Fossil Water, 'Renewables Capitalism': Land, Groundwater, and Solar Power in Siwa Oasis, Egypt

By Youssef Ramez Boktor & Amr Khairy

Written by Youssef Ramez Boktor & Amr Khairy

Reviewed by Mads Barbesgaard & Hamza Hamouchene

Copy-edited by Leo Zeilig

Proofread by

Graphic design by Bas Coenegracht

The authors acknowledge with gratitude a grant from TNI for conducting the research for this study, and the support they received through CEDEJ Doctoral Fellowship (for Youssef Ramez Boktor) and CEDEJ-Ifao Postdoctoral Fellowship (for Amr Khairy).

The authors thank Badr Al-Rifaay, Rasmus Larsen, and Christian Suhr for their generosity in sharing and allowing the use of some photographs in this study.

Published by Transnational Institute (TNI), June 2025.

Table of contents

1 Introduction

Siwa oasis is one of the remotest agrarian settlements in Egypt, with 300 kilometres of barren desert separating it from the closest town. A long highway connects the town and a small cluster of adjacent satellite villages and hamlets of roughly 34,000 inhabitants, to Marsa Matrouh on

the North Coast.[1] However, the road does not extend with any substantial traffic anywhere else from this agrarian community in the middle of the arid Sahara, giving Siwa oasis the aura of a final destination - a place that feels like you are at the 'ends of the world' on this warming globe.

A few kilometres south of Siwa is one of many farms that sprung up over the last five decades around the oasis and introduced an increasingly intensified farming-for-export model. It is in the range of 200-300 acres (80-120 hectares). It grows dates, olives, and clover (animal fodder), with irrigation from the abundant groundwater (the great Nubian Aquifer System, NAS), that an impressive futuristic-looking solar power station pumps up from over a hundred meters underground. The farm extends on uneven terrain, with a huge dune at one of its ends, 30 meters high, away from the road that goes farther south into the northern tips of the Great Sand Sea. At that end, immediately at the foot of the dune, is a large peaceful looking pool. The pool is new, formed over the last few years and expanding, claiming more land, fed by the runoff irrigation water from the farm, that trickles ceaselessly towards that small topographical depression. Recently, the pool expanded to the extent that it leaked into the accommodation of the dozen labourers who work on the farm. They woke one day to find water surrounding their beds. Its salty water ate away at many of the palm trees and destroyed the clover field on the farm. The more water in the pool, the more green algae accumulates on the bottom, making it harder for the water to penetrate the sand and runoff underground. This process is drowning the solar-powered farm.

This article seeks to explore and understand a scenario unfolding across the oasis that the situation of this farm echoes on a micro scale. Siwa – home to a thriving indigenous agrarian population for hundreds of years, and home also to unique plant species not found elsewhere (local varieties of olives, dates, grapes, pomegranates, berries, and wild desert flora and fauna) – is facing the imminent threat of being drowned under the impact of the ever-expanding lakes at its centre, that continue to grow due to increasing quantities of runoff irrigation water, coming from the new farms on reclaimed desert land surrounding the oasis, powered by Photo-voltaic Cells (PVCs).

Runoff irrigation water is drowning Siwa while, historically, groundwater gave home to an agrarian community in the middle of the Sahara. The water lies at a low depression that brings it closer to the extensive NAS groundwater, and for millennia this water circulated by natural pressure upwards and sustained fertile land. The new reclaimed desert land on surrounding higher ground is currently using solar power to pump NAS groundwater, but the extra irrigation unabsorbed by the crops finds its way through gravity to the lakes close to the town's centre and is gradually expanding.

The green technology of PVCs is powering an uneven boom in reclaiming new lands and water from the oasis. Yet this is happening while Siwan farmers are finding it increasingly challenging to access both water and land. Because of the growing dominance of the intensified export-oriented farming model in Siwa over the last five decades (accelerated further since the early 2000s), which focused on cultivating only a few varieties of palm trees and imported olive trees, several local variations of both palm and olive trees are facing extinction.

The agribusiness model of intensified mono-cropping for export is unfolding across the reclaimed uplands and replacing Siwan organic traditional farming knowledge with farming practices that depend on chemical fertilisers and pesticides. As part of these dramatic changes in farming practices, small Siwan farmers are losing their relative economic independence (growing part of their food and selling dates and olives grown on their land) as their small pieces of land deteriorate in quality, and accordingly, they become more dependent economically on the fast-expanding agribusiness that is increasingly dominating land around them, and the precarious labour market on these new more extensive and capital-intensive farms. PVCs suck the groundwater from under the feet of Siwan farmers, making expensive further investment in PVCs on their farms necessary to keep drawing even more water for irrigation that once flowed naturally without the need for investments in machine-generated power. As a consequence, their economic model of farming is threatened as developments have raised water salinity and accordingly decreases olives and dates productivity.

In this article, we ask how Siwa ended up in a situation where renewable energy accelerates socioecological collapse, in contradiction to its often-assumed sustainable role in a post-fossil fuels future. Section two lays the ground by presenting the bio-geophysical knowledge produced on Siwa's ecological crisis, where the delicate regime of using NAS's non-renewable groundwater in irrigation – within limits – has been disrupted and radically changed over the last 50 years. This has led to a situation of 'displacement in place', where economic, social, and ecological change is pulling the former somewhat stable order of the economy, society, and nature in Siwa from under the feet of its inhabitants, turning small farmers into landless hired labourers.

To simplify this intricate history, we divide the story (in section three) into three *waves,* across which capitalism in agricultural practices intensifies extractivism of labour and nature, while the global market dynamics penetrate further into Siwa, using solar power to extract wealth from monocrops and exploit the majority of Siwans in the process. In section four, we analyse the dynamics through which PVCs-powered water pumps are leading to mounting risks of the drowning of Siwa, while enabling the intensification of capitalist agricultural practices of commodification and redistribution of land to medium, large, and mega investors.

At the outset, we summarise our assumptions on what capitalism is, and on how it is becoming the dominant mode of production in Siwa. *Capital* describes determinants of 'the creation of value by the consumption of labor power', where the latter exists as a purchasable commodity. *Capitalism* is a descriptor of capital: a 'concrete social formation' in which capital assumes all matter to the value-form.[2] In simpler terms, capital is the generalised production of the commodity for its exchange value, through the worker selling their labour power as a commodity.[3] In relation to capital, Capitalism is "the rule of capital" over labour and nature.[4]

How and when capitalism came to dominate Siwa is a question we do not offer an answer to (even while we suspect that it is a process in the making), though this article contributes to its answer. How? We trace the trajectory of the agrarian means of production over the last 40-50 years, particularly the history of groundwater extraction technologies, whose development makes it possible to intensify the production from more land around the oasis. With this agenda, investigating the recent history of agrarian technology in Siwa is a useful means to examine the accelerating extension of capitalist agriculture in the oasis, because in combination with this history of developments in groundwater extraction technologies in Siwa, we see how agribusiness - as a form of 'the generalized production of the commodity: capitalism' (since agribusiness comes to intensify mono-cropping for outside markets, including export markets) - is increasingly dominating Siwa and introducing intensified forms of exploitation of labour and nature. This means that we are not interested in the trajectories of the transition to capitalism. Instead of stumbling across the article in defining what is capitalist and what is not in this process we describe, we assume that what is happening in Siwa -the gradual rise of the rule of capital - is a 'complex range of lived relations and institutional permutations that variously combine different aspects of the whole in novel, dynamic and unpredictable ways.'[5]

Analysing the complex ways through which water extraction technologies developed in Siwa (culminating in solar power) shows certain aspects through which Siwa and its people are impacted by evolving capitalist agriculture (which we equate with 'agribusiness'). This process is depriving the majority of Siwans from their water (managed as commons) and rendering their means of production obsolete, since it is increasingly becoming essential for all farmers to invest capital to access groundwater for

irrigation. This means tying their access to water and land to intensive capital investment and gradually rendering their traditional farming model impossible. It includes depriving them of their cultural tools of production – traditional farming knowledges and practices – in addition to depriving them of their native plant species and local seed varieties which have been helping Siwans to survive for centuries. Beside turning some farmers into landless agricultural labourers, capitalism in Siwa – powered by green technologies since the mid-2010s to the present – is sourcing wealth from the non-renewable groundwater and leading to the flooding of the heart of the oasis, destroying human and non-human nature.

1.1 Definitions and Methodology

We acknowledge that peasant differentiation and the dynamics of class formation among Siwan farmers across this ongoing process of potentially disastrous transformation is a crucial inquiry. We acknowledge that some of the Siwan farmers are benefiting from these unfolding transformations while the great majority are losing out.[6] However, our inquiry is mainly into the relation between the rise of solar power in combination with the rise of agribusiness in Siwa, and the disastrous ecological consequences of this process.

Although we are not studying class formation in Siwa, we need to state our assumptions on peasant classes in 'old' Siwan lands, and landowners in the reclaimed desert uplands, because it is important for our understanding of how Siwa's ecological crisis is unfolding socially. We use the terms old land and lowlands interchangeably to describe pieces of land that had been historically irrigated through self-flowing co-managed wells closer to Siwa's town centre and the geological depression that forms the historical oasis (generally known for irrigation purposes as *aradi al-ghamr* or *flood irrigation lands*). These lands were historically owned and inherited through families in the local Siwan community and are still largely associated with the local farmers. Uplands are newly reclaimed desert lands surrounding Siwa (*aradi istislah,* or reclaimed lands), in general owned by persons and companies who and that came to Siwa since the late 1970s, and this process of reclaiming uplands accelerated over the last two decades. Those new owners buy claims on parcels of land in the uplands from local tribal owners, then at a later stage after they start cultivating the land they can apply for governmental deeds and pay fees, in a process known across Egypt as the legalisation of titles by occupancy, or in Arabic: *Taqnin aradi wad' yad*.[7] This is the process through which several investors we talked to acquired their land, but the government also sells parcels of land farther outside Siwa through a formal process, which accelerated over the last few years. Since 2014, *El-Reef El-Masry* (The Egyptian Countryside Development Company, a governmental entity that coordinates the process between the Ministries of Housing and Agriculture and Irrigation) handles the selling of desert reclamation lands, including to the east of Siwa, where the minimum purchasable unit is 1,000 acres (400 hectares) that no more than 23 investors can apply to buy collectively.[8]

Concerning lowlands, small farmers is a term we use to describe peasants with landholdings below two acres (0.8 hectares). Medium farmers are landholders of 2-5 acres (0.8-2 hectares), and big farmers are those who own more than five acres (2 hectares). In the uplands, we mention the two categories of investors and companies. Small investors or 'investors' reclaim below 50 acres (20 hectares), while big investors and companies reclaim over 50 acres (up to thousands of acres). The categorisation of small farmers in lowlands is guided by the Egyptian Ministry of Agriculture's data on land holdings across the country (where the smallest landholding category is "under two acres" (under 0.8 hectares), which constitutes 35% of all agricultural land of Egypt).[9] But more importantly, it is based on how we define small farmers in Siwa: landowners who cultivate land that is not big and/or productive enough to sustain their and their families reproduction, so they do other agrarian and non-agrarian work: owners of land, and labourers in rural and non-rural sectors (farming for others and working part-time in Siwa's transportation and tourism sectors for example).

One of our interlocutors for example inherited half an acre, an old *genina* (orchard) in the middle of the historical oasis with a few palm trees and olive trees, and where he grows vegetables for family consumption. He takes a regular day job as a labourer on 40 acres (16 hectares) of reclaimed land in the uplands where he spends six hours of his day six days a week, and during olive oil season he buys oil from friends and sells it to retailers. Another small farmer owns a small share in an acre in the lowlands and one acre in the reclaimed uplands, but he has to work a

Lowland farm (left) and upland farm (right) in Siwa. April 2024 © Authors

few days each week as maintenance technician for local eco-lodges to supplement his income.

In the medium category - which we define on the same criteria: if the landholding can independently sustain a farmer and his family - an interlocutor owns four acres in the lowlands and one acre in the uplands, and as such does not need to work for others or take a second job. It is worth noting that fractions of an acre in old farms is usual in Siwa to the extent that it is very common for people who do not necessarily work as farmers (including women) to own two to five palm trees (and the land between them) and pass them on as inheritance. We have seen ownership documents of a one acre orchard (0.4 hectare) in the lowlands owned by dozens of cousins, passed on from one grandfather. Only a few of the owners are actively farming the orchard (which has palm trees only) and shares in kind or in cash are passed on to the owners of the smaller plots.

Finally, to further elucidate the categories of small and medium farmers for the purposes of this article, we turn to nuances in the concept of 'petty commodity producers' (or PCP). Small and medium farmers in the old/lowlands in Siwa would fit into Henry Bernstein's category of 'petty commodity producers', as less and more successful (or economically stable) PCPs based on landholding size. Bernstein defines the term as those 'who have to produce their subsistence through integration into wider social divisions of labour and markets',[10] but those producers are subject to class differentiation,[11] and medium farmers (those we define here as cultivating 2-5 acres) include 'relatively stable petty commodity producers',[12] in the sense that they are not compelled to labour for others, and are instead integrated into wider social divisions of labour and markets through the production of their land and the surplus it provides.

The marker of 50 acres (20 hectares) in the uplands is based on a simple calculation: the smallest irrigation infrastructure that could be bought for accessing the NAS system needs motive power that can be also used to distribute irrigation water across 30-50 acres (12-20 hectares) horizontally. Since reclamation uplands are cheap in proportion to the irrigation infrastructure and the required power, a minimum unit of 50 acres (20 hectares) seems to be a reasonable marker of small investors. Across the uplands which we visited the smallest possible investors or farmers moving to uplands from elsewhere in Egypt tended to follow the scenario of individually or collectively buying and cultivating 50 acres or less. Owners of over 50 acres in the uplands are individual investors and companies with bigger capital.

This is a very simplified categorisation, since there is also the grey area where some Siwans bought 1 to 5 acres (0.4-2 hectares) in the uplands, but immediately adjacent to flood-irrigated lands towards the centre of the oasis, and as such they relied for long on self-flowing groundwater irrigation (availability of self-flowing water made it feasible for them to cultivate those small plots in the first place). Also in the 1990s, a large group of small and medium farmers from Damietta (in the Nile Delta) bought smaller than 50 acres (than 20 hectares) plots of land in Abu-Shruf, a village outside Siwa. There are also some upland farms in the range of 10-20 acres (4-8 hectares) that were reclaimed more than a decade ago by investors from Cairo and other places across Egypt (and which are closer to the lowlands) and now have fully-grown palm trees, so if resold in the near future their new owners - who would be thus buying older and highly productive land - would not qualify anymore as small investors. So, in summary, there are many exceptions to this categorisation, but it is clear enough that small investors do not correspond to

small farmers in the lowlands, instead they more closely fit medium farmers in the lowlands.

The purpose from this discussion is to make it clearer to the reader what we mean by small farmers, investors, and companies, in this article, because of the centrality of the questions of property (of land and production technology) and labour. Meanwhile, we refer to 'Siwans' and 'local farmers' as a unified category to indicate all Siwan farmers of all classes with lands in the lowlands, in some contexts below, often opposed to the ecological problem of rising groundwater levels and waterlogging. It is a problem that will likely drown all lowlands equally, both small and big farmers, but what the latter can do to mitigate and adapt is another question we do not pursue in this study.

Another reason for referring to local farmers as 'Siwans' is because they form a distinctive ethnic group who speaks a different language (a local dialect of Amazighi), and where language is still a strong marker of group identity.[13] We also assume that all 'farmers' are males. We did not see women working on the land in Siwa, either as farmers with landholdings or landless peasants, nor have we heard interlocutors talk of exceptions to the broadly known fact that farming in Siwa is dominated by men, landholders and labourers, even while women inherit and own land. Moreover, nothing in the historical sources we consulted indicated that women worked in farming across the last two centuries. Though women, in all likelihood, are handling rural labour tasks in the context of the household, most probably those related to the processing of dates and olives, and other rural household activities.

Finally, as Henry Bernstein explains, we assume that small farmers are not subsistence cultivators exclusively or primarily those who live an ideal life of self-sufficiency: they are 'integrated in capitalist commodity relations, they are subject to the dynamics and compulsions of commodification, which are internalized in their relations and practices.'[14] This can be seen from our criterion for defining small farmers (as peasants who do work beside cultivating their own land). We also understand that medium and big farmers are integrated in fundamentally *different* ways in capitalist commodity relations, as employers of labourers, traders, land speculators, etcetera. If there are any shadows of 'romanticising the past' in this article, this is because in Siwa's case, *small is beautiful, and big is ugly* (!) since going big over the last five decades has led the oasis and its rural community to the precipice of an existential ecological crisis. The article explains this in full.

For this investigation, we used the following methods. We surveyed the scholarship produced recently on the groundwater aquifer system that feeds Siwa, and the geology and hydrology of the oasis. We conducted desktop research on relevant socioeconomic changes in Siwa's recent history. But before that we have been visiting the oasis frequently over the last decade, and increasingly so towards the last four years. Any uncited information we present below is first-hand knowledge from this extensive and prolonged period of fieldwork. The information cited as gleaned from interviews is from the following: two group discussions with seven small farmers and landless agrarian labourers, two interviews with solar power experts, and three separate interviews with Siwans working in tourism and agriculture. The interviews were conducted in April 2024, but we have also been heavily invested in seeing and thinking about the change in the oasis witnessed over the last few years, which includes talking to (medium and small) farmers, technicians, and investors over the years. We did not hold interviews with big investors and companies. Our interlocutors remain anonymous.

2 Ground and Underground: The Parameters of an Imminent Socio-Ecological Disaster

Drinking and irrigation water that allowed the formation of an agrarian settlement at Siwa since at least Ancient Egypt comes from the Nubian Aquifer System (NAS). NAS is the largest fossil water aquifer in the world. It extends under Egypt, Sudan, Chad, and Libya. It is 1,600 km wide on north-south and east-west diagonals, covering an area of over 2.6 million km square;[15] the water is high quality and drinkable. Rough estimates show that NAS holds around 150,000 billion cubic metres of water that are accessed to varying degrees across the four countries.[16] Across the Pleistocene (two and a half million to 11,000 years ago) it had been recharged repeatedly by rainfall, but since the last Ice Age (11,000 years ago) recharging became negligible to non-existent, 'effectively zero.'[17] As a consequences it became a non-renewable fossil water reserve beneath the hyper-arid eastern zone of the great Sahara of North Africa. NAS is the lifeline of Siwa.

The oasis, situated in a depression of 0-17 metres below sea level, is one of many naturally formed oases across Egypt. The NAS occupies a sandstone formation at a depth of a few hundred to over two thousand meters beneath sea level. Above it is the Post Nubian Aquifer (PNA). The latter is a shallower, two layered cluster of several geological formations, to which the NAS discharges its water upwards regularly through fissures and cracks between the two layers.[18] It is through PNA that Siwa thrives on NAS fossil water.

For thousands of years, these shallow and deep aquifer systems have created conditions that sustained agriculture for the population of Siwa. It is a small community that had until the 1970s led a life of subsistence on local agrarian production supplemented with trade in a few commodities, in exchange for dates. Before the last quarter of the twentieth century, Siwans cultivated land in proportion to the naturally flowing water springs that rose to the surface. European tourists who visited Siwa over the nineteenth and early twentieth centuries reported that it was largely self-sufficient, with trade through camel caravans that brought habit-forming commodities (tea and sugar for example), some grains (barley and wheat) and luxury items (including items like handkerchiefs from Manchester in the 1920s).[19] The traders who came to buy dates from Siwa also brought with them slaves from sub-Saharan Africa, who were purchased by big farmers and in all likelihood were put to work on the production of dates for trade.[20] Slave trade likely continued in Siwa well into the twentieth century. [21]

According to typically racist European reflections from the 1920s, Siwans were said to be an 'unenterprising' lot, showing an 'Omar Al-Khayyamish outlook on life' [i.e. lazy]: 'they only work in the gardens where the soil, after centuries of watering and manuring, has become very rich.'[22] Siwans sold dates and olives only, while the other crops they grew, fruits and vegetables, were considered shameful to sell.[23] The latter were for household consumption, in other words: produced exclusively for their use value. It is a practice, the production for use value of all crops except dates and olives, that remained until the 1970s-1980s.[24]

Siwa had always been connected to the world, but the nature of the connection radically changed starting in the 1970s. Before Siwa was tied more closely to the modern capitalist economy through this recent rise of agribusiness around the oasis, its mode of agrarian subsistence created markets that went only as far as selling dates and olives to buy agrarian 'hands' (slave labour) and a few necessary commodities.[25] Along with the slave labour ('slave' is known locally as *igbit,* a word that some people still remember) there was a bigger category of labourers: landless Siwan peasants working on the lands of rich Siwan farmers, who seem to have been some variety of serfs. They were known as *zaggalah*.[26]

A telling insight on how Siwans could have understood the hyper-mobility that came with capitalist free trade - as opposed to this localised pre-capitalist feudal-like economic arrangement - is their alleged view on Britain and global trade in the nineteenth century. Around 1850, a British tourist who visited Siwa was told by his interlocutors, some *Sheikhs* (tribal leaders) of the oasis, that they think the British are 'a degraded race without a home, wandering about the ocean in ships.'[27] This take on the British empire and its colonial trade emerged at a time when Siwans used the money that they received from Arab traders (who came to buy dates), in purchasing

beans, rice, and wheat from other traders who visited at different times of the year.[28]

In the 1920s, while the local population did not expand their cultivated land, some of them were taking arduous trips to Marsa Matrouh on Egypt's north coast to work as hired hands on growing barley for Bedouin landowners in that coastal enclave.[29] One can detect here two possible scenarios: the small farmers traded their labour in Matrouh for barley or money (as they did not produce enough dates and olives to trade for money that would have covered buying the barley and other needed items), *or* richer farmers sent their labourers (*zaggalah* and slaves) to work for money or barley, instead of expanding in and developing more land in Siwa.

This is a situation where we can glean how local nature and pre-capitalist labour relations (of slaves and serfs-like landless peasants) created a unique articulation between a pre-capitalist local and relatively isolated economy (integrated through two commodities only, but not yet hosting institutions like companies and banks for example, like in the present), and a national economy that deployed capitalist labour relations. Perhaps the means of production in Siwa were not technologically advanced enough to allow harvesting groundwater beyond the self-flowing groundwater that was enough for the lands already under irrigation (an imperative of nature and technology: groundwater geology combined with the absence of wells-digging technologies). It follows from these geological-technological determinants related to irrigation before a certain point in time, that capitalist labour relations *attracted* pre-capitalist labour seasonally to Marsa Matrouh. This could be one unique way through which Siwa was integrated in broader circles of capitalist economic activity before the 1970s, along the lines of what Gavin Capps proposed; on how different agrarian communities can develop complex lived relations that combine different aspects of pre-capitalist and capitalist economies across time.[30]

Whatever the motives, we can see that Siwa's abundant groundwater reserves and expanding food production was not pursued or even made possible until the late twentieth century. Today we have an idea of what would have happened if Siwans increased their acreage: the Intergovernmental Panel on Climate Change's (IPCC) special report on climate change and land from 2019 states that since cultivation of more land in Siwa started to accelerate in the late twentieth century, soil salinisation and vegetation loss had accelerated greatly.[31]

Soil salinity and loss of agrarian production rose hand in hand with Siwa's very recent deeper integration in the circuits of capitalist economies, *beyond* the earlier centuries-long patterns of trade in dates. In the late 1970s, the state started building an asphalt road to connect Siwa for the first time to Marsa Matrouh and the national network of highways. Siwans who witnessed it say that at the time when President Anwar Al-Sadat came in an entourage of several ministers and other senior officials, the main promise delivered by the state was building the road to Marsa Matrouh.[32] The road was concluded in the early 1980s. Simultaneously, Siwa was included from 1977 in the national plans of desert land reclamation, through a USAID-funded Food and Agriculture Organization (FAO) project.[33] It was one of the first American development aid programmes in Egypt after the state signed a peace accord with Israel in 1978. With this process, from 1976 to 2009, the population rose from 7,000 to 26,500 people, then increased to over 32,000 by 2016.[34] Cultivated land rose from 2000 acres in 1960 (810 hectares) to over 30,000 acres (12,000 hectares) by 2024.[35]

This agrarian expansion (see section three) resulted in a complicated ecological crisis for Siwa, where more parts of the oasis drown, and agrarian soil's salinity rose. There is a growing body of geophysical scholarship on Siwa's rising salinity over the last few decades, in combination with this expansion in cultivation. We glean from it chiefly that 'water quality in Siwa oasis is deteriorating over time.'[36] Salty lakes across the oasis - while they had always been part of the landscape - kept expanding, as a general trend, since the 1970s.[37] The water with high salinity that forms these expanding lakes comes from runoff irrigation. It comes from newly-reclaimed uplands through shallow groundwater to the lowest points in the oasis, topographically speaking, at which the lakes are formed.

Before the 1970s, the only way to irrigate land was artesian (not artisanal) wells. [38] These are shallow wells that water flows from without need for motive power, also known as Roman wells in Siwa (*Aabar Romaniyya*); attributed to Roman era wells-digging methods. This was (and still is) a communal water management process with long traditions on the old farms. Any single artesian well irrigates several adjacent plots of land with different owners. The regulation of water rights is preserved in writing and in oral traditions. Farmers in plots irrigated by the same well (known, this cluster, as *hattiyya*) would agree on a supervisor who strictly policed and arbitrated the taking of turns in irrigation. Across the old lands, some people

An artesian well. 1927 © *Misr Al-Haditha Magazine*, 25 November 1927, p. 16.

also acted as registry keepers (*rikab*) of water rights. These rights could be very specific, including at which times in the day or night which farmer can irrigate, across the seasons. Water rights in these shared arrangements are transferred to the new owners when the land is sold. The runoff irrigation water from self-flowing wells flowed into small lakes (until the 1970s) that evaporated in the summers and re-accumulated new run-off irrigation water in the winters.[39]

Since the 1970s, with the rise in reclaiming more lands in Siwa, and in the absence of good drainage infrastructures, the oasis became increasingly waterlogged around these accidental lakes.[40] They occupied 18% of all surface area of the oasis in 1973, then were doubled in surface area to 35% in 2005.[41] Another estimate, presenting the same trend, shows that lakes increased by 90% in surface area between 1987 and 2000, then shrunk by 24% from 2000 to 2010, when the government replaced hundreds of shallow wells with more organised and properly managed fewer deeper ones.[42]

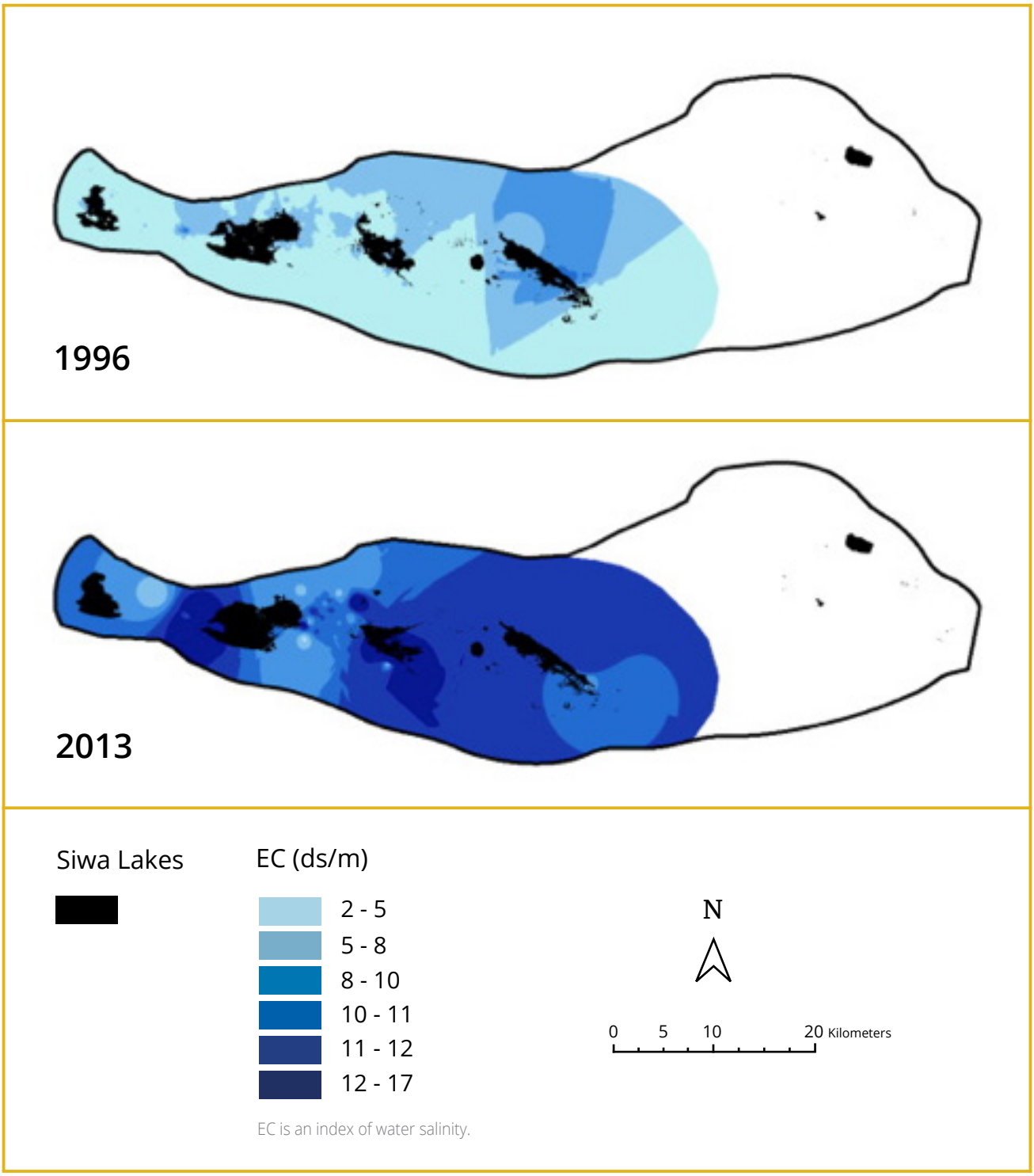
According to a recent satellite imagery analysis, the lakes' surface area increased between 1990 and 2021 by 58%.[43]

What these different figures show, is that generally, lakes expanded during the decades when more uplands surrounding Siwa were reclaimed and turned productive. The expanding lakes take more lands, including productive farms and houses in Siwa's rural hamlets surrounding the town.[44] Meanwhile, the state did not yet solve the drainage infrastructures problem effectively. A water geologist from Alexandria University expressed frustration at handling this crucial issue when he said: 'All attempts to take the water out of Siwa didn't bear fruit. They are all projects and blueprints on paper. In recent years, we – Alexandria University – joined hundreds of meetings to handle the drainage crisis, but nothing came out of it.'[45] The flooding under expanding lakes, according to consensus, is strongly tied to expansion in irrigating of the newly reclaimed desert uplands around the oasis; with the rise of the salty lakes, salinity in the soil across Siwa rises, impacting the old farms closer to the lakes.

Figure 1 shows salinity rising from ranges of 2-5 and 5-8 ds/m (more favourable for growing most crops) in 1996, to ranges of 10-17 ds/m by 2013, in which Siwa's traditional products like dates and olives wither and lose productivity.[46] The study that brought these findings shows that, 'There

Figure 1

Salinity levels in Siwa oasis between 1996 and 2013.



Source: Moghazy and Kaluarachchi, 2019. Figure reproduced with permission from the authors.

is a direct relationship between groundwater withdrawal and lake areas. [A] large volume of unused excess water is accumulated in addition to an existing poor drainage system, producing salty lakes [that are] causing waterlogging in Siwa.'[47]

A more recent study that tested samples from dozens of shallow artesian and governmental wells in Siwa (both types tap only into the shallow PNA groundwater systems, and the latter are the ones the government dug to greater depths, dozens of metres, in the early 2000s) concluded in 2023 that, 'the majority of the private and governmental groundwater wells are brackish groundwater type and no fresh groundwater type in the governmental groundwater wells is detected.'[48] With this general rise in salinity, crops lose substantially in productivity.[49]

Through FAO, Siwa is a recognized Globally Important Agricultural Heritage Site (GIAHS), being a reserve of diverse genetic plant resources, including its varieties of dates and olives, beside other crops.[50] While more lands are being reclaimed and turned productive on the uplands surrounding Siwa – using deeper wells over a hundred metres deep – the agrarian core of the oasis that forms the bulk of the GIAHS, is losing footing fast.

There is an ongoing displacement of some Siwans, even while they keep living in their oasis. A displacement that pulls the oasis ecosystem subtly and rapidly from under the feet of its inhabitants, without them moving anywhere, while simultaneously feeding lands under development by investors and agribusiness. This process, we argue, can be usefully seen in three waves between the 1970s and the 2020s. It is a trajectory that currently places us in a situation that will existentially upend Siwan ecology and lives: the intention to cultivate over 50,000 acres (20,000 hectares) by big agribusiness; an area that exceeds all cultivated land in Siwa, old and new, where the prime mover of irrigation pumping will be renewable clean energy (and renewable clean energy in the form of PVCs that we have seen in Siwa since the early 2010s). We turn to this analysis in the following section.

Rising saline shallow groundwater ruining several pieces of land, 2 km south-east of Siwa town. April 2024 © Authors

Groundwater rising in trenches recently dug to extend electricity, at the same location. April 2024 © Authors

3 Displacement in Place

In *Slow Violence and the Environmentalism of the Poor,* Rob Nixon brilliantly deploys the concept of 'displacement in place' to flesh out the slow and progressive alienation of local populations from their lived ecologies that witness substantial development, a 'threat of displacement without moving', which entails, 'being simultaneously immobilized and moved out of one's living knowledge as one's place loses its life-sustaining features', with the coming of capitalist development and 'new' economies.[51] An example of how such a scenario plays out elsewhere in the Arab region, would be the rain-dependent small-scale farmers of Souss-Massa, Morocco, who over the last twenty years suffered – because of climate change – meagre rainfall combined with a state-sponsored turn to agribusiness to serve EU-destined food exports, which has meant that many of the landowning small farmers who stayed on the land have become precarious hired hands.[52] With this theoretical category in mind, we describe and analyse below how the local population in Siwa are becoming increasingly displaced with the progress of agrarian capitalism, from the 1970s to the present, across three distinct periods.

3.1 The First Wave (1970s-1990s)

The first remarkable transformation of the oasis' former economic model of a largely pre-capitalist agriculture was between the mid-1970s and late 1990s. This first wave came with the construction of the first asphalt road – concluded in 1986 – which connected the oasis to the north coast. Until the late 1970s, all the cultivated land in Siwa was estimated at 2000 acres (810 hectares), which maintained the lives of some 7000 people.[53] Until that moment most of the irrigation water came from some 200 artesian wells, most of which had been running for hundreds of years. Accessing the shallower layers of the PNA through this basic technology ruled out the potential for cultivating new lands, since it relied exclusively on water that flowed to the fields. Siwans deployed a very strict and socially respected system for distributing water communally among farmers across the old fields (see section two).

By the mid-1970s, Siwa witnessed the beginning of radical economic, cultural, social and technological transformations. Many poor Siwan labourers migrated to work in the neighbouring, oil-rich Libya; but generally, Siwans used to have strong social networks in Libya. At the turn of the twentieth century, Siwa was seen as the gate to its neighbouring oasis Al-Jaghbub in Libya – 60 km to the west – the stronghold of the Senussi movement (a Sufi order), from where the Senussi led the resistance against Italian occupation.[54] With Libya's oil boom of the 1970s, it was the first immigration destination for Siwan workers. There is no clear record of how many migrated to work in Libya (which might have been several hundred),[55] but we know that migration at the time was extensive enough to cause a labour shortage in the oasis. As a consequence, seasonal day labourers from Upper Egypt started to come to work in Siwa. Although most of them visited first as seasonal labourers during the harvest of dates and olives, many eventually settled in the oasis, and one of them opened Siwa's first coffee shop – to serve as a marketplace for day labourers from Upper Egypt, from where they could offer their services.[56] This was a turning point for the local labour market dynamics, as previous established social arrangement of the community had no need for such a public space (coffee shops), as Siwans already had established social structures for arranging agrarian labour(through word of mouth, those who needed seasonal labour knew which Siwan labourers to contact and where to find them).

Soon after, local workers who migrated to Libya had to leave the country with the rise of political tensions between Libya and Egypt. With the arrival of Upper Egyptian labourers, the traditional *zaggalah* system of labour in Siwa had ended: a semi-feudal labour regime that dominated labour relations in the oasis for centuries. The returning workers, as well as the newly arriving Upper Egyptian workers, came with new ambitions and economic needs.

These dynamics, in combination with the construction of the Siwa-Matrouh highway, meant the mid-1980s was the peak of the first wave of expansion in land reclamation, beyond the traditional models that the oasis had witnessed previously. In combination with the increased appetite for growing crops on more lands, a new technology of digging shallow wells found its way to Siwa. The changing economic and social landscape was then

ready to welcome the new technology exported from the Bahariah oasis (425 km to the east). The new technology (known as *al-khabbat,* the knocker) for tapping shallow wells enabled reclaiming new lands – yet still within the peripheries of the lowlands.[57] The new digging technology mechanised an older manual method for digging artesian wells that used as a tool a heavy iron pipe. Before this mechanised method was developed, diggers used to manually pull the pipe up, then let gravity take it down to hit the ground, hundreds of times (hence the term 'knocker'), until it produced a shallow 3-4 meters-deep hole, through which groundwater rose up.

An interlocutor told the story of the rise of the new technology. In his childhood, he witnessed how it was developed and adopted locally. Two Siwan men – one of them was a resourceful car mechanic – borrowed a gearbox used in amusement parks (probably from a Ferris wheel) and attached it to an Indian motor. The motor, equipped with the powerful gearbox, pulled the heavy iron pipe up, 'so they got a slower yet stronger movement out of the motor.'[58] By mechanising the digging process, hundreds of acres of Siwa's lowlands became available for agriculture. The irrigation motor used in the wells dug by the new *khabbat* technology continues today and is now known by the name of *al-makana al-Hindi* (Indian Machine), a motor that was developed in India to be cheap and easy to fix by its farmers – with no need for technicians – as part of India's drive to decolonise technology after its independence.

The new technology enabled Siwans with financial means to expand in the practice of reclaiming desert land. The cost of digging wells using the new technology was not expensive, and the wells went deeper (approximately 20-30 meters). However, reclaiming new land still needed the ability to invest money and wait for years to get a return. Most small farmers could not afford reclaiming new large farms, but many of them were able to reclaim small new farms of a half or a quarter acre. These small farms helped some small farmers financially. They were too small to cover all their living expenses, yet they gave them some freedom, so they did not have to work for others on a daily basis. Until the present, one can see in the oasis many farmers who depend partly on these plots of land which are now largely inherited from their fathers, becoming smaller as they are divided among siblings.

Siwa's salt mines, 2024. © Rasmus Larsen

Salt spilled from trucks on a new road connecting the salt mines to Siwa-Matrouh highway. © Authors

Also in the 1970s, oil prospecting started in the oasis and its surroundings.[59] In 1969-1973, a Russian company drilled for oil a few kilometres outside the oasis, but their exploration was unsuccessful.[60] The drilling brought nothing but water, from the deeper layers of the NAS, and the oasis had its first deep well (800-1,000 meters).[61] Another interlocutor remembers how, in his childhood, he accompanied his uncle to the company's drilling site to collect empty dynamite wire spools, which he used to make a wooden cart; imagining in his childhood games that it was the powerful Russian company's truck that moved seamlessly over sand dunes outside the town.[62] This well, now known as 'Well Number One,' provided the purest drinking water the oasis had ever known. At the time, families had to lead their donkeys several kilometres outside the oasis every other day to access clean water.

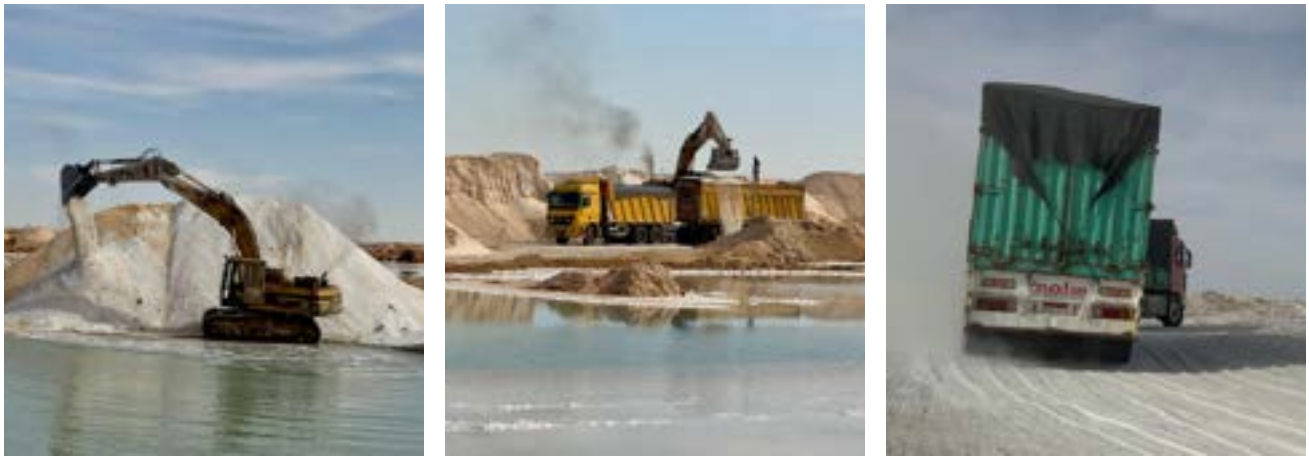
Roughly fifteen years later, the first mineral water bottling company, a government-owned business, Regwa, drilled the first deep well inside the oasis. This well provided drinking water of acceptable quality with easy access due to its close proximity to the town's centre. It also provided the first source of natural hot water. Since then, until today, after several other water bottling companies drilled deep wells to access pure water, the local community has not received much benefits in exchange for the exploitation of their resources (land, groundwater, salt, etc.), except for the right to fill drinking water for free from the wells at certain water bottling factories.

Until the mid-1990s, visiting Siwa needed special permissions. It was not hard or expensive to secure access to the enclave for impoverished seasonal workers from Upper Egypt. However, permission for other visitors kept the first wave of expansion within certain limits. Although the asphalt road was already functioning since 1986, special permission was still needed to visit the oasis limiting the development of tourism.

3.2 The Second Wave (2000 - 2020)

By the early twenty-first century, a second wave of expansion – and hence extraction – of the oasis, its land, groundwater, and other resources started. To sketch a bigger picture of the economic and cultural dimensions of the second wave, it is important to look at two other factors: tourism and salt mining, in addition to the increasing land use for agriculture by investors. Although desert land reclamation had by far the biggest impact on Siwa's ecology and economy, the significant boom in tourism and salt mining added considerable pressure on the oasis' socioecological, demographic, cultural, and economic conditions.

With the new millennium, tourism increased significantly. Two years after the Egyptian revolution of 2011, a sudden boom in tourism flooded the oasis.[63] While many countries prevented their citizens from visiting Egypt at the time, fearing political instability, local tourism replaced the former limited international flow of tourists. Within a few years, after 2011, Siwans found thousands of tourists walking the oasis streets. Prices of land and homes surrounding the town centre spiked – in some cases tenfold – in less than a decade.



Salt mining in Siwa. January 2022. © Christian Suhr

Simultaneously, a new extractive activity began in Siwa in 2010-2011.[64] Just south of the town lies extensive fields of salt marshlands. Mining salt from these fields had been organised as commons owned equally by all. Sheikhs of tribes observed a written code on equally sharing the salt,[65] and historical sources show that salt was indeed shared equally and respectfully through a certain ritual.[66] Meanwhile, no historical sources speak of any trade in Siwan salt.[67] But this centuries-long code was violated. Since 2011, Siwa's salt began to be exported to Europe, for use chiefly in de-icing of pavements and roads; the mining companies targeted at least 20 billion tons of salt in the ground.[68]

This mining activity is mainly controlled by the state in addition to a few big businesses. Siwans got little in return for the exploitation of their salt – one of the most important natural resources of their oasis, and almost no research exists on how taking away all this salt may impact water salinity in other regions of the oasis. To serve the new mining industry, the state is building a concrete-supported highway parallel to the Siwa-Matrouh highway, which can tolerate the heavy trucks that transport the salt to Egypt's Mediterranean ports. As with the asphalt road from 1986, a new road likely means new possibilities for expansion and extraction.

Along with the expansion in activities of cultivating more desert land, tourism, and salt extraction, came thousands of new inhabitants from across Egypt. In a village a few kilometres outside the town's centre, Abu-Shruf, small farmers who migrated to the oasis from the Nile Delta (the northern region of Nile-irrigated agrarian Egypt) in the early 2000s became the majority of the population, and elected their own local, non-Siwan governor: *Omdah.*

In addition to the boom in tourism and salt mining, the most significant realm of extraction in the second wave was in reclaiming new land by big agribusiness. The second wave came with the introduction of three new technologies: the percussion well drilling technique (known in Siwa as the *Borkeshen*), drip irrigation systems, and solar energy (the latter starting in the early 2010s). The combination of these new technologies enabled reclaiming the uplands surrounding the central depression. This three-pronged technological development made it economically feasible to buy and invest in cultivating medium and large farms. Capital-intensive farming came to Siwa.

The new percussion drilling technique depends on a truck equipped with a drilling machine. It pulls upwards a one-ton iron pipe then lets it dip. This fast and mobile technique is capable of digging 100 to 200 hundred metres holes. The new technology, from the early 2010s, enabled digging for water in lands surrounding the oasis' central depression for the first time in its history, and it enabled digging wells deep and big enough to sustain large-scale investments in the uplands. [69] The previous hybrid Indian motor (*khabbat*) could not dig more than 30 - 50 metres. The *khabbat* could provide irrigation infrastructure that fitted only the purpose of irrigating the lowlands at the oasis' centre, which tended to be smaller plots owned by local small farmers. Drip irrigation, which was totally new to Siwa, combined with the percussion drilling technology described above enabled cultivating new large-scale farms on the uplands. Solar-powered pumps, however, were the really revolutionary change in this equation. Photovoltaic Cells (PVCs) water pumping from the deeper new wells as long as the sun shines powered the economic model for agricultural companies that exploited thousands of acres in both the low and uplands (see section 3.3 below).

The percussion wells drilling technique, used in uplands around Siwa since the early 2010s. © Badr Al-Rifaay

The second wave, consisting in the rise of agribusiness in and around Siwa was so vast that it became almost impossible for the small Siwan farmers to access lowlands which could be farmed in the traditional way (self-flowing artesian wells), given the impact on land prices. Most of the lowlands surrounding the oasis' old centre have already been sold – mostly to small and big investors, including rich city people who buy land, enclose it, and build small villas. The prices of the rare available lowlands soon became out of reach for most small and medium Siwan farmers. Moreover, these categories of farmers cannot afford to reclaim the cheaper uplands, which can be planted only using drip irrigation systems, since this model is capital intensive, and only profitable when scaled on large plots of land.[70]

This wave of expansion landed Siwa in a situation where the majority of small local farmers lost hope in a future where they could have their own farms. Unlike their fathers who could afford to reclaim new small plots, small farmers lost this hope in the recent speculation in land. Without capital to invest in the newly-arriving agrarian extractivism, the only future for their children – many of them fear – will be as landless agricultural labourers for existing and emerging big agribusinesses.[71]

In addition to thousands of acres of upland, the second wave did not only co-opt most of the lowlands to richer landowners and deprive small Siwan farmers of the possibility of reclaiming new small farms, but it also led to the rise of water salinity in many traditional shallow wells, on which all Siwans with farms in the lowlands depend (see section 3.3 below, and section 2 above). Rising water salinity decreased the yield of palms and olives trees. One of the interlocutors, a small farmer, explained, 'in the old days there were no capabilities in the oasis, and we were poor, now there are a lot of capabilities, yet we are even poorer.'[72]

3.3 The Third Wave (2020 - Present)

The third wave came with the availability of a digging technology which can reach depths of several thousand metres. What is new here is not the technology itself, but its availability to investors. As mentioned above, the first time a deep water well (between 800-1,000 metres deep) was drilled in Siwa was in the early 1970s by a Russian company searching for oil. It did not find oil but left behind the first well to ever tap directly into the deeper stratum of the NAS; the purest fossil water available to the oasis with the lowest salinity, dug as a contingency of drilling for fossil fuels that were not found. Across the 1980s-1990s, the government drilled a handful of these deep wells to

provide good-quality potable water for the local population. Most of these wells were rented to public and private bottled water companies, which packaged and sold the water outside Siwa. Up until the late 2010s, the state monopolised the right to operate and own the equipment necessary for drilling the deep wells. These are known officially, and by Siwans as *Aabar Wizariya*: ministerial wells!

In December 2015, the Egyptian president announced a national project to reclaim 1.5 million acres of desert land across Egypt (0.6 million hectares), this was the first phase of a bigger four million acres (1.6 million hectares) 'reclamation' project. Most of this land is to be irrigated using groundwater from the NAS.[73] Egypt's water share currently stands at 560 m^3 annually per capita, which is far below the water poverty line (1000 m^3 annually per capita). Because of climate change, the annual share of water per person is expected to drop below the 500 m^3 threshold of absolute water scarcity before 2030.[74] Governmental estimates are at an annual water deficit of around 21 billion cubic metres.[75] Announcing a plan to reclaim 1.5 to 4 million acres for agriculture in Egypt, mostly depending on the non-renewable NAS (fossil water), raises serious concerns about the politics of reclaiming desert land and the ecological consequences of such projects.

In the late 2010s, El-Reef El-Masry, the public company responsible for developing the 'four million acres' projects (1.6m hectares), initiated its plans to reclaim desert lands to the east of Siwa – towards the small neighbouring oasis, Al-Garah, inhabited by one Amazigh tribe (literally meaning either 'the neighbour', or possibly Al-Qarah, meaning 'the continent', or 'the settled one').[76] In 2018, El-Reef El-Masry announced an agreement with a Spanish investor to reclaim thirty thousand acres (12,000 hectares) east of Siwa for growing olive trees.[77] In just one sweeping agreement – in this ongoing third wave of expansion – the state gave a private sector agribusiness the right to reclaim an area that almost equals all the reclaimed lands in the second wave.

To understand how the state thinks about this project and the kind of investors it aims to attract to Siwa, it is important to know that in 2019, El-Reef El-Masry increased the basic purchasable unit of land in this project to 1,000 acres (about 400 hectares). In the case of 'small farmers' pooling their money together to buy one unit (of 1,000 acres), the maximum number of partners should not exceed 20-23 individuals (almost 50 acres each).[78] Accordingly, the government believes that investors who would afford buying and planting 50 acres each, are to be considered 'small'

A ministerial well (between 800-1,000 meters deep) in Bahi Al-Din village, Siwa. © Authors

farmers in the agrarian development planned for Siwa and its surrounding desert lands.[79] However, most of the buyers the project attracted so far are big investors who could afford buying and cultivating thousands of acres. In these latter cases, the state gave big investors access to the technology of digging deep wells of 1,000 metres. It did not grant them permission to use this state-monopolised technology themselves, rather digging the deep wells for them. The fees for digging one of these wells which tap directly into the NAS was estimated at £5m (Egyptian pounds) in 2020, $316,500 (US dollars), bringing up 500 cubic metres of water per hour, compared to an average of 100 cubic metres/hour from wells that use the percussion technology (100-200 meters depth), in the uplands immediately surrounding Siwa's centre.[80] Moreover, these deeper NAS wells are under high pressure and self-flow when they are dug, and once opened, they cannot be sealed again, as the pressure would seep out of weak points and escape to the surface. This leakage could spread across the PNA (the shallower groundwater system), eventually reaching Siwa's growing central lakes.

The limits of ambitions of the third wave of expansion in land reclamation in Siwa are not clear. What we know as a matter of fact is that the targeted lands in 2018-2024 far exceed all the cultivated land of the oasis across its history. Along the outskirts of the state-led El-Reef El-Masry project, located east of Siwa, hundreds of medium and big investors are reclaiming land along the road leading to it. A solar power technician, explaining how vast and fast recent developments have been, said in April 2024,

> 'it is awful, unbelievable, absurd… [that] every week new wells, new buildings [are built] on farms. Everyday someone is reclaiming hundreds of acres. Everyday new solar power stations are installed. Only four days ago I was summoned to install a solar power station for a person reclaiming 500 acres [200 hectares]. This is one example among many. It is just unbelievable, how fast this is proceeding.'[81]

The ongoing third wave of expansion is raising fears in Siwa on two levels: First, there is the question of who gets water. With the rising salinity of shallow wells and the declining water table due to excessive groundwater extraction, obtaining sufficient irrigation will soon become a privilege to those able to drill very deep wells that tap directly into the NAS. In very limited cases, the state provides medium-depth wells (around 500 metres deep) for old farms, while deep wells (exceeding 1,000 metres) are drilled for large investors. In both scenarios, it seems that the looming crisis will not just be about accessing irrigation water of low salinity in the oasis, but rather about who is powerful and rich enough to obtain it. What used to be a relatively straightforward process with the first drilling technology (*khabbat*) making irrigation water accessible, will now depend on the state's approval or the availability of millions of Egyptian pounds ($20,000 is roughly equal to £1m as of 2024-2025) for major investors to drill ultra-deep wells.

Second, there is the prospect of the drowning of the oasis. The rising volume of runoff irrigation drainage flowing into the lakes within the oasis has already caused the flooding and waterlogging of lowlands across several spots in Siwa's old centre. Concurrently with the third wave, the government announced its intention to undertake a massive project to divert agricultural drainage from the oasis to a neighbouring depression in the desert. The Prime Minister inaugurated this project in July 2023.[82] However, its initial stages were not promising. The drainage channel, running alongside El-Reef El-Masry megaproject to the northeast of the oasis and intended to carry drainage out of the central geological depression, resulted in the salinisation of adjacent lands and threatens to undermine the asphalt road constructed next to the canal. There is consensus among the farmers interviewed that the performance of the new drainage system is significantly below expectations.

The local population have had unfortunate experiences with similar initiatives in the past where the government promised to resolve the chronic water crisis (since the expansion in land reclamation started in the 1970s-1980s) but without success. The fear of the flooding of farms closer to the lakes have grown to encompass the possibility of drowning the entire oasis. Siwans are now discussing the potential for lake water levels to exceed the elevation of the town's centre. Last year, the collapse of a land bridge led to the drowning of hundreds of acres and some homes in the Bahi El-Din area, a few kilometres west of the town's centre. One of our interlocutors remarked in a statement that sums up Siwa's existential crisis,

> 'In family gatherings we talk about three things: the incoming labourers to Siwa, the land reclamation investors, and agricultural drainage. If the new drainage project succeeds, everything will be fine. If it fails, may God have mercy on us.' [83]

4 Renewable Energy, Fossil Water

The story of how the transition to solar power arrived in combination with the transition to increasingly large-scale agrarian capitalism in Siwa is far from being straightforward. The PVCs tended to replace gasoline-fuelled irrigation pumps, in order to access ever-increasing amounts of NAS's non-renewable fossil water. In this process – which has the impact of flooding the oasis' central geological depression more and more each day – there are several contingencies that go in different directions. Below we chart them in some detail.

Until the end of the first wave of expansion in Siwa (1970s-1990s), all peasants, rich and poor, were still able to maintain their traditional farming practices, which did not need aid of any machines or motive power. With the exception of the process of digging shallow wells aided by the Indian motor (the *khabbat*), the whole process of traditional agriculture needed no water pumping power: the groundwater flowed on its own by means of the natural pressure and leveraging gravity in designing the irrigation pools and canals. For centuries – until a decade ago with the rise of PVCs – all Siwans enjoyed a farming system in which water naturally erupts from both historical artesian wells and shallow *khabbat*-dug wells. They collected the rising groundwater in big pools (known as *Talis* in Siwi) then opened the pool into canals that distributed the water to their fields. In old farms – that were cultivated before the first wave – they deployed a very strict, highly precise, and socially-respected system for distributing water among different plots of land that collectively fed on the same well. It was an efficient system, without a need for any external power to pump water or distribute it.[84]

Across the 2000s, farmers and investors, who bought land in Siwa outside the central batch of communally distributed water from artesian wells, had to rely on gasoline for irrigation. Farther from the water table in uplands, power was needed for pumping, after the percussion technology made it possible to dig deeper wells (average 100 meters deep) in the mid-2000s. Gasoline motors were the

Dying olive trees (upper right corner of the image), in a farm 10 km south of Siwa. © Authors

standard, using the Indian motor as the pumping engine. Two factors affected the economic feasibility of fossil-fuelled irrigation: changing fuel prices and the availability of technical expertise and spare parts for the motors that tended to break down occasionally, decades after they were imported from India. A solar power technician from Siwa sums this up concisely:

> The gasoline [motor] was a chronic hole in your pocket (*kharab biyout*). You pay for gasoline every time you irrigate. There were many breakdowns and long waits for fixing. You need to change the lubrication oil occasionally, bring the mechanic to clean the injection and valves. Sometimes no gasoline was available at the gas station for the day, so you needed to wait. And more importantly, a labourer was needed to be retained on fulltime to bring the fuel to the farm in the morning, ignite the engine to irrigate, then turn it off, in the morning then another round in the evening; gasoline costs money. Then the problem with the spare parts. We did not have most of them in Siwa. Once you need a spare part you must buy it from Cairo or Alexandria, or have it delivered. This could take a week given the long distance.[85]

It also seems that gasoline motors were not conductive for big agribusiness, given the cost considerations. As an example, a farm in the range of several hundreds of acres 10 kilometres south of Siwa was cultivated before the 2010s, and before PVCs led the transition to irrigation by renewables. At some point, gasoline prices spiked suddenly, and the farm owner had to permanently stop irrigation to cut losses. The thousands of olive trees they cultivated died slowly, before the company recently installed four large PVC stations to resurrect the land.[86]

In 2009-2010, a PVCs retailer and technician moved to Siwa from Sohag, Upper Egypt. This pioneer renewables entrepreneur started installing small PVC stations for farmers in uplands, in the capacity of – roughly – three to five horsepower (HP).[87] Over the next few years, PVCs efficiency increased, and their prices decreased. By 2024, PVC stations in capacities ranging from three to 70 HP are being installed every day for irrigation, across the peasant classes and agribusinesses, and 100 HP stations are not

Solar power (PVCs and batteries) shop, one of many in Siwa town. © Authors

unheard of. At least four stores in town sell PVC equipment at the moment, and the solar power market in Siwa is growing in huge leaps.[88]

The arrival of PVCs ended the problems with gasoline irrigation (and by extension carbon emissions from irrigating the reclaimed land), but they brought in bigger capitalists, across the second (2000-2020) and third (2020-ongoing) waves of expansion. Let us dig deeper into this two-part statement.

First, concerning the problems with gasoline that solar power solved, PVCs replaced the daily changing costs of fossil fuels with a fixed investment at the outset of the project (the PVCs run for at least two decades). Economic calculability of the land's productivity becomes sharper and more certain. The occasional breakdowns of the gasoline motors and the fuel's volatile prices have been replaced with a process far more conducive for business. As one respondent explained:

> With solar power, if the well's pump (*el-ghatis*) breaks down, you can buy a used one. It is far cheaper than the gasoline motors. You install the spare in no time and send the original one for fixing. Very often I get phone calls [from] farmers and investors saying their PVC control boards are acting up. This is the kind of breakdowns you get with PVCs. I tell them over the phone how to reset the system, which buttons to press, etcetera. You do not need a mechanic to fix the daily operational problems of PVCs. You do not need occasional lubricant oil change, or frequent change of spare parts. You do not need a full-time labourer to work the irrigation system: it can be configured to work automatically. They cost money, but in the longer term they are cheaper. The farmer at first would look sceptically at the PVCs-powered motors. Their pressure is less than the gasoline-powered ones, but they can irrigate all day, instead of irrigating in short high water pressure sessions, with no added costs at all. A year or two into this, the initial investment [has been] recovered.[89]

Second, concerning solar power and big investments, the power potential of the smallest purchasable PVC units on the market – largely tied to the economic feasibility of digging percussion wells on uplands surrounding Siwa, and these wells' pumping power needs – is enough to irrigate 30-50 acres (12-20 hectares). In talking to farmers and investors about to start upland reclamation projects in Siwa – a great number at the moment [90] – the most frequently mentioned technical detail is how the smallest PVCs station for irrigation would be able to irrigate 30-50 acres. The rest of the discussion is usually, 'it does not make sense to buy 5-10 acres only'.[91]

This tendency of renewables for going big is associated with the process of digging percussion wells. The cost of the digging gives a better return on investments if the well is used to irrigate dozens of acres, not just smaller plots; mainly because the cost of the land itself is still relatively cheap in comparison to land prices elsewhere in Egypt. Likewise, the PVCs required to lift the groundwater from wells in the uplands provide enough power to *also* irrigate larger plots. The overall effect is one where a combination of land prices, cost of percussion wells and PVCs, tends to bring investors who pass as medium and big farmers, with investments starting from £1m (approximately $20,000 as of July 2024).

The very few and big agribusinesses who did pay millions for the state to dig for them 1000 meters wells tapping into the deeper stratum of the NAS did not need PVCs to bring the water up. It rises on its own because of different geophysical dynamics (that provide a water pressure of 15 bars on average) at this greater depth, but they need PVCs to distribute the water horizontally to the thousands of acres on these farms. Also, irrigation on such bigger projects – regardless of distance between well and plant – needs to have an intermediary phase for cooling water in big tanks, because the deeper water as it rises up is too hot to send directly to irrigation (averaging temperatures of 40-50°C), so the horizontal distribution of irrigation needs solar power by definition regardless of the high vertical water pressure.[92] This means that the very large farms that put unprecedented stress on Siwa's fragile ecology are no less reliant on renewables.

While the economic calculability of the 'PVCs-percussion digging-land prices' cluster introduced bigger and more powerful new landowners to the oasis, the smaller landowners found themselves compelled to adopt PVCs irrigation. This is the second aspect of the self-replicating dynamic that pushes rapidly towards greater flooding risk. How does this happen?

A farmer who was among the first Siwans to buy a small plot a few kilometres south of the oasis years ago, had irrigated his farm without machinery until – roughly – the year 2020:

Solar panels in an uplands farm. © Authors

> I had self-flowing water (*maya fawwara*) because its pressure… meant that I just needed to open and close some valves to irrigate. Recently, with so many PVC stations on percussion wells in the new farms uphill [farther south and on higher ground], the water flows on its own only in the early morning and late evening. For most of the day, when the sun is stronger, and as long as all these wells are drawing, the pressure falls, and I do not get any water. I need to install a PVC station, when I have the money.[93]

'Now 70% of Siwan farmers are using solar energy to cultivate their land. It has become a necessity', said a solar power technician who installs PVC stations in Siwa in April 2024. A decade ago, self-flowing wells (*maya fawwara*) were the standard for Siwan farmers closer to the centre of the geological depression. Now, as the water table of the PNA keeps falling, they talk about it as a blessed memory from the past.[94]

The 1,000 meters wells dug for the big agricultural companies of the third wave flow on their own, and the pressure is powerful enough to the extent that the runoff irrigation water that gravitates towards the centre of the oasis and fill its lakes is far greater than the water that evaporates: 'the amount of wasted water is just mind-numbing', an interlocutor said.[95] The percussion wells of the second and third waves (year 2000-ongoing) also tap into the upper stratum of the NAS (i.e. the PNA) and lower the water table of the shallower (above 1,000 metres) section. This makes irrigation harder (increasing the need for pumping power by the day), and the shallow groundwater more saline (with deteriorating crop productivity), while raising the lakes level and with it the danger of flooding the centre of Siwa.

Renewable energy made capitalist agribusiness possible in the remote oasis, far from state infrastructures of power and irrigation around the Nile valley. Once it became deployed in enough concentration to make traditional irrigation harder, the farmers who never needed mechanisation had to join in. With this, even *more* pumping power needs to be applied. On the smallest farms, it is obvious that a huge percentage of the raised water runs off to the lakes. So pumping power begets more pumping power to fix the ecological problems created by cascading waves of capitalist expansion, and the more expansion in pumping power is applied, the more the oasis – with its millennia-long cultural heritage and thriving society and ecology – becomes more vulnerable to destruction.

Conclusion

In this article we have shown how the rise of capitalist agriculture in the Siwa oasis, one of the farthest habitable regions from the Nile valley in Egypt, is unfolding hand in hand with the rise of renewable energy. Solar power is usually imagined as a solution to global warming, but in this scenario, it is integral to the rise of capitalist intensive agriculture which is a major factor in global warming. We explained the precarious biogeophysical situation of the oasis and its groundwater systems that have the effect of 'displacement in place' on Siwans. The Siwans did not leave, but their centuries-long fragile ecological balance that remained relatively stable suffered a sudden deterioration, making it increasingly hard to maintain livelihood by relying on subsistence agriculture.

In section three, we broke down the change Siwa witnessed with unprecedented levels of intensification of capitalist agrarian production since the 1970s, into three waves, presenting with each wave how the evolving technologies of digging wells to tap into the Nubian Aquifer System (NAS) and the Post Nubian Aquifer (PNA) above it, went hand in hand with the rise in exploiting Siwa's lands, and, as a consequence, changed labour and land ownership patterns. These were processes which concentrated wealth and land in the hands of fewer Siwans and outside investors and companies. In section four, we analysed how the ongoing third wave leaves us with the curious situation of solar energy (Photovoltaic Cells, PVCs) leashed to capitalist growth in land exploitation, where small and big investors use renewable energy to harvest agrarian commodities (mostly dates and olives) from the lands surrounding Siwa. We conclude that solar power deployed with an ongoing enormous growth rate across tens of thousands of acres around Siwa is leading to the rapid collapse of the oasis' socioecological fabric and turning the local small farmers into hired landless labourers. This has taken place alongside deteriorating soil quality on their lands, and the prospects of the flooding of old farms, has seen these small farmers increasingly tied to agribusiness in the uplands as waged labourers.

There are a few solutions we suggest towards remedying the situation, which are inspired by discussions with many of the farmers we met. Before we conclude, it is important to state that we do not claim that there is something inherently wrong with solar power. It is the social and economic context that this technology is situated in which determines its trajectory wherever it is placed in the world. The combustion potential of coal was known for centuries before it ignited global warming with the invention of the steam engine. The steam engine was invented to bring coal in much greater quantities from the mines to the surface. The steam-powered railway was invented to move coal from mines to shipping destinations. The whole process evolved with the rise of the generalised production of the commodity: capitalist production through fossil fuels in other words was the process leading to the rise of steam power.

The same processes apply to PVCs and Siwa. These processes are – unlike fossil fuels – an energy source that does not impart carbon emissions beyond their manufacture and shipping to requisite destinations. They are, however, deployed in the broader fabric of capitalist expansion in agriculture in the oasis. The generalised production of the commodities of dates, olives, and water-intensive animal fodder for example, pushes for the deployment of more renewable energy in the face of technical and financial challenges that stood in the way of previous capitalist agriculture in the oasis with its unique ecological and infrastructural features. These uniquely capitalist developments devastate the geologically and ecologically vulnerable oasis. *Capitalism, not the technology it wields*, is the prime mover of the devastation and 'displacement in place' underway.

How may this steep trajectory of extractivism, crisis and socioecological destruction be averted? Extractivist agribusiness in Siwa is particularly devastating because it suddenly and rapidly intervenes in delicate ecological balances. Solutions should focus on derailing the crisis by returning as much as possible to the ecological balancing act of the Siwa oasis, informed by *both* the unique geological nature of Siwa and the multidimensional harm capitalist agriculture is causing.

First, the ongoing drainage infrastructural project for Siwa – through which the lakes are to be controlled – should be the first priority for the government, not *new* land reclamation. Technical solutions that might incur substantial expenses to enhance the project's efficiency need to be pursued. The returns on these costs include nothing short of saving Siwa's agricultural and cultural heritage from extinction.

Second, the state should reformulate land reclamation plans. Expansion should not proceed until the volume of lakes – and the risks of drowning – is decreased substantially. Plans should be tied to drainage efficiency: no new lands should be granted to investors as long as drainage solutions are not delivering their promise. These plans should include enforceable regulations on crops and groundwater pumping volumes. Crops that consume larger volumes of water should not be allowed on new lands and already cultivated uplands surrounding the oasis. These plans should include lower thresholds of ownership, and subsidies, that will enable larger numbers of small farmers to access water and land. The small farmers of Siwa had long managed to operate a cultivation model that used these two resources effectively.

Third, solar power deployment should serve the crucial purpose of keeping Siwa thriving, instead of leading to rising lake levels. Taking the cue from the local traditional irrigation distribution system, where neighbours take turns irrigating their plots, the state should consider planning the distribution of the deeper 'ministerial wells' communally across the land, instead of privatising this precious non-renewable NAS water in a paid service scheme through which mega-investors who serve the global market co-opt the Siwans' commons. In such an arrangement, solar power can also power horizontal distribution of irrigation instead of vertical pumping only.

Behind these largely technical suggestions is an alternative agrarian model to neoliberal extractivist capitalism currently being imposed on Siwa and its small farmers. Let us call it 'thriving in place' as a counter-model to the ongoing process of 'displacement in place.' We think that framing it this way, in reaction to the current extractivist processes in and around the oasis, means staying sensitive to the emergency mode the Siwan population and their local nature are facing. What 'thriving in place' entails is first to pull the brakes on the process of seeing Siwa as a place of accumulation as much as technology (renewables included) can feasibly allow. Second, it means taking food sovereignty and the central place of the peasantry seriously. The owners of the land and the water should be able to use renewable energy to thrive. While Siwa needs to stay 'small', it should not by any means return to the dynamics of a local past of feudal relations of production and their own forms of inequalities and injustices.

Renewables should enable the small farmers to transition towards a more secure life, where they have greater control over their land, its productivity, and the resources and inputs needed. Local democratic forms of water and land governance (including plans for communal management of solar-powered irrigation and food processing factories for dates and olives) need to be developed. Otherwise, whatever quick fixes that are proposed to solve the problem of the expanding lakes will simply further the dynamics pushing towards *more* displacement and ecological disaster.

Endnotes

1 2022 census data, 34,000 up by 30% from 2011: Ghazalah, Azza Mahmoud Abdulqadir (2024) 'الجدوى الاقتصادية لبعض المشروعات الصغيرة الخاصة بالمرأة في واحة سيوة" [Economic Feasibility of Some Small Projects for W'men in Siwa], Journal of Agricultural Economy and Social Sciences, 15(3), 36.

2 Versieren, J. and De Smet, B. (2022) 'Lost in Transitions? Feudalism, Colonialism, and Egypt's Blocked Road to Capitalism (1800–1920)' Journal of Historical Sociology, 35(2): 200-221.

3 Krätke, M. R. (2020) 'Capitalism.' In The Marx Revival: Key Concepts and New Interpretations, edited by Marcello Musto. Cambridge: Cambridge University Press, 6-8.

4 Ibid.

5 Capps, G. (2016) "Tribal-Landed Property: The Value of the Chieftancy in Contemporary Africa", Journal of Agrarian Change, 16(3): 452-477, 458.

6 Bernstein, H. (2010) Class Dynamics of Agrarian Change. Rugby, UK: Practical Action Publishing.

7 For a detailed critical study on the legal and historical aspects of desert land reclamation in Egypt, see: Al-Nour, S (2017) الأرض والفلاح والمستثمر: دراسة في المسألة الزراعية والفلاحية في مصر [Land, Peasants, and Investors: A Study on the Agrarian Question in Egypt], Cairo: Maraya Publishing, chapter 4. The chapter elucidates developments in the regulation and practices of desert land acquisitions since 1952.

8 On the activities of and regulations applied by El-Reef El-Masry, see: Ibid, 138-142. On the company's recent activity in Siwa see section 3.3. of this article.

9 Agrarian Census Data Unit (2019) قراءة اقتصادية لبيانات التعداد الزراعي في مصر [An Economic Interpretation of Agrarian Census Data in Egypt]. Cairo: Ministry of Agriculture and Land Reclamation, 72-74.

10 Bernstein (2010) op. cit., 4.

11 Ibid.

12 Ibid, 105.

13 Serreli, V (2024) Language, Society and Ideologies in Multilingual Egypt. Berlin/Boston: de Gruyter Gmbh, 58-64.

14 Bernstein (2010) op. cit., 103.

15 Voss, C. I. and Soliman, S. M. (2014) 'The transboundary non-renewable Nubian Aquifer System of Chad, Egypt, Libya and Sudan: classical groundwater questions and parsimonious hydrogeologic analysis and modeling.' Hydrogeology Journal 22: 441-468.

16 Morton, M. C. (2019) 'Ancient water underlies arid Egypt.' Eos, 100, June 2019: https://doi.org/10.1029/2019EO126407.

17 Ibid.

18 El-Sheikh A. E. et al (2023) 'Hydrogeological and hydrogeochemical insights on the salinization of the shallow groundwater aquifer in Siwa Oasis – Western Desert – Egypt.' Scientific African 20; Moghazy, N. H. and Kaluarachchi, J. J. (2019) 'Assessment of groundwater resources in Siwa Oasis, Western Desert, Egypt.' Alexandria Engineering Journal, 59(1): 149-163; Abdulaziz, A. M. and Faid, A. M. (2015) 'Evaluation of the groundwater resources potential of Siwa Oasis using three-dimensional multilayer groundwater flow model, Mersa Matruh Governorate, Egypt.' Arabian Journal of Geosciences, 8: 659-675;

19 Tourists and travelers include: Stanley, C. V. B (1912) 'The Oasis of Siwa,' Journal of the Royal African Society, 11(43), 290-324; Cumins, S. L. (1912) 'A Summary by Major S. L. Cummins, Royal Army Medical Corps [of] A Report on the Oasis of Siwa By Captain C. V. B. Stanley' BMJ Military Health, 18: 323-328; St. John, Bayle (1849) The Libyan Desert and the Oasis of Jupiter Ammon. New York: George P. Putnam; White, Silva (1899) From Sphinx to Oracle: Through the Libyan Desert to the Oasis of Jupiter Ammon. London: Hurst and Blackett, LTD; Particularly on the exact information cited: Pelgrave, C. Dalrymple (1923) Siwa: The Oasis of Jupiter Ammon. London: John Lane & the Bodley Head LTD.

20 Pelgrave, C. Dalrymple (1923) Siwa: The Oasis of Jupiter Ammon. London: John Lane & the Bodley Head LTD.

21 'The Slave Trade in Tripoli' (1910) Anti-slavery Reporter and Aborigines Friend Series V, Vol. 1, No. 2, London: The Offices of the Anti-Slavery & Aborigines Protection Society, 68-69. It is hard to pin down with any certainty the exact dates of the slave trade, because the oasis has always been isolated as well as being located on the slave trade route of the Sahara. The cited source mentions this as happening in 1910.

22 Ibid, 155-156.

23 Ibid.

24 Our interlocutors agree that this practice was sustained until the 1970s-80s.

25 On slaves in Siwa: 'The Slave Trade In Tripoli' (1910) Anti-slavery Reporter and Aborigines Friend Series V, Vol. 1, No. 2, London: The Offices of the Anti-Slavery & Aborigines Protection Society, 68-69; see also: Palgrave, op. cit. Trade - obviously - is not necessarily 'capitalism.' Trade from Egypt, across the Mediterranean was practiced on a huge scale during - for example - the 10th and 11th centuries. Towns in Fayoum (Middle Egypt) and Tennis (northern Delta) were factory towns producing flax and cloth for consumers in Tunisia and Italian cities. Peasants across Egypt were importing olive oil from Tunisia. See: Chris Wickham, The Donkey and the Boat, chapter 1.

26 Zaggalah, were a substantial category of landless labour at least until the 1970s, who were working on the lands of big farmers as part of their households, and they were usually from the same tribes, if not the same extended families. According to Ahmed Fakhry, they were 'among the poor who owned no land and had to work for the rich.' Their services were also used in the night as guards of the oasis, providing security. They were not allowed to enter the town of Siwa before they reach the age of 40. They were provided with meals and clothing by their masters and granted specific amounts from the crops seasonally. see Fakhry, A. (1973) Siwa Oasis. Cairo: AUC Press, 40-41.

27 St. John, Bayle (1849) op. cit. 151.
28 Ibid, 159.
29 Pelgrave, op. cit, 156.
30 Capps (2016) op. cit. We do not pursue this point further, but more broadly, two relevant works on how capitalism unfolded in Egypt (as opposed to Egyptian capitalism), and Egypt's successful transition to a certain variety of a 'failed capitalism', see successively: Jakes, A., and Shokr, A. (2021) 'Capitalism in Egypt, Not Egyptian Capitalism.' In A Critical Political Economy of the Middle East and North Africa, edited by Joel Beinin, Bassam Haddad, and Sherene Seikaly. Stanford: Stanford University Press; Adly, A (2020) Cleft Capitalism: The Social Origins of Failed Market Making in Egypt, Stanford: Stanford University Press.
31 Mirzabaev, A., J. Wu, J. Evans, F. García-Oliva, I.A.G. Hussein, M.H. Iqbal, J. Kimutai, T. Knowles, F. Meza, D. Nedjraoui, F. Tena, M. Türkeş, R.J. Vázquez, M. Weltz, (2019) Desertification. In Shukla P. R, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (Eds.) Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.
32 Information from several interviews, Siwa Oasis, between 2021 and 2023.
33 Afaq al-Bi'a wa al-Tanmiya Magazine [Maan] (2023), تحقيق: سيوة واحة مهددة بالغرق ووعود الحكومة المصرية تبقى حبراً على ورق [Siwa: an oasis threatened by drowning; promises from the Egyptian government remain ink on paper], 1 August: https://www.maan-ctr.org/magazine/article/3984/
34 Moghazy and Kaluarachchi, op cit.
35 Ibid.
36 Elsheikh et al, 2023, op cit; Repeated almost verbatim in: Elnazer et al (2022) 'Siwa Oasis groundwater quality: factors controlling spatial and temporal changes.' Environmental Monitoring and Assessment, 195(61): https://link.springer.com/article/10.1007/s10661-022-10646-z
37 With a reported shrinking in size in the 2000s upon intervention from the state to regulate and rationalise artesian wells: Moghazy and Kaluarachchi, op cit.
38 More on artesian wells, as a general concept: https://www.usgs.gov/special-topics/water-science-school/science/artesian-water-and-artesian-wells
39 From several interviews, and: FAO (2016) Siwa Oasis, Egypt: Proposal for designation as Globally Important Agricultural Heritage Site: https://openknowledge.fao.org/server/api/core/bitstreams/bdbb8b53-a477-4326-b603-ae98bf184d4e/content
40 Hedia, R. M (2015) 'Assessment of drainage water quality in Siwa oasis and its sustainability for reuse in agricultural irrigation.' Egyptian Journal of Soil Sciences, 55(4): 501-515.
41 Ibid.
42 Moghazy and Kaluarachchi, op cit. According to the authors, the many shallow artesian wells that were dug between the 1980s and 2000 were 'without proper management' and 'poorly designed.' After the government closed many of them and irrigation on the lands after the year 2000 was through 'newly designed wells' dug by the government – 'with proper management' - groundwater withdrawal decreased across the decade.
43 Maan, op. cit.
44 In section four, we will see how the drowning of the oasis recently became an existential threat that the community identifies as such.
45 Cited in: Maan, op cit.
46 ds/m or dS/m is: "decisiemens per metre", a measuring unit for groundwater salinity relying on electric conductivity. 1 siemen is equal to 10 decisiemens.
47 Moghazy and Kaluarachchi, op cit.
48 Elsheikh et al, 2023, op cit.
49 Moghazy and Kaluarachchi, op cit.
50 IPCC, op cit., chapter 3.
51 Nixon, Rob (2011) Slow Violence and the Environmentalism of the Poor. Massachusetts: Harvard University Press. 19.
52 Ou-Salah, L. (2024) 'Gendering Climate Change in Moroccan Souss-Massa,' Souffles Monde: A Pan-African Journal and Platform, Issue 2: https://www.soufflesmonde.com/posts/gendering-climate-change-in-moroccan-souss-massa; War On Want, 2022. Profiting from Hunger: 9. The Power of Unions In Morocco: workers organising against exploitation in export-oriented megafarms. [online] https://waronwant.org/profiting-hunger/9-moroccan-workers-organising-against-exploitation-mega-farms
53 Moghazy and Kaluarachchi, op cit.
54 White, Silva (1899) From Sphinx to Oracle: Through the Libyan Desert to the Oasis of Jupiter Ammon. London: Hurst and Blackett, LTD, chapters 12-13; Badran, W. (2020). عمر المختار: "أسد الصحراء" الذي أصبح رمزاً لمقاومة المستعمر في ليبيا" [O -Mukhtar: The "Desert Lion" who became a symbol of fighting colonialism in Libya", BBC Arabic, 5 September: https://www.bbc.com/arabic/middleeast-54029241
55 Ahmed Fakhry estimates the number at "more than 300": Fakhry, A. (1973) Siwa Oasis. Cairo: AUC Press, 37.
56 Ibid, 36-37.
57 The second wave of expansion is marked by another digging technology that enabled reclaiming uplands farther away from the centre, as we will detail in the next subsection.
58 Interview with Magid (pseudonym), April 2024, Siwa.
59 More on oil in Siwa: Fakhry, op. cit., 37.
60 The following information is from interview with Maged (see footnote after the next), but the date range for the Russian company drilling in Siwa is from: Al-Banbi, Hamdi (1999) البترول المصري: تجارب الماضي وآفاق المستقبل [Egyptian Petroleum: Lessons of the Past and the Outlook for the Future'], Cairo: Dar Al-Maarif, 179.
61 Known as Beer Wahed or Well no. 1, drilled in July 1969 according to: Ibid.

62 Interview with Magid, April 2024, Siwa.
63 Group interview, April 2024, Siwa.
64 Interlocutors remember it as "slightly before the January 2011 revolution". It is 2011 according to: Al-Batriq, E. (2018) "الدولة تحكم السيطرة عليها بعد عشوائية دامت سنوات.. "الملح الصخري" في سيوة.. ثروة قومية" [The state controls it after years of chao "rock salt in Siwa.. A national treasure"], Al Ahram, 25 November: https://gate.ahram.org.eg/daily/NewsPrint/682674.aspx
65 Group interview, April 2024, Siwa.
66 Stanley, op. cit, 294: 'A year's supply of this salt is collected by the natives on the Eve of Courban Bairam and at no other time, and on this day hundreds of donkeys and labourers can be seen taking loads of it away from the Khamisa district, where the best salt is found.' Ahmed Fakhry (op. cit., 64) also speaks of salt - in the 1940s - as part of over a week-long celebration in Siwa around Bairam (Eid al-Adha): Zaggalah brought 'large quantities of salt from a special district in one of the salt lakes' on the eighth day of Zu al-Higga month (the 11th is the Eid al-Adha).
67 Interlocutors actually claimed that salt was deliberately left in the ground (used for local needs only) in the Sheikhs agreement.
68 Al-Meligi, S. and Al-Sherif, G. M. (2019) "غرفة التعدين: سيوة تمتلك 02 مليار طن ملح متجددة.. وتصدير الخام جريمة" [Mining Chamber: Siwa possesses 20 billion renewable tons of salt, exporting it in raw form is "a crime']. Al-Masry Al-Youm, 28 February: https://www.almasryalyoum.com/news/details/1374060
69 Interview with a wells-digging technician, Siwa, April 2024.
70 According to several investors, during field visits to farms.
71 Group Interview, April 2024, Siwa.
72 Ibid.
73 On the project and NAS reliance (the state plans to use NAS for 90% of irrigation in reclaimed land across the Western Desert), see: Hamed, A. (2022) "أعوام أضافت 4 ملايين فدان للرقعة الزراعية لتوفير الغذاء للمصريين" [8 years have added 4 million acres of agricultural land, to provide food for Egyptians], Al-Ahram, 9 June: https://gate.ahram.org.eg/News/3543550.aspx
74 Goodman, E. (2021) Dual Threats: Water Scarcity and Rising Sea Levels in Egypt, The Tahrir Institute for Middle East Policy, 20 August: https://timep.org/2021/08/20/dual-threats-water-scarcity-and-rising-sea-levels-in-egypt/
75 "Water Management Challenges in Egypt", Fanack Water, 5 July 2023: https://water.fanack.com/egypt/water-management-challenges-in-egypt/
76 Youssef, G. A. (1970) "ريغصلا مأ ةراق' [Qarah Um '-Saghir], Al-Fenoun Al-Sha'biya, 4 (13): June 1970. Cairo: Ministry of Culture.
77 Musad, A. (2018) 03 اتفاق بين "الريف المصري" ومستثمر أسباني لزراعة ألف فدان زيتون بسيوة [El-Reef El-Masry signs a contract with a Spanish investor for 30,000 acres to cultivate olive trees in Siwa], Masrawy, 6 November.
78 Hasan, S. (2019) "الريف المصري ترفع سقف تملك أراضي "سيوة" لصغار المزارعين إلى ألف فدان" [El-Reef El-Masry raises the minimum land plots for small farmers to 1,000 acres], Al-Borsa, 25 June: https://www.alborsaanews.com/2019/06/25/1217403
79 This decision pushing for large scale might have to do with the technical capacities of solar power. A unit of PVCs that can irrigate 3 acres (1.2 hectares) can provide enough water for 50 or 100 acres. We discuss this in detail in section four.
80 Abu Amra, M. (2020) الريف المصري: تسليم أراض جديدة لمنتفعي مشروع الـ 5.1 مليون فدان بسيوة [El-Reef El-Masry hands over new land plots to the investors of the 0.6 hectares in Siwa], El-Watan, 20 November: https://www.el-watannews.com/news/details/5056037
81 Interview with a solar power technician, April 2024, Siwa.
82 Osman, D. (2023) "رئيس الوزراء يزور "سيوة" لمتابعة المشروعات الخدمية والتنموية" [The Prime Minister visits "Siwa" to fo up on service-delivering and developmental projects], Al-Masry Al-Youm, 11 July: https://www.almasry-alyoum.com/news/details/2930279
83 Interview with Halim (pseudonym), April 2024, Siwa.
84 Information from several interviews, April 2024, Siwa.
85 Interview with solar power technician, April 2024, Siwa.
86 Ibid.
87 Ibid.
88 "...but nothing in the range of 200 and 250 HP stations we hear are installed in Upper Egypt', the technician added. Ibid.
89 Ibid.
90 All interlocutors without exception noted in April 2024 the unprecedented, accelerated pace of investments in the uplands.
91 Observations by the researchers in Siwa oasis over the last four years.
92 Interview with a solar power technician, April 2024, Siwa.
93 Interview with Tamir (pseudonym), April 2024, south of Siwa.
94 Group interview with several agrarian labourers, April 2024, Siwa.
95 Ibid.

The Transnational Institute (TNI) is an international research and advocacy institute committed to building a just, democratic and sustainable planet. For 50 years, TNI has served as a unique nexus between social movements, engaged scholars and policy-makers. And for two decades, TNI has been working on public alternatives with a focus on public ownership of energy. The project towards establishing an international Public Power Observatory is embedded in this accumulated knowledge and expertise. https://www.tni.org/en