, as well as safe and high-quality agricultural products. Also recreational uses of water require good water quality. Climate-induced water shortages and pollution will therefore severely affect tourism. Egypt plans to produce 20% of the country's energy using new and renewable energy sources by 2020. The MENA region is capable of providing enough solar electricity to meet regional as well as European electricity demands using CSP technology. Water scarcity will also severely impact these plans.

Concluding, any kind of development will have to include these urgencies to transform the Nile Delta and its adjoining reclaimed land in a sustainable way. Recent initiatives by UNEP to raise awareness among Egypt's financial institutions for sustainable banking may be seen as a step in the right direction (see Farid, 2014).

URBAN GEOGRAPHIES

The delta and its fringes

The Nile Delta is one of the most densely populated deltas worldwide with Greater Cairo and it's roughly 20 million inhabitants located just 20 km upriver from the delta. While urban development in the delta was previously defined by the Nile branches and its canals, the network of highways further steers urban development today. Until the 1950s, the waterways also served as a transport route: 25% of goods were shipped via the river and its canals. Today, Nile transportation only makes up 1%. Since the 1970s a network of highways connecting the coastal cities of Alexandria, Rosetta, Damietta and Port Said with Cairo superimposes the evenly sprinkled pattern of small towns and villages that have evolved across the delta.

Next to the extension of existing cities and the stumbling development of holiday homes along the North coast, Nile Delta urbanization is dominated by informal building processes mainly for the lower income sector while the formal sector is focusing on new cities on desert land. The vast urbanization may be considered an even bigger threat than climate change. To overcome the pressure of land scarcity in the Nile Valley and Delta, which make up only 4% of the country as a whole, the ongoing governmental strategy since the 1970s has been desert land reclamation for agricultural, industrial and settlement purposes. Also along the delta's fringes ambitious, but challenging land reclamation schemes are underway (see fig. 2). Up until today the so-called "New Urban Communities", new cities erected in the desert vicinity of existing cities and given the same name with the addition of a "New" before, have not been able to attract the designated number of inhabitants as they fail to meet the needs of a large part of the population. Instead they have become market-steered recluses to a growing middle class longing for a suburban life style and able to afford it. Apart from offering a privileged life style, desert developments are investment objects for the private sector. In the formally organized planning processes, sustainable design remains vanguard although construction in these new cities is expected to follow the green building code. In contrast, as low-rise, high-density and mixed-use neighborhoods, informal developments evolving along canals and transportation nodes in the delta, provide compact city models that, although unplanned, meet a number of sustainability criteria. While these neighborhoods should not be romaticised as they lack proper infrastructure and accessibility internally and inhabitants often suffer from insecure tenure, it is their location that may be considered the main deficiency in the light of an increasing geographic vulnerability of the delta.

Desertification and population increase are not only decreasing spatial capacity so radically that reclamation of the desert seems an inevitable approach. Population increase has also triggered a housing demand specifically for the lower to mid-income sector that neither the government nor the formal market have been able to accommodate. Since the 1950s social housing programs have been carried out, unfortunately with little success thus triggering informal urbanization. Unplanned areas (Ashwayat) pose a threat to the availability of agricultural lands and water scarcity, but also for challenges to come such as rising sea levels. Based on different scenarios, sea level rise is projected to make between around 26,000 to 110,000 (2030-2060) housing units vulnerable to inundation with an estimated current value between 16-66 billion Egyptian pounds (El Dhin, 2013).

In summary, currently both formal, market-steered developments on reclaimed desert land as well as previously erected holiday compounds along the Mediterranean coast, but also informal developments in the Nile Valley and Delta lack ecological awareness. While formal developments follow a logic of land planning, but are not developed according to the landscape conditions, informal settements may offer vernacular qualities, but lack any kind of strategic planning.

Informal urbanization

The dynamics of informal urban development are exceeding the expected area of lost agricultural land induced by sea level rise. Population increase, perverse market incentives on agricultural products and of course the safety from floods for almost 50 consecutive years may be considered the drivers (Shawkat, 2010). Due to sea level rise, between 1800 and 4500 km^2 of crop land out of a total area of 25,000 km^2 in the delta may be lost by the year 2100. At the same time, urban expansion will claim between 12,500 to 25,000 km^2 of the delta. It is over five times more threatening to cultivable land than climate change, and threatens the entire delta. Almost 10% of arable land in the Nile valley and Delta has already been lost to largely informal urban development. If urban growth continues as it has for the last 20 years the arable delta will be lost in no more than 120 years (Al Gamily, see Shawkat, 2010c). It is important to understand that the vast majority of informal settlements in Egypt are not slums, but informally erected, multiple-story structures built in reinforced concrete and brick.

The Informal Settlements Development Facility (ISDF), the governmental institution in charge of informal areas defines four grades of unplanned and unsafe areas according to the degree of risk exposure for the inhabitants. Immediate intervention through resettlement is only considered for unsafe areas that threaten lives such as the exposure to floods (Algohary, 2010). Beyond resettlement, the integration of climate change and its consequences in informal urban areas has only recently been addressed in the GIZ Participatory Development Program in Urban Areas (2011) with the aim of raising awareness and promoting initiatives that improve the resilience of the urban poor in the Greater Cairo region. Beyond this local initiative, most institutions involved in informal settlement upgrading are focussing on the pressing issues at hand. A pilot project to cope with encroachment along the Nile and the canals was recently conducted by the Ministry of Water Resources and Irrigation. The key hindrances to implementing innovative solutions being lacking institutional capacity and expertise to reform implementation and contracting procedures of conventional solutions (Redeker, et al 2013).

New urban communities

Historically, small communities have settled in the desert regions of Egypt clustering around oases and historic trade and transportation routes. The national strategy to reclaim land in the aligning eastern and western deserts relies on the extension of existing canals or the excavation of new ones brings water to the delta's edges in order to reduce development pressure on the agricultural land limited to the 12 km-wide strip of the Nile valley and the delta fan. The Nubaryia Canal to the west as far north as Lake Maryut, the extension of the existing Ismailiya Canal to irrigate 310 km^2 on the east side of the Suez Canal and a giant new canal known as El Salam Canal to be constructed eastward from the Damietta branch over a length of 240 km are to be combined with the discharge of the Bahr-Hadrus drain. The El Salam canal was planned to bring water to nearly 2500 km^2 of land south of Lake Manzala and along the Mediterranean coast on the east side of the Suez Canal. A project that is now on hold. Yet, with the aim to raise numbers by incentives such as the provision of additional infrastructure and job opportunities, the national strategy for the delta continues to be expansion into the desert. For the time until 2050, using underground irrigation systems, the intention is to reclaim 8000 km^2 of desert land to host a population of 15 million (CAPMAS, 2006) and eventually increase the populated area in Egypt to 25%. The delta population is to be diverted to the existing desert cities Sadat City, Nubaraia Gedida, 10th of Ramadan, as well as the desert hinterland east of Bilbis. Existing new urban communities in the delta could host roughly 2/3 of the 10 million new inhabitants expected by 2020, while another 4 million can be accommodated in the northern delta and the coastal zone, which has some undeveloped areas (GOPP, 2008). Yet also here formal development activities might be preempted by self-building.

Looking for alternative expansion sites that are not on desert land, further capacities may be allocated in the market-driven vacation home developments along the northwestern coast where the revolution has left building skeletons and vacancies. These provide a potential yet untapped for development if adapted to sustain projected sea-level rise.

The government has tried with mixed success to encourage migration to newly irrigated land reclaimed from the desert, but apart from the shere effort to reclaim land from the desert "New Urban Communities" are not attracting the number of people expected (see Shawkat, 2013). Lacking modes of public transportation, lacking densities that would enable low-income jobs and services and the failure to supply affordable housing needed by the majority of the population may be seen as the main reasons for poor results in the residential sector. Although large scale public housing programs have been launched in the past decades, inefficient distribution, missing financing models and the lacking incorporation of retail and commercial uses in housing developments have failed to meet the needs of a large part of the population. As of yet, desert cities target the automotive middle and upper class. As long as fuel is subsidized, the network of highways will remain the primary mode of transportation, nonetheless it remains viable only for a small part of the population, a situation which will become even more pressing with currently implemented limitations on subsidized fuel. Public transportation, a key to successful resettlement, is not being developed sufficiently and can be considered a key impairment for the growth of new desert cities as (see Sims, 2009). The percentage of Egypt's population living in rural areas is estimated at around 57% (CIA, 2010). Around 30% of Egyptians are employed in agriculture and therefore dependent on irrigation systems (El Dhin, 2013). In the case of agricultural expansions into the desert, mechanized techniques such as piped irrigation systems for large-scale commercial farms are implemented. As capital-intensive, corporate agricultural enterprises they only demand for labor during harvest, making it a seasonal job that does not imply moving the family (see Sims, 2009).

In summary, any formal design strategy will have to provide customized solutions for the different landscape types and the neglected lower-income sector inhabitants, ideally building on the inherent dynamics of self-organization. This will demand for a rise in density and the provision of a job market and public services such as transportation for NUCAs. It will also need an integration of eco-engineering and landscape design. Currently, landscape planning and landscape architecture are not only not embedded in formal planning procedures, they do not exist. Any urban design relies on a strictly morphological approach. All water used for irrigation in the desert is lost. Landscape design as practiced today is called scenery arrangement (Tassamim Al Bim) which illustrates the lacking connection with the ecological urgencies at hand.

WATER SENSITIVE URBAN DESIGN (WSUD)

WSUD as a strategy for Egypt

Water Sensitive Urban Design (WSUD) is a land planning and engineering design approach that integrates the urban water cycle, including stormwater, groundwater and wastewater management, as well as water supply to minimise environmental degradation and to improve the aesthetic and recreational appeal (BMT WBM, 2009). It is reliant on a systemic approach and may offer a number of benefits for the vast urbanization and water scarcity Egypt is facing. Solutions may span from the informal to the formally planned desert communities for the middle and upper class that lack to accommodate those most in need and neglect the landscape conditions of the desert to fulfill the suburban dream of a lush green environment. WSUD may be considered relevant for Egypt as a country suffering from overall water scarcity and rising sea water levels, but also from domestic water consumption with an average of 200 liters / day twice as high as Germany (NWRC, 2007). It may not only provide a new landscape conception that includes functionalities such as an improvement of the microclimate and shade to make life in the desert and in highly dense urban environments in a hot and dry climate bearable. WSUD may provide strategies that address rising sea water levels, improve water quality and reduce water consumption. For new urban communities this could imply the inclusion of water recycling in the actual landscape design and a differentiation between landscape designs for different uses that demand for different water qualities (see Deister, 2013). For example, constructed wetlands that polish recycled water provide beautiful landscapes and improve the microclimate, but remain visual features, whereas areas that are used for playing or other uses and involve direct contact demand for a higher water quality implying the use of potable water or polished recycled water.

For both formal and informal settlements, grey water recycling urgently needs to be included in the design starting from the building scale. This could be developed via decentralized systems. Also compost toilets provide a viable way of saving water and producing soil. Further food could be grown locally and in dense urban areas rooftop gardening and green façade systems could be installed that also mitigate urban heat islands. As practiced by Schaduf Microfarms in Cairo, financed via microcredits, roof top gardens may not just provide food, but also an additional income for families.

WSUD could also be applied in those areas affected by sea level rise to handle excess water. This would demand for adaptation strategies on the building scale, restrictive zoning for the most vulnerable areas within districts and, if necessary, giving up land in combination with resettlement strategies. Methodologies from other deltas (e.g. UFM Dordrecht) could serve as frameworks that would of course demand an adaptation to the specific socio-economic, ecological and cultural conditions.

Already today water cleansing plants in the desert are irrigating adjoining forest plantations to produce biomass, wood, a rare building material in Egypt, as well as biofuel crops. Egypt produces over 6.3 billion m^3 of sewage water annually. 5.5 billion m^3 of this sewage water is sufficient to afforest over 650,000 hectares of desert land and to store over 25 million tons of CO_2 annually. Potentially, large-scale afforestation may also stimulate cloud formation that could result in urgently needed rainfall (El Kateb, Mosandl, 2012).

THE CURRENT STATE OF FORMAL PLANNING

Constraints facing integrated water resources management

According to El Dhin, 2013 there are several constraints facing the successful application of integrated water resources management in Egypt. Apart from the named population increase and social and economic factors, he considers the fragmentation of agricultural tenure, the free crop structure and water pollution as key hindrances, but also the legal framework. It is weakened by overlapping jurisdictions, weak penalties and fines related to water violations as well as a slow litigation process within a system that is too centralized and not accessible for the private sector to participate.

Strategic planning in Egypt

Since 2008 Egypt has adopted a multi-scalar strategic planning approach (Building Law 119 / 08) organized under the General Organization of Physical Planning at the Ministry of Housing in cooperation with UN Habitat (see UNHSP, 2013). It involves a new urban boundary "Haiez" for the city that allows planned urban expansion until the target year of 2027, an integrated urban development plan with the involvement of stakeholder groups, proposed land use, planning and building regulations for development areas within the new boundary, detailed feasibility studies and action plans for a group of priority projects that have been agreed upon by stakeholders, a delineation of informal areas in the city and preparation of detailed plans to develop these areas, proposes mechanisms for partnerships with the private sector, and an integrated data base using GIS (Khalifa, 2012). Strategic urban planning for cities in Egypt offers a framework capable of including WSUD as a mandatory part of any planning consideration. Unfortunately, so far strategic planning has failed to tackle the named challenges. Centralized structures and lacking budget reliability hinder true local empowerment, thus strategic planning fails to touch ground. Strategic planning was also set out as a tool to produce urgently needed data bases, also mandatory to include integrated water management and water sensitive urban design. This is hindered by missing local capacity and data base maintenance. In parallel the plans are non-responsive to change and often outdated by the time of implementation (Yousri, 2013).

Visionary proposals

Visionary proposals on a larger scale remain van guard. Egypt 712 is one such vision that evolved from the NGO Remal founded after the revolution. It proposes 12 new regions to be developed site specifically according to potential mainly green economies that could evolve. And of course western academia is interested in the Nile delta as an international case study for delta urbanism, bringing forward such projects as the "Nile Metropolitan Delta" design proposal developed by master students at TU Delft.

Design guidelines

A more pragmatic approach is chosen by the EU-funded MED-ENEC project. The recently published "Energy-Effciency Urban Planning Guidelines for the MENA Region" (Kotb et al, 2013) promote passive design strategies to reduce energy consumption and to produce not only comfortable indoor but also outdoor climates for new urban developments. Compacting and diversifying the urban layout in terms of functions and promoting pedestrian movement aims to provide alternative urban models to the currently car-reliant urban expansions in the desert. Already today black-outs occur on a daily basis as current energy consumption is exceeding production by around 12%. Passive design strategies such as building orientation, natural ventilation and shading are the most cost-effective ways to save energy, but need to be considered at the initial planning stage (Kotb, 2013).

Beyond the urgent need to become more energy-efficient, one of the key priorities is to reduce water consumption. One of the key threats not just to the Egyptian Delta, but all of Egypt is water scarcity and inefficient water use. Beyond the delta, land reclamation projects in the desert are thriving to be green instead of sand-coloured. Today, 2/3 of the drinking water in New Urban Communities is used for irrigation. Water sensitive urban design measures therefore need to be included in design strategies if the growing population is to be accommodated in the horizontal urban expansions on desert land. Much may be learned and adapted from the vernacular knowledge of the Bedouin tribes who have lived in the Eastern desert for centuries, but traditional knowledge is considered backward by a planning elite that has been educated in and still relies on modernist planning approaches. WSUD strategies need to be outlined in similar guidelines to those developed to promote energy-efficiency: By providing a hands-on approach that informs planners, architects and developers how to integrate WSUD in the initial planning stages, how to priorize measures, what ministries to involve to enable those changes and what economic models are demanded for implementation. The very pragmatic approach chosen in the recently published Energy-Efficiency guidelines is an exemplary alternative to the highly bureaucratic approach of current Egyptian planning. It makes transparent what formal institutions to involve and could easily be expanded to include water sensitive urban design measures.

AWARENESS BUILDING

The examples on how WSUD could mitigate pressure on the Nile Delta and beyond are ample. Yet, it will need awareness building and economic incentives to change the current water use towards a more sensitive approach. In other water scarce regions, such as California, municipalities are publically monitoring water consumption and resources online (see www.marinwater.org/300/Water-Watch). Awareness building is urgently needed in Egypt among all people. Specifically, the middle class needs to take a lead as domestic water consumption is higher and, of course, because they can. Environmental education remains key to raise awareness.

Of course, rural areas in Egypt, although urbanizing, differ from the country's urban realm in terms of poverty, fertility rates, and other social factors. Agriculture remains the key component (El Dhin, 2013). According to the UN Human development report 2011 an estimated 30-40% of Egyptians is illiterate. To create climate change awareness among the larger part of the people therefore demands a language capable of conveying qualitative and quantitative information in a graphic way. The Isotype Pictorial language was developed by the Austrian philosopher and economist Otto Neurath and the graphic artist Gerd Arntz and aimed to inform the proletariat about it's own situation. It evolved in the context of the Viennese Settler's movement after the first world war and eventually led to one of the most successful state housing programs in Europe. It relied not only on the development of libraries, museums and exhibitions, but also on the development of building cooperatives which then created a link to the formal planning sector (Redeker, Decaix, 2001). Reliant on political will, the pictorial language and its application in post-war Vienna shows many parallels to the Egyptian situation today and could provide a model for involving rural and informal communities.

The struggle of finding spatial solutions will rely on the success to improve and link formal planning with the majority of developments today that are self-generated. It will also need a systemic approach that incorporates small scale local initiatives to capitalize on the, as of yet, untapped potential of the informal sector. Therefore it is crucial to identify social situations, for example women gathering to wash dishes and clothes by the river and canals, as places to foster communication. Also culturally rooted typologies could be adapted to meet today's needs. The hybrid islamic typology of the Sabir, composed of a public drinking water fountain on the ground level with a library on the first floor was historically donated by wealthier families based on the Waqf tradition of charity that can still be found with the donation of drinking water fountains today. Yet, the combined educational facility has been lost. The relevance of this typology can not be underestimated as it addresses two such crucial issues as drinking water and education while being deeply rooted in islamic culture.

CONCLUDING

From an optimistic perspective, the speed of developments could enable a fast learning curve. Egypt is on the right path by aiming for a green economy. This change in direction will demand for a convinced people and a financial sector to invest accordingly, but also a much more serviceable public sector. WSUD as part of a larger strategy to face the urgencies at hand is reliant on innovation and therefore reliant on political will. The public sector today is not only notoriously underpaid and therefore venal, but also a beaurocratic hindrance to change. Beyond being severely affected by the political and social state of flux, Egypt is, as the urbanist Omar Nagati coined, in a "battle for a frame of references". Therefore, the inclusion of the public is key to generate change. This will be reliant on awareness building and incentives within the given spectrum of social and topographical extremes.

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