Experience of a Genuine Geodesign Act

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Abstract: In the course of our teaching routine and landscape architectural research efforts, we studied the Greater Cairo Area. Our academic project included ten days of fieldwork in Egypt and three days of Geodesign workshop activity. The results are embedded in the research project "Changing our Global Infrastructure: An International Geodesign Collaboration (IGC)". When the workshop group questioned and discussed the sober statistics, numbers, and predictions for Cairo's incredible growth – in 2050, the megacity will need to house about nineteen million more people than today – a particular momentum of design thinking began to unfurl. We succeeded in putting the limited concept of landscape architecture behind us and experienced a genuine Geodesign act.

Keywords: Geodesign, landscape urbanism, International Geodesign Collaboration (IGC), urbanization and informal development, mega city

1 Initial Position

We continue to include ourselves in that professional school of landscape architects who refer to their operations and results as landscape architecture. As a matter of course, we watched, *ab initio*, the abating debate over the term "landscape urbanism". And, to be sure, we witnessed, from the very beginning, the development of the concept of Geodesign. As one of the most plausible out of the many attempts to define what landscape architecture might be exactly, we bring, every so often, Hans Loidl and Stefan Bernards' version to our mind: "Unlike architectural spaces, landscape-architecture spaces are not covered over, they have no roof" (LOIDL & BERNARD 2014). We repeatedly worked through *The Landscape Urbanism Reader* (WALDHEIM 2012), but we did not identify a convincing definition of landscape urbanism, one we would promulgate without reservations. Notwithstanding, we claim to have understood the great potential the concept of landscape urbanism holds in principle, and to be able to identify the phenomenon of landscape urbanism, in the offing or in execution. And Wikipedia's omniscient exegesis makes sense to us: "Landscape urbanism is a theory of urban planning arguing that the best way to organize cities is through the design of the city's landscape, rather than the design of its buildings" (WIKIPEDIA 2019).

As the most perspicuous and sustainable definition of Geodesign, we regard Carl Steinitz' concise formulation, "Geodesign changes geography by design" (STEINITZ 2012). We tend to interpret Steinitz' use of the term "geography" as an intentional broadening of the concept of Earth's surface, with respect to the near-surface environment, termed Earth's "critical zone" (RICHTER & MOBLEY 2009). By furthermore bearing in mind Mike Flaxman's statement that Geodesign is a design and planning method which tightly couples the creation of a design proposal with impact simulations informed by geographic context (FLAXMAN 2010), we feel equipped with a robust framework that allows us, as landscape architects, to tackle large-sized assignments of a landscape urbanistic nature, by applying the methodological instruments of Geodesign. It was a fortunate coincidence that our plan to work with a group of

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Master of Landscape Architecture students from Leibniz University, Hanover, on the metropolitan area of Greater Cairo was invigorated by an invitation to participate in the project "Changing our Global Infrastructure: An International Geodesign Collaboration (IGC)". The IGC project delineation lies in the hands of the principal investigators Carl Steinitz (Harvard University Emeritus, and Honorary Professor at the Centre for Advanced Spatial Analysis, University College London), Brian Orland (Professor of Geodesign at the University of Georgia College of Environment & Design), and Thomas Fisher (Director of the Minnesota Design Center, and Dayton Hudson Chair in Urban Design, University of Minnesota College of Design). Teams of fifty-six universities from twenty-nine countries participated in the first year of the Geodesign Collaboration. The collective challenge reads as follows: "How do we organize and conduct the very beginning and strategic stages of designing for longer-term changes in large, multi-system, multi-client and contentious contexts?" (STEINITZ, ORLAND & FISHER 2018). The IGC research project is ongoing, and we are on no account qualified to elucidate or commentate the IGC undertaking as such – we merely set out to reflect on a discrete Geodesign workshop related to the prospective urban growth of Cairo, Egypt.

2 Cairo – Mother of the World

Um al-dunya, an Arabic hyperbole, meaning 'Mother of the World' and glorifying ancient Cairo and Egypt, is the bequeathed nickname of the city that antedates almost every other human conglomerate larger than a village, and, as an imperial capital, antedates them all (STEWART 1969).

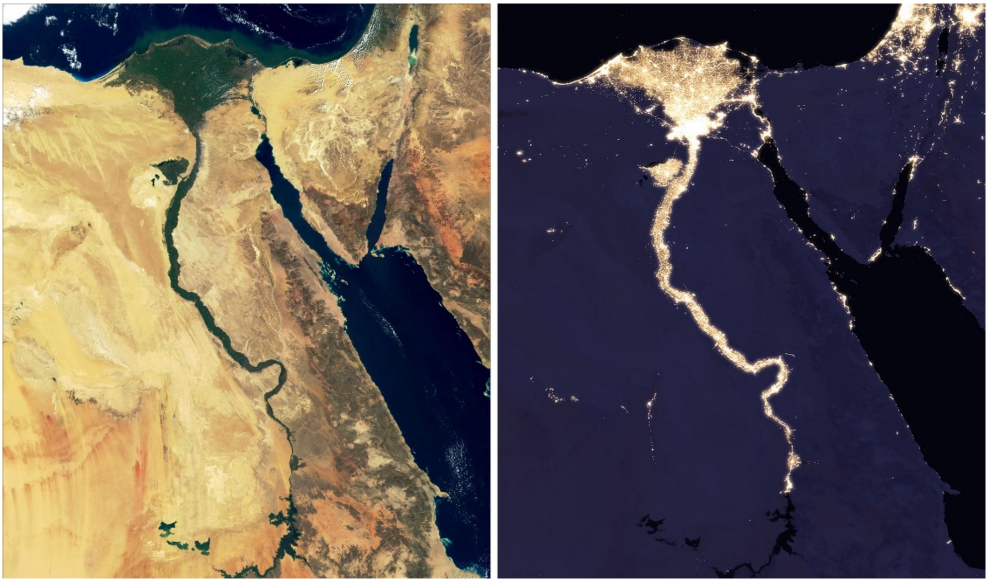

Fig. 1: Left: Farming is possible in Egypt almost exclusively where the river Nile allows irrigation (visible as green [dark] texture in daylight). Right: The night image shows that scarce arable land almost exclusively forms the settlement area for a nation of more than 100 million people. (left: Modis/Modland/Descloitres 2000/right: NASA, BLACK MARBLE 2017)

Cairo's present-day condition and statistics are alarming. This is no surprise in a country like Egypt that represents a geographic, demographic, and climatic extreme. 95% of its land area is barren desert. Egypt's primary and almost sole water source is the Nile, hydrologically an allochthonous river (MAINGUET 1999). The Nile's different sources are located in countries with humid climates, while it flows through arid Egypt without tributary waters, before discharging into the Mediterranean Sea. The Nile serves about one hundred million Egyptians as their absolute lifeline. The river is the backbone of Egypt's industrial and agricultural sector, and, at the same time, the primary source of drinking water for the entire population. Almost exclusively where the mighty river renders irrigation farming possible, in only 3.8% of the country's territory, Egypt's population hitherto built, and continues to build, their settlements – rural, suburban, and urban (Figure 1). The yearly increase in the country's population ranges at just under two per cent, which makes the scarce and vital arable land increasingly contested. The annual growth rate of the urban population is estimated at 2.2%, continuing until 2050 (OSMAN et al. 2016).

Cairo is the capital of Egypt, and its metropolitan area (Greater Cairo), with more than twenty million people, forms the largest urban settlement in Africa, the Middle East, and the Arab world. The city and its urban agglomeration have been widely built on fertile arable land – scarce soil that is the only basis for domestic food production, and which is absolutely essential for sustaining the rapidly growing population. Egyptian governmental planners see this dilemma and continue to push for implementing large housing projects in the desert, beyond the agricultural zone. Nevertheless, the majority of housing in Egypt continues to be built informally, and illegally, to an estimated share of over seventy per cent. This illegal housing construction business entirely takes place on farmland, and, due to the population growth, at an accelerating tempo (Figure 2). The problem of unsustainable farmland consumption has been diagnosed by state officials and has long been banned by law – starting with Law No. 53 of 1966 on Agriculture, amended by Law No. 116 of 1983 – though without having yielded any significant effect so far (MASRI & ABDELATY 2018). Histrionic threats of punishment and scores of decrees for the best are thwarted by deep-rooted and pervasive corruption.

Fig. 2: Left: Field after field of fertile arable land gets consumed by the informal private building sector. Right: The formal private building sector unfurls on desert land, establishing vast areas of upmarket low-density housing. (Photos: REKITTKE 2018)

Having said that, most Cairenes would simply be homeless without the productive informal housing market. The illegal houses this shadow industry makes available are not feeble shacks or fragile structures, but massive multi-story building blocks of sturdy quality, built in the same brick-and-concrete technique applied in the formal housing market. The problem is that continuing to build on farmland is like biting the hand that feeds. This predicament is aggravated by the fact that most of the bricks are made of fertile, non-replenishable Nile mud, obtained by means of detrimental and illegal topsoil harvesting (ORTLEPP et al. 2015). Cairo represents a city, and Egypt a nation, that cannot survive without its original cultural landscape. That is why landscape urbanism stands to reason as a serious alternative approach to the current Egyptian building practice. As a consequence of the portrayed exigency, our ongoing research and design efforts for Cairo's inevitable growth are subject to a strict avoidance of any further farmland conversion. Such an uncompromising target is not an ingenuous brainchild, but would, in contrast to common current infringement, abide by the existent Egyptian law. A moratorium on further farmland transformation implies an unconditional shift towards the urbanization of desert land (Figure 2). This is not an unproblematic move in a country that proclaims an actual water shortage of over 13 billion cubic meters per year. The shortage is compensated for with drainage reuse, which is likewise not unproblematic, and is expected to continuously increase (OMAR & MOUSSA 2016). We categorized the Greater Cairo quandary as a quasi-ideal baseline for a Geodesign workshop on approaches and designs "[…] for longer-term changes in large, multi-system, multi-client and contentious contexts […]" (STEINITZ, ORLAND & FISHER 2018).

3 The Geodesign Workshop

Before we conducted the workshop, we travelled to Cairo for a fieldwork expedition of ten days. During the stay we navigated the megacity for hundreds of miles via a minibus that served as a rolling office and an essential cloak of invisibility for our optical equipment. Egypt was in a state of emergency during our visit, and it is generally strictly forbidden to photograph police as well as military personnel and facilities – an exacting condition in view of their ubiquity. Although we consider fieldwork to be mandatory for all our academic design research projects (REKITTKE 2015), not all workshop participants were able to attend the field trip, primarily due to visa issues.

The subsequent Geodesign workshop took three working days. We divided the workshop into two stages. In an initial two-day workshop with all participants – team "Heat" – we worked out the main structure and baselines of our proposal (November 2018). In a final one-day workshop with a small number of selected participants – team "Final" – we produced the conclusive output (January 2019). We availed ourselves of the opportunity to conduct the first workshop stage together with Hrishikesh Ballal, founder and managing director of the Geodesign Hub platform (geodesignhub.com), who also contributes to technical support in the IGC project. The web based Geodesign Hub software enables teams to create and share concepts, to design collaboratively, and to receive change assessments instantly. Participants of the Cairo workshop exclusively operated with the Geodesign Hub tools. Due to the IGC guidelines (STEINITZ, ORLAND & FISHER 2018), the eligible size options of the study area, the systems (e. g., agriculture, low-density housing (LDH), high-density housing (HDH), blue infrastructure, and so on), and the color codes of the systems were predefined. Further discussion on the general procedures of a Geodesign workshop with "little time and small data" is unnecessary. It has never been described more vividly than in Carl Steinitz' DLA paper on his post-tsunami commitment in Japan (STEINITZ 2014).

In the Cairo workshop, we experienced something that swayed us, inducing a change of our comprehension of Geodesign. We consider this experience, though of unspectacular nature, relevant for a paper on digital landscape architecture. Having participated in a couple of Geodesign workshops before, we observed that the term and respective methodology of Geodesign still seems to be a controversial subject, in the guild of landscape architects. We are positive about having put the limited concept of landscape architecture behind us, and having experienced a genuine Geodesign act, during the Cairo workshop. It was not triggered by a creative epiphany or the Geodesign craft itself – the thoughtful drawing of polygons and lines of specific bearing – but by an artless excel sheet (Figure 3). The sheet came into play when the workshop coordinator (H. Ballal), instead of getting started by introducing and exploring the precalculated initial evaluations (evaluation maps) and restrictions, began to discuss and determine, together with the group, some of the key figures that the Geodesign Hub platform would run in the background, during the subsequent real-time evaluation of proposed measures (designs). When the group began to question and swiftly recheck the statistics investigated so far, documented numbers and related predictions for Cairo's future growth and development, a particular momentum of design thinking began to unfurl. Everyone became a bit unsettled and unsure about the reliability of their actual knowledge of the city, but through an iterative fact checking and finding process – a very focused collective endeavor that took about 1.5 hours – the team was able to work out the kinks in some ambiguous but important numbers and assumptions. In this *ad hoc* effort of swarm intelligence, the group scrutinized key figures, broke down essential information, searched for proofs and made calculations in parallel, quickly exchanged arguments followed by fact-checking again, and added a good dose of common sense, in order to complement the big picture of an elusive case and place.

Hong Kong	6.400											
Monaco	18.000											
Berlin	4.000											
Giza	5.600											
							2035 population	2035 usage		2035		
		Low Density Housing	LDH	2.000	people / sq. km		104.063	52	sq.km	5.200	hectares	
		High Density Housing	HDH	26000	people / sq. km		5.099.075	196	sq.km	19.600	hectares	
							2050 population			2050		
							135.937	68	sq. km	6.800	hectares	
							6.660.925	256	sq. km	25.600	hectares	
			BAU									
			Total study area		160000	ha						
			Housing requirements		2035	2050	2035 population	2050 population				
			LDH		5.200	6.800	104.063	135.937				
			HDH		19.600	25.600	5.099.075	6.660.925				
			AG land requirements		17010	22200						
					2035	2050						
				Water consumption for LDH	56.818.267	74.221.733						
				Water Consumption for HDH	511.364.403	667.995.597						
				Water Consumption for AG	38.816.820	50.204.000						

Fig. 3: Excerpt of an excel sheet that the Geodesign workshop group filled out and scrutinized collectively. Sober digits that triggered a deeper understanding of what Geodesign stands for.

When we returned from fieldwork in Egypt and commenced our studio work by preparing the Geodesign workshop, all of us were a bit at a loss, and we had a rather vague notion of what the next steps in our design process should be. It was first and foremost those objective digits we had filled into the Geodesign Hub excel sheet that suddenly and perceptibly triggered our deeper understanding of the site, the situation, and the related appropriate design assignment. It was new to us to be enlightened and inspired by naked numbers and mirthless spreadsheets.

Greater Cairo currently houses about 22 million people. The self-defined size of our core study area was 160,000 hectares, marked as a square of 40 by 40 kilometers (Figure 4). Within this square we put the population at 13 million people. An average rate of population growth of 2% will result in an additional number of over 5.2 million people by 2035, and over 6.7 million people by 2050 – considering the 40 by 40 square kilometers alone. Cairo in its entirety will have to accommodate about 9 million more people by 2035, and about 19 million more people by 2050. Back to our 40 by 40 square kilometers: for the increased population in 2035, it will need 5,200 additional hectares of building area for low-density housing, and 19,600 additional hectares for high-density housing. By 2050, these numbers will rise to 6,800 hectares for low-density housing, and 25,600 hectares for high-density housing. To feed the increased population of the 40 by 40 square kilometers, 17,010 additional hectares of agricultural land will be needed by 2035, accumulating to 22,200 hectare by 2050. In Egypt, agriculture is not possible without irrigation, so the demand for additional watering of the expanded farmland will come to roughly 39 million cubic meters by 2035, and, accordingly, some 50 million cubic meters by 2050. People need drinking water as well, not only in Egypt. This means an additional demand for around 57 million cubic meters of potable water for the calculated 104,063 additional inhabitants of low-density housing, and an additional demand for around 511 million cubic meters of potable water for the calculated 5.09 million additional inhabitants of high-density housing by 2035. By 2050 this will add up to an additional demand for about 74 million cubic meters of potable water for the calculated 135,937 additional inhabitants of low-density housing, and an additional demand for roughly 668 million cubic meters of potable water for the calculated 6.66 million additional inhabitants of high-density housing. For the Geodesign workshop, and based upon what we experienced in the field, we presumed that only 2% of future Cairenes (in Greater Cairo) will live in low-density housing. For low-density housing, we stipulated a minimum of 2,000 people per square kilometer, which is on par with the density of some housing areas of Abu Dhabi (featuring an average density of 1550p./sq.km), and a maximum of 4,300 inhabitants per square kilometer. We presume that 98% of future Cairenes will live in high-density housing, for which we stipulated a number of 26,000 people per square kilometer. This ranges higher than the average density of Monaco (18,000p./sq.km), and approximately on a level playing field with central Mumbai (26,400p./sq.km) and central Hong Kong (25,900p./sq.km). The underlying statistics fluctuate, but constitute sufficiently robust reference points for our purposes (STATISTA.COM 2018).

The present water shortage in Egypt of over 13 billion cubic meters per year has already been mentioned above (OMAR & MOUSSA 2016). This problem also caught our eye during fieldwork. An illegal building boom continues to proliferate on agricultural land, while a legal building boom currently takes place in the desert around Cairo, manifesting itself in form of vast, gated, low-density communities for those who can afford to escape the packed city and can finance one or more cars. A forest of gargantuan signboards advertises pools, gardens, and an upscale lifestyle in the desert, but it remains inscrutable where the necessary water will come from. Road tankers – we saw them stocking up on water at the banks of the Nile – help to create selective, strategically placed illusions in the desert, convincing property buyers into signing purchase contracts before their object is built. As a part of our workshop, we conducted a brief financial analysis around the sought-after low-density housing projects in the desert. In our what-if analysis, this type of housing is targeted towards 2% of the Egyptian population. Assuming that 350,000 people are housed in 90,000 dwellings with a floor area coverage of 0.6 per dwelling (see Figure 2), we reach a density of around 4,300 inhabitants per square kilometer. As a comparison, the average population density of Berlin is 4,000 inhabitants per square kilometer (STATISTA.COM 2018). This type of housing is advertised extensively in Cairo. Assuming a 5 % inflation rate, and that all 90,000 units will be sold on mortgages, and calculating the net present value and discounted cash flow analysis over 30 years, our analysis showed that this scheme is profitable only if the cost of capital is around 1.5 – 2.5 %. This makes it a very risky investment, fully dependent on the current low interest rates. Thus, although low density housing is targeted towards the "upwardly mobile" in the city, such investment is very leveraged and risky. The current building boom is intoxicating, though it does not shake our certainty that "pool-and-garden homes" are the wrong building type in a bone-dry desert environment.

4 Outcome: Geodesign *per se*

In light of the overwhelming challenges of Cairo's future, we limited our design assignment to essentials. The studio and workshop participants had to draft the locations for the millions to come and to be accommodated in the future. Building on farmland is imprudent and unsustainable; therefore, not a single additional square meter of agricultural land could be at the designer's disposal. On the contrary, the existent area under crops has to be expanded significantly, implying the provision of the necessary water quantity.

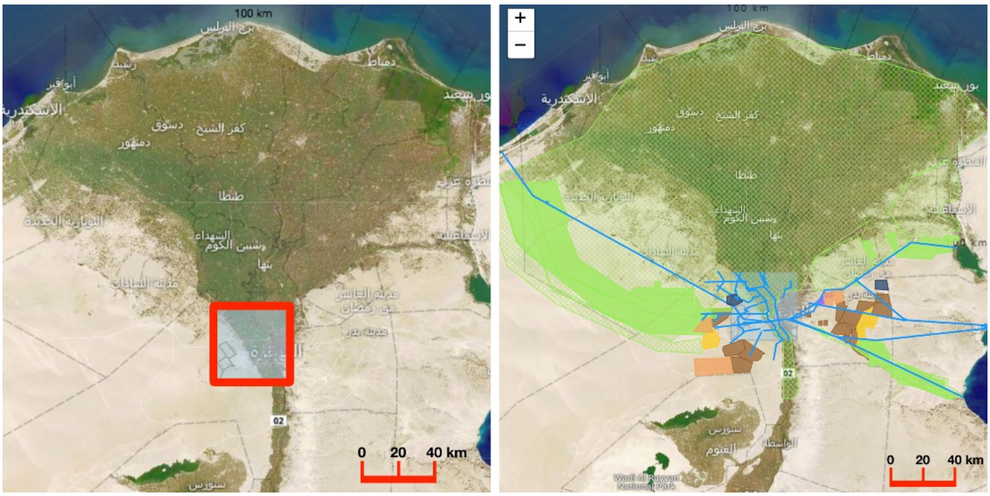

Fig. 4: Left: The red square marks the focused 40 km by 40 km investigation area for the IGC Geodesign workshop. Right: Impression of a Geodesign outcome (in Geodesign-Hub), showing that the proposed measures feature geographic dimensions.

We invited our students to tackle the task of drawing up the maps of a place that will have roughly 20 million more inhabitants in 2050 than it does now. Future Cairo will be a city of unprecedented size and egregious thirst. Popular design gimmicks do not seem to be appropriate; autonomous transport pods and flying vehicles might appear slightly far-fetched and beside the point. The probability that Cairo will top the most-livable-city charts, is limited, and it must be suspected that the Pyramids will outshine Cairo's modern comforts forever. Survival is the order of the day for those (designers) who want to render a sustainable Cairo possible. Very large and bold lines have to be drawn, standing, for instance, for new long pipelines that must carry billions of cubic meters of fresh water provided by new desalination plants at the Mediterranean and the Red Sea into the depth of the Nile delta and the adjacent desert. Powerful public mass transport systems must handle masses of future commuters. Hundreds of thousands of hectares of settlement area must be projected and built. Any existent crop area must be protected, soil harvesting must be stopped, and hundreds of thousands of hectares of new agricultural land must be brought into being. Disciplinary specialists can do their best and apply their tools and methods – landscape architecture, for example – in the course of the problem-solving process. However, to cope with the totality of the mammoth task of drafting new space for future Cairo, a much more inclusive design approach must be practiced, one related to the geography of the entire Nile delta – the natural asset which rendered Cairo possible. We are convinced that such task cannot be performed by landscape design alone. It has to be accomplished by Geodesign *per se*.

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