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WATER IN GAZA: PROBLEMS AND PROSPECTS

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Water in Gaza: problems and prospects

Clemens Messerschmid*

1.Introduction

"It is almost impossible to believe that the Gaza Strip was ever an oasis. But Gaza's fresh sweet groundwater has been nourishing inhabitants for over 3,000 years. It was always the first stop of conquerors leaving Egypt for the riches of Syria. Like the Pharaohs before him, Alexander the Great sought the cool wells of Gaza at the end of his trek across the Sinai desert. Wadi Gaza and Wadi Beit Hanoun, that used to run clear with fresh water, now stagnate like cesspits" (Zeitoun 2007, 5).

It is often said that the Middle East is the driest area of the world (**Fig.1**). This characterisation "naturalizes" the water crisis and it overlooks the large differences within the region. If we focus on actual withdrawals of fresh water we find Gaza and even the relatively wet West Bank at the very bottom of the scale – of course due to the severe restrictions Israel's ongoing occupation imposes on the water sectors and hence on resource development in the occupied Palestinian territories (oPt).

2.Gaza's crisis of water quality and quantity

Conditions in Gaza and the West Bank are almost the exact opposites of one another. While the West Bank is rich in groundwater, Gaza has hardly any appreciable recharge from rain. The West Bank enjoys a relative abundance of naturally available and renewable freshwater resources (some 750-800 million cubic meters per year (mcm/yr), abstracted from the aquifers emerging in the West Bank[1]); Gaza, in contrast, lies in a much drier climate zone. As the isohyetic map (**Fig.2***)* shows, the Gaza Strip covers the transition zone between semi-arid (>400mm of rain per year) and arid (<200mm/yr) climates.

In the West Bank access to the locally available groundwater is severely restricted by the occupation, while in contrast Gaza suffers from too much access and severe over-abstractions from the small shallow aquifer. And although groundwater in the West Bank is mostly of excellent quality, almost all water in Gaza is contaminated.

In consequence, and on the technical level, while the West Bank suffers from a quantitative supply crisis, Gaza is exposed to a severe environmental and water quality crisis. And while renewable groundwater is

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[1] However, about 90% of this flow from wells and springs remains under Israel's exclusive control, imposed illegally by the occupation.

a finite resource of low supply elasticity, population has grown enormously over the past century, thus diminishing local in-situ water availability per capita at a dramatic pace.

3. Water under the British Mandate and after

"Specified flows"[2] in the Gaza district between 1920 and 1943 were approximately evenly distributed between Jews and non-Jews: Altogether, some 27mcm of well pumpage are recorded by British Mandate Authorities, of which 12 mcm can be attributed to Palestinians and 11mcm to Jews (the remaining 10%, or around 3mcm, can be attributed to "others" – other minorities, such as Druze or Tcherkessians – or cannot clearly be attributed to either Jews or Palestinians).

It should be noted that Gaza district then was more than three times larger than the Gaza Strip today. It reached beyond Isdod (Ashdod) in the North and almost to Al-Qubeibeh to the East (see British mandate maps - **Figs. 3 & 4**). Its size changed from 1196km^2 in 1931 to 1111km^2 in 1945 due to administrative reforms under the Mandate. Thus, if evenly distributed, only some 10mcm/yr of well pumpage would fall into the area of today's Gaza Strip. As map 2 shows, most of the wells in the district then were concentrated north of today's Gaza perimeter. According to census data gathered in 1922, 1931 and 1940, the population density in the district grew from 61.8 persons per km^2 to 79.1 and 100.3 persons per km^2. (Compare this to almost 5000 persons/km^2 today!).

The map in **Fig. 4** shows the historical distribution of wells (and the lack of springs) in and around Gaza district.

A letter from the High Commissioner for Palestine in Jerusalem (10 Dec 1932) documents that wells supplying drinking water reached a pumpage of at least 50m^3/h (equal to 0.4mcm/yr) and one such well supplied 60% of Gaza city. The letter reports the plans to establish one additional hand-dug well (19m deep) and two boreholes (25m deep, 12" diameter) for Gaza City Water Supply. If each of these additional wells supplied only 30-40m^3/h, Gaza City's population would have been served with a bulk supply of some 90-105 litres per capita per day (l/c/d).[3] (High Commissioner 1932: 1).[4]

[2] The 'specified flows' are British Mandate water measurements, quoted from Messerschmid (2008a, 15). These data were compiled according to three data registers which focus on the period 1920-1943:

- *Water Resources of Palestine* (1943), by the Government of Palestine (copied from the UK National Archives and set up as Excel files) listing some 2000 water sources over a period of 23 years; hereinafter referred to as **G.S.I. H.Q.** (1943).

- *Water Measurements Prior to 1944* (1947), by the Palestine Government, detailing mainly hydrological (surface) rather than hydrogeological (groundwater) data from rivers, springs, streams and wells. Some 2000 well entries on water level and salinity have been set up in Excel; hereinafter referred to as GoP (1947).

- *Geology and Water Resources in Palestine* (1947), written by G.S. Blake, the government geologist and listing another 277 wells and 230 springs with flows and other data of interest, hereinafter referred to as Blake (1947). Of these data points, 72 are saline and were excluded, and the rest compiled with **G.S.I. H.Q.** (1943).

[3] Daily per-capita supply in: Litres per capita per day, in the following abbreviated as l/c/d.

It is thus evident that the absolute water stress and the natural water resource scarcity in the days before the Nakba was far less than today. Gaza district's population grew from some 72,000 in 1922 to 94,000 in 1931 and then to 151,000 in 1945[5] (**Fig.5**). The turn for the worse in Gaza came with the mass expulsion of Palestinians in 1948/49, when hundreds of thousands of refugees flooded the small strip. Suddenly and overnight, the water supply was barely enough to even satisfy biological minimum drinking needs (**Fig. 6**). As will be shown in the following, Palestinians never recovered from this blow.

Under Egyptian rule, thousands[6] of wells were drilled, most of them for agriculture.

4.The transboundary Coastal Aquifer (today shared by Israel, Gaza & Egypt)

The primary water resource in Gaza is groundwater. Surface flows occur only occasionally after heavy storms in Wadi Gaza – a portion of which is further blocked upstream by Israel. The groundwater-bearing strata in Gaza belong to the so-called Coastal Aquifer. This aquifer stretches along the Mediterranean coast from Mt. Carmel in the north into the Sinai in the South and is thus a classically shared transboundary watercourse, as defined by customary international water law, such as the 1997 UN Convention on Transboundary Water Courses.[7] The main principle under this international law is called "equitable and reasonable share" and is based on a composite of several factors, such as **hydrological factors** (the size and distribution of the resource), **demographic factors** (size of respective populations) and the **use pattern** (past and current use), as well as factors from the wider realm of socio-economy like the **type of use** (for domestic, agricultural or industrial supply) and considerations **beyond the respective aquifer** in question (such as the dependency of a state on this source, or alternative water sources that a state may have), and of course 'vital human needs'.

The aquifer, as mentioned above, is mainly pumped by Israel (**75%**). In the years since Oslo II was signed in 1995/96 Israel's abstractions have been between 370 and 523mcm/yr with an arithmetic average of 437mcm/yr, while Gaza has an average abstraction rate around **154mcm (=25.5% share**). A similarly strong contrast emerges if the sustainable yields in Israel and Gaza are compared: Gaza has a natural recharge of some ~**60mcm/yr**. More importantly, and as stated before, this Coastal Aquifer constitutes the only water source of the Gaza Strip itself (especially under conditions of complete separation from the West Bank).

[4] The total pumpage from these wells is only 1.1 to 1.4 mcm/yr for an urban and peri-urban population of 17,000 and 35,000 respectively (High Commissioner 1932, 1).

[5] The margin of deviation in different population statistics is some 2,000 or <3%.

[6] There are 2600 registered agricultural wells (according to PWA, 2010) – mostly from the Egyptian period – and another 2000 agricultural wells drilled in recent years without any registration or governmental supervision.

[7] The full name is "United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses, May 21, 1997, adopted by the United Nations General Assembly and opened for signature in 1997" herein cited as (UN-GA 1997).

5.Groundwater recharge, abstractions and quality

The Coastal Aquifer (also called "Coastal Aquifer Basin" – CAB) is a shallow aquifer that consists mostly of sand and gravel. The aquifer is replenished by direct rainfall infiltrating into the sands. In addition, return flows from leaky supply networks, agricultural irrigation flows and domestic or industrial sewage play an increasing role in the overall water budget of the aquifer. Last, but not least, lateral subsurface groundwater inflows from neighbouring aquifers have an important impact on both the quantitative and qualitative conditions of its groundwater.

In Israel in most years, total pumpage **(466mcm)** lies slightly (9%) above total recharge (426mcm).

As **Table 1** shows, almost 60% of recharge is from rain and about 30% comes from the Shafdan treatment plant, whose treated effluents are re-infiltrated in sand beds. The rest of the recharge mainly comes from irrigation return flows (7%) and from leakage in water reservoirs (4%), which are filled mostly by flood water.[8] A part of this flood water stems from the upper Wadi Gaza, which Israel intercepts and stores on its side of the border. Direct recharge through wells with water from the NWC and the Western Aquifer existed in the past (7.1 mcm in 97/98) but virtually ceased (0.002% now). Of the total pumpage, 46% goes to agriculture,[9] and the other half mostly to domestic supply.

UNEP (2009) reports rainfall recharge of 45 mcm/yr inside Gaza (equivalent to a rainfall-'*recharge coefficient*' of ~41.4%),[10] while pumpage is quoted there (UNEP 2009, 55) as 163mcm/yr for the year 2007.[11] PWA (2010, 19) reports over 4600 agricultural wells, 2000 of which were drilled without regulation or supervision in past years (PWA 2010, 11, 19). **HWE (2010, 42)[12] estimates recharge** at 138.8mcm/yr, with rainfall recharge at **35mcm/yr (Table 1**) and abstractions at **176.6mcm/yr** (**Table 1**), thus calculating an annual deficit of 38mcm/yr (deficit = 27% of recharge).[13]

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[8] For the year 2006/07, the Hydrological Service of Israel (HSI 2008, 110) accounted for 17.05mcm of indirect recharge from reservoirs, of which 13.52 came from floods and storm runoff and a mere 3.53mcm from water pumped in the National Water Carrier (NWC).

[9] Two-thirds are fresh water from boreholes and the NWC, one-third is from treated effluents as in the pump schemes around Shafadan.

[10] (300mm/yr*362km^2*41.4%=45mcm/yr) The *recharge coefficient*, in other words, means that out of 100 litres of rain falling on a given area, 41 litres infiltrate into the ground and replenish the groundwater-bearing aquifer strata beneath the ground.

[11] Pumpage in 2007 was an estimated 163mcm/yr with 60-65% agriculture and 35-40% domestic and industrial. Quotation: (UNEP 2009, 55 – quoting CMWU 2008).

[12] Table 5-1: Water Balance for Hydrological Year 2008/09. NOTE: The HWE Groundwater Protection Plan (HWE 2010, 42) in its Table 5-1 (Water Balance for the Hydrological Year 2008/09) calculates a total municipal abstraction rate of 94.2mcm/yr. Yet, leakage from ailing networks is reported high – between 25% and 30%. If we apply a 25% rate of physical losses (24mcm), this results in a net supply of 71mcm/yr. A 30% loss rate (31mcm) would result in only 63mcm/yr of net supply.

[13] Notes on HWE-calculations with respect to 'Return Flows': For the inflowing water, Return Flows should refer to only to the actually consumed domestic water only, not to all produced water; For the outflowing amounts, network leakage should also be subsumed under Return Flows.

In Gaza, recharge from rain, lateral groundwater inflow and anthropogenic return flows amounts to ~124 mcm/yr (Vengosh 2005, 17), while total abstractions amount to more than 150mcm/yr – thus creating a total annual deficit of ~31mcm/yr (or 20% of the budget), which means that one fifth of all abstractions are not covered by the yield of the aquifer. An overview of the above components of the Water Balance of Gaza is shown in the schematic flow chart (**Fig. 7**).

It should be added that it is not only in Gaza that the aquifer is over-pumped. The largest depressions of groundwater tables are actually found in the vicinity of Rehovot (**Fig.8**), near the main population centres in Israel, where the abstraction rates are especially high.

A schematic spatial overview of abstraction rates is shown in the following map (**Fig.9**), with the amount pumped indicated by the length of each column for two rows each.

This map (**Fig.9**) also shows that contrary to frequent but wrong allegations, Israel does not heavily pump around Gaza in order to intercept groundwater flow before it can enter the strip (among other reasons due to the aforementioned poor water quality in the South). Israel only abstracts ~25mcm/yr in the Southern CAB, but 345mcm/yr in the Central and Northern aquifer areas.[14] On average, Gaza, with ~176.6 mcm abstractions, enjoys a share of only one quarter (27%) of total abstractions from the aquifer (see **Table 6**).[15] It should be stressed here that high salinities in this aquifer are by no means a new phenomenon, as the comparison of historical and current salinities in the map (**Fig.11**) makes clear.[16] The map shows for the Central Gaza strip, for example, that moderately fresh to slightly brackish water conditions (200-350mg/l) have given way to strongly brackish and saline conditions (600-1000mg/l). South of Rafah and East of Deir Al-Balah, a highly saline plume is encroaching the strip from SE directions towards the coast (dark grey, >1000mg/l Chloride contents) – see **Fig.10**. Surprisingly, the strongest deterioration of freshness has occurred in the heavily pumped Central Israeli Coastal Plain, where formerly fresh water (light grey - <200mg/l) is now increasingly brackish to saline (between 200 and 1000mg/l) - see **Fig.11**!

It is important to note here that salinities – contrary to the widespread but mistaken narrative – encroach Gaza from **two** directions: From the Coast, as seawater intrusions, due to groundwater levels dropping below sea level; but also, and even more so, from the southeast, in other words, from within Israel, where the Coastal Aquifer is naturally connected to saline and hypersaline older regional aquifers (of Eocene age, "Avedat formation" in Israeli nomenclature) – here as well due to the dropping water levels inside Gaza, and thus increasing hydraulic gradients towards Gaza.

The above cross-section (**Fig. 12**) and the map of water levels (**Fig. 13**) below, both show schematically the flow connection with the saline "Avedat" aquifer/aquitard of Eocene age inside Israel.

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[14] This refers to the year 2003/04; source: (HSI 2005, 33).

[15] This share refers to the sum of Israeli and Palestinian abstractions, not including additional abstractions from the Egyptian part of the aquifer in Sinai.

[16] British Mandate groundwater salinity map from 1934/35 and Hydrological Survey of Israel data map 2004/05.

6. Sources of pollution and salinity

The large deficit in the water balance leads to a steady drop in water levels and thus a steepening of hydraulic gradients, both towards the borders of Gaza (both the sea and the eastern border). When groundwater levels drop below sea level, seawater intrusions are enabled. More importantly, the dropping water levels also increase the natural inflows of saline groundwater from the east and southeast. Other sources of pollution, besides the salt water intrusions from the sea and from the southeast, are mainly due to human activities on the ground inside Gaza, such as waste water effluents, solid waste disposal and agricultural by-products like fertilizers, pesticides, herbicides and the like. While the direct rainfall replenishment is of relatively fresh water quality, the other flows constitute a stress on the salinity and overall quality of the resource. In addition, surface pollution from unregulated solid waste deposition and agricultural use of pollutants such as fertilizers and pesticides renders the infiltration rain water dirty, thus contaminating the unsaturated zone and ultimately – with a delay of several (up to ten) years – the groundwater resources themselves.

Probably the largest sources of pollution finally are large amounts of untreated or insufficiently treated waste water infiltrating into the aquifer.[17] Mark Buttle, coordinator for the WASH cluster[18] concluded that the "main reason is sewage infiltrating into the ground, while agriculture plays [only] a part through fertilizers. Khan Yunis, for example, relies entirely on cesspits and isn't connected to sewers."[19] Yet groundwater pollution is not restricted to Khan Yunis but ubiquitous throughout the Strip. Mark Buttle adds that there also was "a localized pollution problem stemming from the storm water lagoon which had a lot of sewage flowing into it for a few years" (Irving 2010, 2). In other words, waste water not only enters the unprotected (unconfined) dune sand and gravel aquifers with ease, in most of the so-called waste water lagoons, percolation into the ground is actually systematically enhanced, by boreholes drilled into the bottom of the lagoon and right into the aquifer!

This deeply flawed design is a feature almost unique to the Gaza Strip and dates back for many decades in the older lagoons, but is also used in the ones built recently. It should be noted that of course, this highly problematic approach, despite being given little attention in common

[17] There are no exact calculations as to the size of the salt and pollutant contribution from waste water. However, model calculations for the chloride mass balance inside Israel suggest that the bulk of salts entering the aquifer come from the unsaturated zone, which means from the delayed arrival of surface pollutants at the water table. According to calculations by HSI (2006, 115/116) for the year 2006/07, of the 137,186 tons of chlorides entering the aquifer, 78% come through the unsaturated zone (with 10% from rain, 36% from irrigation and 32% from the spreading beds of the Shafdan effluents re-infiltration scheme). Only 22% (30,114 tons) are groundwater inflows from the east. And to the west, despite local seawater intrusion, the aquifer shows a slight net loss of 674 tons of chlorides into the sea. In other words, surface pollution by far outweighs subsurface entries of salty inflows (seawater and lateral groundwater from the east). In Gaza, the relative weight of subsurface salt entries is higher than in Israel, but it is still unlikely that they deliver more salt than the agricultural and waste water return flows (data from: HSI 2008, 115 ff.).

[18] WaSH - Water Sanitation and Health Cluster working group of Palestinian and International NGO's in the oPt.

[19] Interview with Mark Buttle; Quotation (Irving 2010, 1).

discussions of the water pollution crisis, has deeper political reasons directly linked to the occupation[20] and merits further explanation. A recent study by UNEP (2009, 32) concludes that water is now so saline in Gaza that it could be the end of agriculture there, or at least "a long-term reduction in agricultural activity."

7. "Enhanced" pollution

For decades Israel, despite its economic power and full sovereignty over its territory, has been dumping raw domestic and industrial sewage into the sea, rendering its streams highly polluted, even toxic; as a result Israel is considered the worst polluter of the Mediterranean. It was only a decade ago that Israel started to step up its efforts to treat domestic sewage, and it still has a long way to go. The first modern treatment plant for West Jerusalem was opened only in this millennium (2001) and East Jerusalem is not even under consideration for its own treatment plant. It should be remembered that an Australian athletic team participating in the Maccabean Games in 1997 fell into the shallow lower Yarqon River when a pedestrian bridge collapsed under them; this resulted in serious injuries, not from the fall or inability to swimming, but simply because they came into contact with the toxic liquids that make up the Yarqon River. Even off the coast, waters are so polluted that Israeli army divers have sued the government for compensation, because so many of them suffer from cancer and other potentially lethal diseases. Even the pride of Israel's waste water treatment system, Shafdan treatment plant near Tel Aviv, not many years ago was dumping the residual sludge into the sea. To this day, many streams in Israel carry untreated domestic and industrial sewage into the sea.

Not so in Gaza under tight direct occupation since 1967 and a total siege since 2007, Not one single modern and sufficiently sized treatment plant was erected there during decades of direct, full Israeli control. The few existing plants only partially treat the sewage and are hopelessly under-sized. Despite the fact that Gazans were given neither tools nor assistance in building their much-needed treatment facilities and often even were refused permits to construct, in Gaza Israel strictly enforces the ban on dumping sewage into the sea. No raw wastewater collection pipe or canal is allowed to channel the sewage directly to the shore; only unregulated runoff towards the sea can be observed (OCHA-CAP 2009, 18).[21]

This strict and discriminatory ban on marine sewage disposal is the reason why the so-called "waste water lagoons" remain the main feature of Palestinian waste water disposal. Originally built to accelerate groundwater recharge with storm water, "the location and design of these ponds was intended to facilitate easy and quick recharge. However, whenever the sewage pumps fail, the infiltration ponds become convenient dumping grounds for raw sewage. The net effect is that raw sewage infiltrates into the groundwater" (UNEP 2009, 56). In order to enhance this active recharge, a

[20] Most of these lagoons were constructed under the occupation and prior to Oslo.

[21] Some 50-80 million liters per day (~24mcm/yr) of raw or partially treated sewage has been released into the sea daily since January 2008 due to the crisis at the wastewater treatment plants. Quotation: OCHA-CAP (2009, 18).

special design was invented – perforating the bottom with boreholes dozens of meters deep that rapidly channel the waste water into the underground. Almost all lagoons in Gaza function in this scandalous way. Hence, nearly the entire freight of pollutants is actively "recharged" into the shallow unsaturated zone between the ground and the water table, sometimes even directly into the groundwater body. More importantly, now even new donor-facilitated wastewater lagoons are designed in this fashion.[22] It is ironic - we have grown so accustomed to this flawed approach that a lagoon where the infiltration boreholes have become clogged over the years, is labelled as "not functioning *properly*".[23]

BOX: A silent Tsunami

For decades the old waste water lagoon with 3 million cubic metres of sewage has been hanging steeply over the city of Beit Lahia (OCHA Aerial photograph, **Fig. 14**).

Old Beit Lahiya Sewage Lake (3mcm, 3km long, 25m deep),

Old emergency lagoon (constructed in Sep '06, collapsed 31 Mar '07) (centre)

Flooded Bedouin community Umm El-Nasser (light grey in the middle),

Relocated two new "infiltration basins" ('new lagoons') 1.5 km North, built in summer 2007

In 2006, Palestinian NGOs made urgent pleas to allow pumping materials required to bring the level of the lake down into the Strip. "With the pleas came a host of consultants to look at the lake. Invariably the consultants would drive out to the lake, look at its saturated sandy levees in astonishment and say, 'If this thing ever bursts it will be a disaster'. And then they, as I did, would drive away." (Zeitoun 2007b).

In late 2006 a new lagoon was added, but at an unfavourable location and with a severe lack of building material. After strong rains, this new small lagoon burst on 27 March 2007, burying the Bedouin community Umm El-Nasser under its stinking floods. 250 homes were destroyed, and five people died in the floods of sewage, immediately termed "wastewater tsunami" by the press (**Fig.15**).

At the same time, all sewage had now to be pumped into the old lagoon, thus threatening to create an even larger catastrophe. The international community came to rescue with an emergency plan: Two new lagoons were to be erected near the northern border of the strip in order to prevent the main lake form collapsing. The two lagoons (**Fig's. 16a, 16b**) were termed "infiltration basins" and indeed with a daily pumping capacity of some 6,000m^3 and a total storage of only 250,000 m^3, these lagoons would be filled in another 40 days. In other words, in order to only contain the small side stream to the new lagoons, 17 such basins would be needed each year to prevent them from rapidly empty their contaminating load into the aquifer beneath (so far the freshest groundwater zone in Gaza, see **Fig.10**).

[22] It could not be otherwise: if these lagoons had their bottom properly sealed against infiltration into the ground, an overflow of the vast structures would be a matter of months, if not weeks.

[23] NB: To avoid any misunderstanding, it should be emphasised that dumping raw sewage into the sea is indeed the second worst option of all. But for a densely crowded stretch of land like Gaza, completely sealed off from the outside and depending solely on its scarce unprotected groundwater resources, the "infiltration basins" lagoons are clearly the single worst option.

Note: The presentation states:

*<u>Aim</u>: "Resume a **normal** operation of the wastewater system"*

*<u>Methods</u>: "Constructing a disposal pipeline to the identified **infiltration area**"*

Thus each lagoon was perforated at its bottom by a series of 'infiltration boreholes' several dozen meters deep that would swallow the daily inflow of sewage; in other words: An active and enhanced wastewater recharge to the aquifer. The problem is "solved": A silent tsunami of sewage keeps flowing ever since, out of our eyes and our minds – until new reports of diseases due to contaminated drinking water are making headlines…

8. "Emergency" for decades

I remember, in early 1997, one of the first meetings I attended was organised by the World Bank dealing with Gaza. The over-abstractions, pollution and seawater intrusion into the aquifer were characterised as an "emergency state of affairs" and it was stated dryly that under "normal circumstances" and in other countries, pumpage would have to stop immediately.

Thirteen years have passed – the problems, of course, being older than this time span – and not only has pumpage not been stopped, but thousands of private new wells were actually drilled and dug into the shallow aquifer.[24] A serious lack of even basic control over abstractions is the rule; we do not even know the approximate number of wells, let alone their annual abstraction rates.[25] Unsurprisingly, UNEP (2009) comes to the conclusion that an immediate halt of abstractions from the aquifer is imperative. So if the years before the Second Intifada were already marked by emergency conditions, how should the current state and latest developments be described? During the 1990s plans for future enhanced supply, upgraded and largely expanded waste water treatment, and other protection measures were drawn up. But by the year 2005, prior to the Israeli disengagement from the strip, 5 years of relentless Israeli counter-Intifada had left the strip in conditions much worse than ever before.

The Intifada

Israeli destruction of infrastructure is of course older than the most recent aggression in 2008/09: During the Second Intifada the hardest hit areas were Rafah and Beit Hanoun in the extreme south and

[24] A period of extreme drilling activity started after the war in summer 2006. With the trauma of the power plants being bombed by Israel and the wells consequently stopped operating, a real frenzy of uncontrolled private drilling broke out. There are only very rough estimates of the number of private wells dug in the year before the total siege was imposed over Gaza; some assume that more than 5000 wells were drilled by everybody who had the funds to do so. Every relatively prosperous homeowner ran to dig his own well, equipped with a pump and diesel generator, to "secure" supply during the frequent power (and water) cuts. PWA (2010) estimates the number of unregistered agricultural wells at 2000.

[25] PWA (2010) can only indirectly derive agricultural consumption estimates by applying an average irrigation water duty to all irrigated fields.

north of Gaza. In Rafah, the Israeli military destroyed 36 km of water lines and 42 km of waste water lines during its invasions in May 2004.[26] An estimated 20% of the existing water infrastructure was damaged by the Israeli military invasions. At the time, an American employee of USAID stationed in Gaza estimated that over 1000 wells had been destroyed, damaged, blown up or bulldozed by the Israeli army.

And yet, even this situation is now remembered as the good old days – before Israel cut off Gaza from all supplies and from the rest of the world, following the 2006 elections and the ensuing power split between Gaza and the West Bank.

When the Israeli government pulled out its settlers and redeployed the army, it left behind a scorched landscape, a raided infrastructure and a shattered water supply. At the same time, there was much hope. Grandiose promises were (once again) made by the international community. Billions of donor dollars were pledged in late 2005, none of which materialised. This is because Palestinians in Gaza had to be punished once again, this time for their fair and democratic elections in January 2006 that brought Hamas a landslide victory.

Israel started to identify Gaza as a 'hostile entity' – and this time was joined by the Western donor states and the Fatah-appointed government in Ramallah. In 2007, when Hamas took control over the Strip, a total siege and blockade was imposed by Israel, soon joined and actively supported by the donors and Abu Mazen's "legitimate government".

The siege

This siege has proven to be a most effective (and cruel) measure of strangulation. No spare parts, no construction materials and no equipment for operation and maintenance were allowed to enter this small, hermetically sealed patch of land. Any attempt to reconstruct after the past devastation, let alone expand and upgrade existing infrastructure, collapsed within weeks, with the last pipe, the last fitting and the last screw leaving the empty warehouses. Half a year into the siege, the strip was already devastated on a new level.

Half a year into the siege, Haaretz correspondent Amira Hass (2008) wrote:

> **"40% of Gazans lack running water"**
>
> "Gaza Strip residents Monday moved from worrying about the electricity cuts of the previous 40 hours to worrying about a water shortage.
>
> The municipality needs electricity to bring water to homes and the houses need it to pump water to the roof tanks. Hence 40 percent of Gaza Strip homes - 600,000 people - had no

[26] For example OCHA (2005) reports damage to 15km (out of the 20km) of sewage networks in Rafah after incursions in May 2004. For the almost monthly invasions in 2004, see also PHG (2005).

running water Monday, the Palestinian Water Authority said. Oxfam International said Monday that unless diesel and fuel supplies were resumed immediately, all the Strip's water pumps could stop working by Tuesday. The non-governmental organization also warned of the sewage system's collapse in the absence of diesel.

'*Without electric power we can manage somehow, without bread too*,' says a resident of the Nasser neighbourhood in northern Gaza.

'*It's cold enough to prevent the food from going bad and we try to open the refrigerator as little as possible. The kids grumble but they can learn to live without the computer. But without water? We calculate each step,'* he says. '*We don't put on the gas heaters, because tomorrow might be colder. We don't cook for long. But to consider whether to go to the toilet? Whether to wash our face? That is insufferable.'* {…}".

By the end of 2007, almost a year before operation "Cast Lead", OCHA reported, "In the same time, water supply is more dire than ever. Long-duration cuts in supply are the rule. Average consumption has dropped from 97 l/c/d before the second Intifada, to 57.8 l/c/d." (OCHA 2008).

International organisations started warning about an outbreak of epidemics, chronic diseases and acute health hazards like blue baby syndrome. Failing water and waste water services were identified as the number one public health hazard in Gaza.

War: Operation Cast Lead

The Israeli invasion, Operation "Cast Lead", further devastated the little that had remained (see **Table 2** below):[27] The Goldstone report found that "there was a deliberate and systematic policy on the part of the Israeli armed forces to target ... water installations" (Goldstone 2009, 22,217).[28] It further concluded that "in the destruction of private residential houses, water wells, water tanks, agricultural land and greenhouses there was a specific purpose of denying them for their sustenance to the population of the Gaza Strip." (Goldstone 2009, 26, par.73). At the height of the Israeli military offensive up to one third of the Gaza population was left without access to clean water, some for ten or more days (El-Jazairi 2008, 14).

UNEP (2009, 83, Table 27) estimates that total environmental damage (water, waste water, solid waste and related agricultural sectors) amounts to US$ 44 million (**Table 3**)

In addition to the long term and war damage, OCHA-CAP (2009, 17) described the general situation in Gaza: "CMWU needs 1,250 tons of cement to repair damaged water tanks alone. 10,000 people [*still*

[27] "Before the war, Gaza had 97% supply coverage at 80 litres per capita per day and 64 % sewage collection & treatment coverage". (UNEP 2009, 78)

[28] Quoted from UN-GA (2009), Clause n.54 (p.22) and Conclusion n.1026 (p. 217). (Goldstone: 22,217)

remain] without access to running water mains. Access to water for the rest of the population is restricted." Yet the siege on Gaza continues relentlessly.

In June OCHA (2010c, 11) reported that imports into Gaza, were 20% of those during the first half of 2007, before the siege. After the Israeli invasion (08/09), 70% of all industrial establishments were closed. Power cuts last up to 16 hours per day. Aid dependency now is 80%. UNRWA reported that by the beginning of 2010 the number of refugees that lived in abject poverty had risen to 300,000. This is a threefold increase from 100,000 in the year 2009. As Mark Buttle, WaSH coordinator in Gaza, explains, this "indicates people's coping mechanisms are coming to an end. For two or three years people have been getting by -- borrowing or selling the odd asset -- but I think there's an indication that people are fundamentally running out of coping mechanisms." (Irving 2010).

The situation after the war

A recent household survey conducted by PHG & UNICEF (2010) shows that although 98 per cent of Gaza's 1.5 million residents are connected to the water network, supply is intermittent. Only 48% of households have running water four or more days a week. Some places receive no running water (like Al Mawasi), or only partially (Khan Younis camp, 52% of households).[29] In other places (Rafah, Ash Shati' Camp) water runs just once a week. However, the majority of the population does not use the municipal water supply for drinking.

Drinking water

13.1% drink water from the networks, and 4.2% get desalinated water supplied by the CMWU through networks or communal filling stations. "The vast majority, 82.7 per cent, rely on unregulated private water vendors, either with tankers or jerry cans." The business of private vendors has grown into a full-fledged industry, "a whole parallel drinking water system from the private sector. There are about 70 privately-run boreholes in Gaza and each one has its own private desalination plant and tanker trucks to deliver the water to people's homes" (Irving 2010, 1).

Water for drinking is a basic right of every human being. According to the World Health Organization WHO each person should have daily access to 100 litres of clean, affordable and reliable water supply (100 l/c/d). The Millennium Development Guideline that deals with ensuring sustainability in environmental matters "aims at halving by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation" (Millennium Goal 7, Target 10 – UN-MDG 2010, 58).

In areas like Gaza such well-sounding promises disgrace themselves – quality and quantity of supply are not on a slow rise, but dropping rapidly.

[29] "In Al Mawasi no household has running water and in Khan Younis camp 52 per cent do not have running water. Al Maghazi camp is the only area where all households have running water the majority of the time, four to seven days a week. In some places like Rafah and Ash Shati' Camp it runs just once a week." (PHG 2010, 14).

The aforementioned 57.8 l/c/d (OCHA, 2008) were an average value for the year 2008, before the war. A recent household survey (PHG 2010, 15) revealed that a mere 6% of households can rely on networked municipal supply as their source of essential drinking water (**Fig. 19**). In the poorest areas, such as Khan Yunis, up to one third of households cannot even rely on municipal supply for purposes, other than drinking (see 'domestic supply'[30] sources – **Fig.20**). Instead, they depend on unregulated and unmonitored private wells or on humanitarian aid for this basic commodity (PHG 2010, 17 – **Fig. 20**). Households that are not connected to any water network, have no other resort but to either dig for water themselves (in some regions the water level is only a few meters below ground level) or to purchase water from private tanker "trucks" (photo – **Fig.17,** graph **- Fig. 19**); in some areas, they drink from agricultural wells.[31]

On average, a jerry can of 18 litres of water costs one NIS, or 56 NIS per cubic-metre, though this varies by area (photo – **Fig.18**). (By comparison, a cubic metre of network water costs 0.5 to 1.5 NIS in Gaza, or 4 NIS in Ramallah.) "Such rates are unaffordable for poor households – spending up to one-third of their income on water" (Mark Buttle in: Irving 2010, 1). Like everywhere in the world, from Bogotá to Lagos, the poorest pay the highest water prices – or have to consume water unsuitable for drinking. Yet despite being unaffordable for many, even this water is not safe: "When produced it's normally pure," says Mark Buttle, adding that this unregulated system fails during handling and transport in private tankers that pump the water into the household tanks. "During a delivery run dozens of people might handle the pipe – it only takes one not to have washed their hands. 70 percent of samples show positive for bacteriological pollution." (Mark Buttle, Electronic Intifada; June, 2010 – Irving 2010)

"Rising poverty forced many people to drink water from private and agricultural wells that are polluted from farming and wastewater seepage. In Al Mawasi, where there is no water network (and only 58% of households are able to buy water from vendors), 47% say agricultural wells are their primary source of drinking water" (PHG 2010, 14, 15).

Across Gaza, only 32% of households can afford to use drinking water for cooking. "Cooking heightens the concentration of nitrates and other salts even further. 44% of respondents said they take daily showers." (PHG 2010, 9).

<u>Water that makes people sick</u>

The over-abstractions and the pollution together create a lethal mix: Water-borne diseases have been designated public health hazard No. 1 in Gaza by the WHO and UN and international NGOs operating in the water sector.

[30] 'Domestic' water here is understood as water for daily household operations, other than drinking water, like laundry, cleaning, and so forth.

[31] GCI (2008) studied water quality in these private owned and operated tankers and found reasons for grave concern about the water quality – mainly due to mishandling in storage and transportation of the desalinated brackish water.

A mere 7.5 % of the 129 municipal drinking water supply wells meet WHO standards of chloride content (**Fig.21**). In the last ten years, the salt concentration has risen around 30%. The water in Gaza makes people sick (Box 1). The household survey (PHG 2010, 9) concludes that on average, due to poor water quality and hygiene practices, 20% of households had at least one child under the age of five who had been infected with severe diarrhoea in the four weeks prior to the survey; locally (Beit Hanoun) this ratio can rise up to 38%.

Box 1: When water makes people sick: water and waste water problems

COHRE, the "Centre on Housing Rights and Evictions" wrote in January 2008 that:

• Water-borne diseases resulting from the lack of clean drinking water included diarrhoea, hepatitis A, typhoid fever, paratyphoid, and gastro enteritis.

• Water-borne infections resulting from poor sanitary conditions included trachoma, conjunctivitis, dysentery, gastro-enteritis and hookworm.

• Children are the most vulnerable. In October 2007, the WHO reported that compared to the previous year, the number of children aged three and under who were diagnosed as having diarrhoea at UNRWA health clinics in Gaza had increased by 20%.

• More than 50% of children in the area around Beit Lahia in the Northern Gaza Strip suffered from parasites and helminths, transmitted by the mosquitoes which are prevalent in and around the waste-water lake. These parasitic infections … can cause long-term effects such as anaemia, retarded growth and mental disorders. Skin infections and allergies are also common as well as respiratory problems due to the gases produced by sewage pools. High salinities in drinking water are also a major cause of kidney problems.

• WHO regularly detects alarmingly high nitrate contents from sewage and agriculture, for example in October 2007, especially in the wells of Gaza city, Jabalia and Khan Younis.

COHRE reminds us of the fact that according to international law,

“an occupying power is obliged to ensure public health and hygiene … The Convention on the Rights of the Child, ratified by Israel, also recognizes the right of the child to the highest attainable standard of health and states that the provision of clean drinking water is necessary to combat disease.) The right to water and sanitation is also essential in order to safeguard people from potentially fatal diseases such as diarrhoea and cholera. The blockade and restrictions on monetary transfers are therefore leading to a violation of international human rights law and international humanitarian law.”

Domestic water for cleaning, cooking and personal hygiene

The reliance on networks or other sources depends largely on the area – and hence water quality – of households. On average, 86% generally rely on the network for domestic water (**Fig. 20**) but half are reluctant to use this water for cooking due to water quality concerns. In many refugee camps, however, water quality (or availability) is too bad even for using water for domestic purposes. In Khan Younis refugee camp only 57% source their domestic water from the network; the rest depend on aid. In Jabalya only 13% are supplied by the network, 45% rely on aid, and the rest on private supply (vendors 29% and wells 13%). In areas with hardly any network, such as Al Mawasi, as few as 1.4% of households receive domestic water from the municipal network while 98.7% draw it from private wells (PHG 2010, 17).

Yet, as already mentioned, water quality has long dropped below drinking water standards and is steadily declining. After the war, UNEP (2009, 61, 62 – Table 16) sampled both private and municipal water wells, with a distressing result: Seven of the nine private wells tested, and all three municipal wells tested, failed to reach WHO standards (especially with respect to chlorides, in some locations).

A vicious circle

In order to prevent people from drinking water from unregulated agricultural wells, controlled networked water would have to be brought to their homes. This requires large-scale repairs and local expansion of slowly rotting networks. Yet the siege on Gaza prevents all such projects from being implemented. No pipes, not even raw materials for plastic pipes, are allowed in. Key water project materials short-listed **by WaSH as priorities** are: Water pipes, cement, steel bar, aggregates and any sort of fittings, as well as generators, mobile water pumps and pump motors. An Oxfam staff member said,

Example: We drew up a clear priority list of things for winter 2009 and started negotiating in October. We received items in March, April and May 2010. The main projects like big sewage and wastewater projects cannot progress without materials coming from Israel, and we're talking tens of thousands of tons of cement.[32] At Oxfam, we're working mostly at an emergency approach … big projects can't happen… (Mark Buttle in: Irving 2010, 1)

Gaza had already run out of pipes in late 2007. “At the moment there is one pipe factory in Gaza which is producing, but there are knotty problems for aid agencies about the legalities of buying pipes when you are unsure if the raw materials entered Gaza through the tunnels. It's a not a simple problem”. (Mark Buttle, in Irving (2010, 2).[33]

This is the way Western donor states, and even NGOs, comply with the total siege on Gaza. The siege on Gaza is not only imposed by an Israeli government known for its contempt for international law. It is supported and deepened by the actions (and inactivity) of Western democracies, NGOs and the rival Palestinian authority in Ramallah.[34]

[32] Each month a handful of trucks are getting through at best, not the many thousands needed.

[33] “Water in Gaza: ‘It's not a simple problem‘” in Irving (2010). 45% of all water in Gaza leaks into the ground.

[34] “Abbas to Obama: I’m against lifting the Gaza naval blockade … because this would bolster Hamas” (Haaretz 24 September 2010).

For ten years, Gaza has seen nothing but destruction in waves ever more accelerating and intensifying, while at the same time, supplies of even the most basic materials for repairs are denied entry. It is against this background that Mark Buttle described the 2008/09 Military invasion with its “deliberate and systematic policy… to target… water installations” (Goldstone 2009, 22, 217)[35] in seemingly euphemistic terms:

“But even this is only the tip of the iceberg. A lot of problems now (such as decrepit pipes) are not due to Israel's invasion in winter 2008-09 ("Operation Cast Lead"). They're down to the overall deterioration of things over time” (Irving 2010, 2).

The water and sanitation situation today, almost 20months after the war, shall be illustrated by two examples: the chronic fuel shortage and the blocking of trucks entering the strip (WaSH 2010a, 1):

a) Fuel

Lack of fuel results in

- 12-18 hours of continuous power cut-off per day; In addition, the current low voltage is inadequate to run CMWU water facilities. Thus 170 wells and 40 sewage pump stations are affected, as well as 4 wastewater treatment plants and 5 water desalination units.
- severe impediments on water supply and production: 25 water wells without standby power generators only operate when power is available.
- a 43% drop in water production and the interruption of pressurized water in the network. Most affected are those living in elevated areas and in residential towers.
- 50% of Gazans having access to water once a week only (6-8 hours).
- a 50% drop of production in the desalination units supplying drinking water. Residents of southern and central Gaza now are forced to purchase drinking water from the private vendors or from agricultural wells (at up to 40NIS/m^3) causing a serious health risk.
- sewage pump stations operating 12 to 24 hours per day and overflowing into the infiltration lagoons. Pump station No. B7 – which usually pumps ~40% of all Gaza City wastewater – now is at risk of total collapse.
- rising wastewater levels: the North Gaza treatment plant was forced to use the emergency latch (to prevent another Umm Nasser sewage flood) relieving raw sewage into the sea. Bathing along the shoreline, one of the few recreational activities available in Gaza, constitutes a great health risk.

Under current conditions, no risk mitigating response is feasible – WaSH dryly states: “No real changes in fuel supply. At present, no specific support is given to CMWU except for UNRWA’s one-time provision

[35] Quoted from UN-GA (2009), Clause n.54 (p.22) and Conclusion n.1026 (p. 217) (Goldstone 2009, 22, 217).

of 100m^3." (WaSH 2010a) A one-time delivery of 100m^3 of fuel in a month, entering a strip with 1.5 million inhabitants is worth reporting![36]

And on July 16, 2010, OCHA (2010b, 10) adds that "Industrial fuel imports for the Gaza power plant continued to decline for the seventh consecutive month to now only 3.6 million litres per month (**Fig. 22**) and thus reached the lowest levels recorded since December 2008." This represents "27 percent of the amount of fuel required to operate the plant at full capacity. The Gaza Power Plant was forced to completely shut down for five days, triggering power cuts of 12-16 hours per day." (OCHA 2010b).

This situation continued for the fourth consecutive year and throughout the summer:[37]

b) TRUCKS

The fuel crisis as well as the general crisis in Gaza is of course the result of trucks with supplies being prevented from entering the strip due to the Israeli siege on Gaza. And thus Gaza is probably the only place in the world where the exact number of trucks crossing the border is counted meticulously and makes daily headlines.

During the first five months of 2010, overall construction material imports (humanitarian and commercial) were 388 trucks or 1% the amount prior to the blockade (then 7,400 per month).

Exports of flowers and strawberries (in the 12 months from April 2009 until April 2010) amounted to 118 trucks. This is 0.9% of their previous level. OCHA (2010a, 11) states that "the continued ban on exports has been one of the key reasons for the collapse of the private sector." (OCHA 2010a, 11).

Water and sanitation here are not the exception: According to OCHA (2010d), the number of all trucks with humanitarian goods in the year 2010 (January to September) was close to zero: All in all, 233 trucks with humanitarian construction materials and only 19 trucks with hygiene and cleaning supplies entered Gaza, equivalent to 0.91 and 0.08 trucks per day in average, respectively. In the 3 months since the "easing" of the siege, from June to August 2010, only 2 (two) humanitarian trucks for hygiene and cleaning supplies entered Gaza.

The WaSH Cluster specifically counts the trucks for Water, Sanitation and Health. **Table 4** shows that in June, July and August 2010, and since Israel announced the "easing" of the siege in June 2010, a total of 64.5 trucks with emergency WaSH materials could enter the strip (44.5, excluding chlorine deliveries). In 2010, 20 WaSH trucks per month on average entered Gaza, or 10.6 trucks excluding chlorine supplies.

Three generations…

[36] Distributed evenly, these 100m^3/month for Gaza are equivalent to 2 millilitres per person per day.

[37] 8-12 hours daily power cuts; 40% of population get water once a week (6-8 hrs) - without power, the water cannot be pumped to the roof water tanks (WASH 2010b, 1).

In July, OCHA (2010c, 8) reports: “Karni Crossing was built and equipped to handle over 750 truckloads a day. However, it remains limited to only one conveyor belt used for the transfer of grains and construction gravel - the main elements of the crossing remain closed (‘security concerns’). In Karni, UNRWA, for example, could transfer only 30 truckloads of gravel per week (in average 4.2 trucks per day) through this one conveyer belt. At this pace, it would take approximately 15 years to bring in the 24,000 truckloads of aggregate needed to carry out 26 frozen UNRWA projects, and about **75 years** to bring in the aggregates needed to implement the whole UNRWA reconstruction plan for Gaza.”

Controlled Items - The Easing of the Siege

Following the attack on the international Gaza aid flotilla, in which 9 unarmed civilians were killed by Israeli troops, world attention once again turned to Gaza. Israel was under pressure and promised in June 2010 to ease restrictions on the entry of goods. But there was not very much pressure, as all sides hastened to agree that they do not seek a fundamental change in policy.

The so-called “easing” consisted of a shift “from a list of permitted items to a list of banned items” (issued on 5 July 2010) such as military and dual use items which remain prohibited or restricted.

Dual-use items are specified in two separate lists, one list of 15 categories of general items, including fertilizers, glass fibre-based raw materials, drilling equipment, vessels and water disinfectants, and another list of 19 types of construction materials (to be limited to projects under international supervision), including cement, aggregates (gravel), prepared concrete, concrete blocks, steel elements, asphalt, sealing materials, and construction vehicles, and so on (OCHA 2010b, 8).

JUNE

“The announced ‘easing’ of the blockade (crossing Kerem Shalom)… however, is not reflected in the number of trucks carrying WASH materials. The WASH sector is currently awaiting entry of materials for 37 emergency projects, worth over 85 million USD. **UNDP** reports that the construction of water tanks is on hold due to unavailability of construction material.” (WaSH 2010b, 2).

JULY

“Imports of construction materials remain restricted. Under the new measures, such materials are considered ‘dual use’ items, and are only allowed for projects approved by the Palestinian Authority (PA) and supervised by international organizations. As a result, no change is expected in the private sector’s ability to address housing needs, which have increased since the imposition of the blockade, and exacerbated by the destruction of homes during the ‘Cast Lead’ offensive.

This month [*July 2010*], Israeli authorities approved a total of 31 new construction projects, including eleven to be administered by the UN. These include eight new schools, and classroom additions at two existing schools, and two health clinics. However, the approved projects are only a small part of what is needed: the value of the approved UN projects (USD 15 million) is only 1.4 percent of the total value of the proposed programme of work for the UN in Gaza (USD 1.05 billion).” (OCHA 2010c, 7, 8).

The new Israeli policy, it turns out, is not so new after all. The “easing” in principle should not be confused with real changes on the ground – real trucks passing the land entry points to Gaza. “So far, approvals have only been given in principle, and follow-up negotiations are required for approval of the detailed list of items, and to establish the entry schedule.” (OCHA (2010c, 8).

“Nearly 22 % of the items would be considered as ‘dual use’ while there seems to be unclear guidance on remaining 10% items including the materials for 'water production' and chemicals for water treatment.” (WaSH 2010c, 3).

“A detailed operational guideline with categorisation of the controlled and dual use items is immediately required for facilitating entry of essential materials to address the urgent humanitarian WASH needs in Gaza.” (WaSH 2010c, 3). However, as Mark Buttle points out, **“**When there is no publicized list of what is allowed in and what isn't, one has to ask, how can you possibly monitor a change in it? Projects never actually get any written response from COGAT, to say: ‘we have now agreed that this can enter’. There are quite clearly two levels of authorization, a political ‘yes’ and a security ‘yes’...Even if we can get a very clear political "yes" from COGAT,[38] the security clearance from Shin Bet delays it several months, easily.” (Irving 2010).

AUGUST

“*Although the vast majority of the WASH materials awaiting entry into Gaza in warehouses around Kerem Shalom or Ashdod are clearly not mentioned on the restricted list, access is still limited.*” (WaSH 2010b, 2).

Three months later, a first balance can be drawn, and it is devastating. While water is counted by the litre, fuel imports indispensable for operating WaSH facilities are counted by the millilitres:

“*Fortunately fuel supplies have increased for the past two months (July, August 2010)*”, rejoices the WaSH cluster meeting of 19 August 2010, “*with together 488 m^3 of fuel entering for UNRWA and CMWU*” (WaSH 2010b, 1). For a population of 1.5 million over 60 days, the amount under this ‘fortunate increase’ is equivalent to an average of about 5 millilitres per person daily.

“limited evidence for improved access…”

[38] COGAT - the Israeli government organization which controls the entry of materials to Gaza.

The most important emergency supplies are still being left to rot in the warehouses outside Gaza (in Ashkelon, Kerem Shalom, …). "*Although, over two thirds of the WaSH items that remain in warehouses are not listed as controlled items (in need of a special permit) and should therefore present no entry problem, only 16%*[39] *entered since 20th June, while an additional 28% received an informal approval*". (WaSH 2010e, 2).

Gradually, carefully and discreetly

"Abbas to Obama: I'm against lifting the Gaza naval blockade:

Palestinian Authority President Mahmoud Abbas is opposed to lifting the naval blockade of the Gaza Strip. … Senior Israeli officials and European diplomats say … the blockade should be altered, but this should be done carefully and discretely. … Egypt … also opposes the lifting of the blockade. … One of the points that Abbas raised is that the naval blockade imposed by Israel on the Strip should not be lifted at this stage. … Abbas told Obama that actions easing the blockage should be done with care and **undertaken gradually."** (Ravid 2010).

As requested by Abu Mazen, the Israeli easing is done with outmost care, discreetly and very gradually, indeed…

9.Myths and Solutions

In box 2 a list of common misunderstanding about the water scarcity in Gaza.

Box 2:

1. **… It's the climate** – obviously, with annual rainfall between 200 and 400 mm Gaza belongs to the semiarid climate zone. It should not be overlooked however that in former times Gaza was esteemed for its high-quality water resources and regarded as an oasis. The climate did not change over the last thousand years, but the number of inhabitants began to explode with the mass expulsions from Israel in 1948.

2. **… It's Israel**, **by intercepting the ground water flow in the shared Coastal aquifer around Gaza** - fact is however: One of the few things, one cannot accuse Israel of, is that it had drilled and was pumping wells particularly in the areas upstream and around Gaza. The bulk of well withdrawals from the shared Coastal aquifer takes place way further north, in the densely populated centre of the coastal plain around Tel Aviv (between Rehovot and Netanya). But according to international law, Israel as the upstream riparian in the shared groundwater flow system is clearly responsible for an "equitable and reasonable" allocation of resources. It would therefore have to supply Gaza with considerably more water.

[39] This is less than 11% of the entire stock in warehouses, which in turn is only a fraction of all supplies short-listed.

3. **… It's the over-abstractions, which lead to sea water intrusion** - however most of Gaza's current salt input stems from natural lateral ground water inflow from Israel amounting to 37mcm/yr and with the bulk of it being contaminated by a very high natural salt content. The salt input through seawater intrusion in the areas where the water level has dropped below sea level due to long-term over-pumping is of course very worrying; but it pales compared to the risen salt inflows from the SE (see map). This fact usually is ignored. Also in Israel the Coastal aquifer is drastically over-pumped and the salt front already reaches more than one kilometre deep into the hinterland. However, in Israel, the effect of this mismanagement is less dramatic since Israel still is bestowed with sufficient hinterland and thus can relocate its degrading wells into fresher areas.

4. **… It's the overpopulation - Gaza simply cannot be self-sufficient** - this of course is true and cannot be over-emphasized: With 1.4mio population on 310km^2 land (without the Israeli cordon sanitaire) Gaza is one of the most densely populated spots on Earth, as if the total Arab population was crowded in the UAE or the world's population in Libya... However: Who would for example demand of an equally "over-populated" area such as Manhattan / New York that it supplies itself "self-sufficiently" and only from within its own city perimeter! Even Beer Sheva, with its climate comparable to Gaza and providing of much more hinterland and catchment area is supplied from Israel's rainy north. In the meantime Israel has actually developed over-capacities in the south, which for technical reasons it cannot pump to the north. Therefore Gaza will have to be supplied from within Israel in the short and in the long run.

5. **… Gaza can only be helped by large scale sea water desalination** - however this 'solution' is misleading, not only because it is entirely un-ecological and unaffordable for Gaza's impoverished population. A cubic meter of normal drinking water from Mekorot in Israel costs 2, 86 NIS (incl. VAT) pumped as bulk supply to the entrance of Gaza. The cheapest desalinated sea water is to be had only for approximately 4 NIS. And in Gaza the pure raw water production within the plant (Az-Zuweida) at present costs over 6 NIS per cubic meter - if there was any electricity, spare parts and raw material available... The net pumping costs at the shallow wells in Gaza (transport also not included here) amount to merely 0,5 NIS/m^3. For several years now, Israel advertises desalination as the new wonder drug for the chronic water conflict - obviously out of its interest not to share any of its existing fresh water use with the Palestinian co-riparians. Unfortunately, for pragmatic-political reasons more and more donor states start advocating this unfair and wasteful option, because they consider the simple alternative as politically not "enforceable" or "unrealistic": to pressure Israel to at least partly sell some of its surplus in the south to Gaza.

It has been shown that the state of water emergency in Gaza has its origin not only in the natural climatic scarcity of water, but also in the political situation (the ongoing occupation and the siege on Gaza) that leaves no room for alternatives. Last but not least, all problems are deepened and accelerated by the fact of the extremely dense population of the Strip. So the question arises: Is there any hope of resolving Gaza's water problems? If yes, how can these problems be addressed? To answer such questions, we must take the political climate into consideration. Without an end to the total siege and without getting rid of the occupation, a permanent solution is not possible. But what are the technical aspects of such an answer?

Waste water reuse, water transfer from the West Bank, and desalination: Will they work?

Usually, three suggestions are made on the technical level. First, waste water can be treated properly and then reused as an additional resource. Second, fresh water can be transferred from the West Bank to the Strip on a large scale. And finally, seawater can be desalinated. Let us discuss each of these three approaches.

1. Waste water treatment.

This is not only a chance to gain additional usable water; it is also imperative to prevent further contamination and degradation of the aquifer. But are we speaking of large quantities? If the actual net consumption of water lies below 60 l/c/d this results in a total consumption of <30 mcm/yr. If 75% of this water were captured by sewage networks, we already would have to consider this a success. Israel currently takes pride in the large amount of effluents it reuses – not for drinking purposes but for irrigation; but the total amount of reused water in Israel is around 360mcm/yr, some 16% of the total, and around 40% of municipal consumption.[40] Applied to Gaza, even if we unrealistically assume the same economic and administrational potential as in Israel, this would result in less than 9 mcm/yr (6% of total current abstractions). It therefore appears obvious that waste water reuse

a) cannot solve the drinking water crisis (due to the poor quality of effluents)

b) cannot, and will never be able to, constitute a major component of overall supplies

c) can only be an optimization of, and an addition to, existing agricultural supplies

2. Fresh water transfer from the West Bank.

This option has been studied and discussed in depth, albeit mainly before the second Intifada: The current disconnection of the two territories and the prospects for the near future make such discussions somewhat utopian for the time being. However, what if the two areas of the occupied territories became one integral political unit? Would it not be a good idea to channel some of the relatively abundant water in the West Bank to the dry Gaza Strip? Has not Israel successfully transferred water from the Upper Jordan River to the Negev?[41] The answer is no. The West Bank as a whole enjoys a relative abundance of water, over 600mm of annual rain in most of the main population centres in the highlands. However, the southern West Bank naturally is the driest place of all the highlands and most areas are rather semi-arid (400mm/yr of rainfall). More importantly, and due to the political climate, the southern West Bank around Hebron is by far the most water-deprived area (except for Al-Ghor). Since Oslo, a handful of new wells have been drilled in the Eastern Aquifer. These wells thus lie on the far side of the mountain ridge from Gaza and pump from very deep water levels (between +200m and sea

[40] Currently, around 730mcm of fresh blue water from wells, springs and Lake Tiberias are produced annually, in addition to some 140 mcm of desalinated seawater. Israel wants to step up its desalination to some 700mcm/yr in the future, thus doubling its already wasteful domestic and municipal consumption.

[41] This is not the place to discuss the “desert bloom” myth in depth. It is enough to state that the large scale basin transfer of illegally appropriated Jordan river water is far from being a success story, economically, ecologically and in terms of sustainable water management – not even to speak of the political dimension.

level).[42] The total yield of these few wells is so low that water production per capita has been in a steady decline since Oslo. Moreover, in the decades since 1967, Israel did not allow the Palestinians to drill even a single new additional well under their own control in the entire Western basin.[43] Therefore, only a **political** solution granting Palestinian water rights in the West Bank aquifers will permit even discussing this **technical** option. Even then, Hebron has no surplus to share with other regions, and transmission costs would be astronomically high.[44]

3. *Seawater desalination*.

There seems to be a consensus among most experts as to the most favourable long-term solution that would overcome the chronic malaise:

- In its conclusions the 'Groundwater Protection Plan for the Coastal Aquifer of Gaza' recommends Element #9: "RO Seawater Desalination Plants" (HWE 2010, 121).[45]

- "CMWU emphasised that the key for resolution to Gaza water problems lies in sea-water desalination and that phased production would help in ensuring supply of clean, safe drinking water to Gazan population without burdening the aquifers." (WaSH 2010b, 2).

- UNEP (2009) recommends: "*Alternative sources of water should be developed and used to allow the coastal aquifer to rest. The only method that can produce water in adequate quantities is seawater desalination.*" (UNEP 2010, 71) – see **Table 5.**

One billion dollars, almost two thirds of the costs for the UNEP's suggested long-term action and rehabilitation plan, is the cost of desalination plants alone (see **Table 5**); sums that an impoverished strip of land such Gaza can hardly afford…

In past years, seawater desalination plants have slowly become a major option in the technical discourse about increased supplies for Gaza. Especially since the summer war in 2006, when Israel bombed the power plants of Gaza and left the Strip for weeks without operating wells, there has been a change of opinion among the general public and those in the water sector. More and more, one hears that "only seawater desalination plants would make us independent from Israel." This, however, is a stark misunderstanding. To the contrary, desalination plants with their sophisticated and sensitive technology are far more vulnerable and dependent on steady, reliable supplies of spare parts and raw materials (chemicals) for their operation. While the currently operating simple old mechanical pumps can be repaired locally and – in the worst case – be kept running with 'spit and wire', high-tech installations such as modern large-scale reverse osmosis desalination plants would make the Gazan water sector utterly dependent on uninterrupted inflows not only of sophisticated tools, spare parts and other

[42] The water has to be pumped up a thousand meters to cross the Hebron mountains.

[43] There are only four small and old wells (Fawwar wells n.1c and n.3, Samu' n.1 and Rihiyeh well) with a combined pumpage as low as 1 – 1.3mcm/yr.

[44] This concerns both the initial investments costs for infrastructure in the order of hundreds of millions of dollars and the permanent operation and maintenance (O&M) costs, especially for the enormous pumping heads.

[45] RO = Reverse Osmosis desalination technology.

supplies, but also of expertise. More importantly, desalination plants have a huge hunger for energy. Each desalination plant currently built in Israel is complemented by a new power plant only to supply the energy its operation demands. The Ashkelon plant has energy needs on the order of a whole city of 50,000 inhabitants![46] It should be obvious that this option leaves Palestinians even more dependent on uninterrupted energy supplies or fuel imports than ever before![47] It should also be mentioned here that desalination for Gaza is also Israel's preferred option and Israel in the past has tried to blackmail Gaza precisely under this option (**see box Desalination blackmail**). Finally, it goes without saying that large-scale desalination of seawater is such an expensive venue that it is prohibitive for almost all nations on earth, except for the energy rich states (without alternatives) in the Gulf – and recently, Israel. But even in Israel, the high real costs of this technology are painfully felt, and provoke debate about the cost of publicly supplied water.

BOX 3: **Desalination blackmail**

Before 2006, Gaza wanted to buy water from Israel and Israel signalled consent to supply water to the Strip. However, Israel wanted Gaza to pay the full cost of desalinated water from the Ashkelon plant although the water from the plant is fed into the National Water Carrier and thus mixed with ordinary blue water, which is very low cost. It should be noted that Israel is supplying its own Israeli customers at the regular price of blue water, regardless whether this water is blue water or desalinated seawater. The Palestinian side still did not call off the deal but wanted assurances that it would indeed receive desalinated water for this high price. In other words, the Palestinian negotiators wanted to make sure that Gaza would not be **subsidizing** the Israeli water sector. Palestinians therefore demanded exact water quality data to differentiate between natural water and desalinated water, which is poor in essential minerals. At this point, Israel refused to cooperate because this would have exposed the fact that, indeed, one day blue water is pumped and another day desalinated water. The deal was called off since it is hardly defensible that the impoverished Gaza Strip should subsidize the Israeli desalination adventures and their politically motivated lack of transparency about the source of the water it sells.

Hence none of the three alleged technical options offers a viable and realistic alternative for filling Gaza's need for a larger, sustainable water supply.

i. Wastewater reuse can only add an increment to irrigation supplies.
ii. Transfer of fresh water from the Southern West Bank – a utopia at the current state of segregation - would require sufficient reserves under Palestinian control and even then comes at prohibitive costs.

[46] It is precisely for this energy demand that "Israel, in contrast [to the European Union], has no plans to reduce greenhouse gases. The best it can do - according to the Environmental Protection Ministry - is to reduce the growth rate of such gases in the coming decades. Expected growth according to a business-as usual scenario (without taking action to reduce gases) is 63 percent in two decades (Rinat 2008).

[47] Israel has no qualms with energy supplies – the Tamar and Leviathan offshore gas fields off the coast of Haifa belong to the largest findings worldwide last year! It should also not be a surprise that the current desal-hype in Israel is driven by "the **even narrower interests** of private-sector companies [*like the gas station and petroleum chains of Paz and Delek!*] that stand to make **windfall profits** from rapidly expanded **desalination**." (Bromberg 2008).

iii. Seawater desalination would leave Gaza more dependent on power supply from Israel than ever, again at prohibitive economic[48] and environmental costs and at a painful political price (see below).

10. The political dimension of the shared resource

One aspect of the technical options has not been discussed – which is the political dimension of all these approaches. It has become a bad habit in the highly funded and donor-driven water sector since Oslo, that technical solutions are continually suggested at the expense of the political rights of Palestinians. All the above solutions have in common that they not only try to circumvent Israel's responsibility as the occupying power under international law to guarantee sufficient water supply to the population under its control, but also deal with Gaza as if it were a viable independent state, owner of its own resources and a fully satisfied riparian to the shared Coastal aquifer. This however, is not the case.

As was detailed above, the coastal fresh water yield that Palestinians control in the Gaza strip is only a small fraction (5-7%) of its current abstractions. In addition, the Gaza Strip has only a 12% share of the total freshwater yield of the basin (**Table 6**).

However, under international law, Gaza as a riparian to the CAB legally has the right to a much larger share of this common resource of about 280 mcm of freshwater per year![49] It should be prohibited to undertake any action that would undermine the Palestinian standing in future negotiations. To the contrary – all current interim approaches should bear in mind the ultimate interest in securing all Palestinian water rights. All interim actions should not only promote and strengthen the starting position for water negotiations, but also strive to improve the Palestinian position.

It is clear that Israel tries to use every opportunity to create facts on the ground and undermine the Palestinian negotiating position. Artificially restricting oneself to a purely technical discussion of remedies to the water crisis is in itself a political approach – one that strengthens the status quo and directly undermines the chance for fundamental change in the political map. Most western government donor agencies prefer to consider technical solutions for a purely political problem.[50] All political approaches are dismissed as unrealistic, utopian, counterproductive, if not aggressive and even extremist.

[48] The Az-Zuweidah plant (in Deir Al-Balah), financed by Austria in 2003, is the only existing seawater desalination plant in the strip, with a nominal capacity of 1000m^3/day. Currently, however, it works a maximum of 8 hours per day, which raises the net production costs to around US-$ 2.5/m^3. If amortisation costs of US$1/m^3 are added, the water price shoots up to some 10NIS/m^3.

[49] The exact amount of legal "equitable and reasonable share" is not defined unequivocally in the general guidelines of the 1997 UN Convention on Transboundary Water Courses. To some extent, and unfortunately, given the balance of power, it remains a matter of negotiation and agreement in future peace talks. From a political point of view, it is therefore even more important to raise the stakes and the bargaining power before such negotiations by promoting public discussion and international understanding of Palestinians' just water rights.

[50] Compare the recent "success" of the quartet envoy Tony Blair, to facilitate "more open borders" to the strip – thus facilitating the import of such ground-breaking supplies as "towels and matraces")

In general, the weaker side in a conflict cannot afford to ignore the political dimension of the problems; it has to broaden and intensify the general call for justice and for enforcement of rights. Conversely, the stronger side has the wind at its back. It can afford to call for so-called 'practical', opportunistic and pragmatic solutions, since they all tend to strengthen or cement the status quo.

"As in most cases of power asymmetry, politically motivated positions that are based on maintaining the (unfair) *status quo*, are considered natural and technical in nature, while even very technical positions contesting and challenging the *status quo* will end up being discarded as politically aggressive, extremist and – of course – politically unrealistic." (Messerschmid 2007, 361)

Desalination for Israel is an ideal tool to obscure the consequences of the occupation and its own long-standing hydro-apartheid. The sea is – at least theoretically – a practically infinite resource. In the new Israeli discourse, Palestinians "no longer need their water rights" on the existing renewable blue water resources. Israel thus constantly alters the discourse on water rights by putting out yet another "generous offer" to desalinate for the Palestinians and deliver this water to the West Bank (and/or to Gaza). Investing billions[51] in large-scale desalination plants not only constitutes an unbearable burden on Gaza's virtually nonexistent economy – it reduces Gaza's prospects to successfully negotiate a larger share in the coastal aquifer's freshwater potential.[52]

11. The only answer to the crisis: Equitable share = transfer from Israel

As has already been mentioned, the demand for an equitable and reasonable share in transboundary water resources stands at the centre of Palestinian water interests and negotiating positions. It is enshrined in the UN Watercourses Convention[53] as well as under customary international law.[54] Many different options of reallocating shared water resources between Israel and the Palestinians are imaginable. But in most such options, Israel would have to deliver water to the Strip from within Israel. This water could come directly from physical water resources within the Coastal aquifer or from other

[51] "In Israel […] the desalting industry is expected to grow 140 percent over the next decade, with a capital investment of $56 billion by 2015" (according to L. Brezosky, quoted in: Sanders 2009) – If we assume 750mcm of additional annual water from desalination in Israel, the US-$ 56 billion breaks down to an investment of US-$ 75 for each additional cubic-metre annually. This is roughly hundred times the capital investment cost of developing conventional groundwater.

[52] No exact figures on such share are available. In fact, there is an almost complete absence of any discourse quantifying such vital amounts. As a very rough first approximation, such demands could lie somewhere between 100 and 150mcm/yr, a three- to five-fold growth in available freshwater resources for Gaza. Any such discussion of Gaza's share will have to be embedded in the overall equations of sharing water between Israel and all Palestinian territories, including all shared resources, the Mountain aquifer and the Jordan River.

[53] "The UN Watercourses Convention calls for 'equitable and reasonable' utilisation of transboundary resources. Finland, Germany, Hungary, Luxembourg the Netherlands, Norway, Portugal and Sweden, have all signed up to this, while Slovenia, France and the UK are considering doing so. (8+3)" Zeitoun (2008b).

[54] This means that these provisions are applicable whether states have ratified the treaty or not.

sources, such as other aquifers, the national Water Carrier, surface water, the Jordan River, marginal[55] water or even the sea. But in any case it would have to be allocated as a "fresh water apportionment" from the shared fresh resources. The issue of cost is a matter for negotiation. One of the many realistic options for negotiation would be for Israel to keep its exclusive abstractions from the Upper Jordan river, but compensate Palestinians downstream with their "equitable and reasonable share" – whether in the West Bank, or in Gaza or divided between the two. A similar approach could be followed for each shared aquifer and for other shared surface water or marginal resources. In every such scenario, Gaza – physically, not politically! – would become a large-scale recipient of water from Israel, but not as a favour or as a purely commercial client, but in fulfilment of its political water rights.

The important practical implication of such an overall approach would be that every water deal with Israel (even if purely commercial) would become an important milestone and practical step towards a historic deal over water rights. Once Israel is established as the side supplying Gaza, this will start to work towards, not away from, a resolution that secures Gaza's "equitable and reasonable share." Once Israel has factored Gaza supplies into its own engineering and managerial equations of water supply and infrastructure, such a deal becomes an asset, rather than an obstacle to a just solution – provided (!) Palestinians don't get tired in the meantime of insisting on their water rights and promoting international understanding and support for such an endeavour. Practically, an established and functioning supply line, network and supply mechanism acts as an incentive to continue along this path and "only" to negotiate over the political terms and legal implications of such supply.

It is worth mentioning that currently Israel has a water surplus in the South, due not only to the new desalination plant in Ashkelon but also to the existing large-scale supply infrastructure of the National Water Carrier that reaches from the upper Jordan River until down to Mizpeh Ramon in the midst of the Negev. As a matter of fact, Israel's water engineers have long regretted the shortsighted design of this carrier, planned in the 1950s and opened in 1964 – which at the time was only envisaged as pumping water from north to south. For many years, Israel has preferred to pump water from the allegedly "dry" Negev towards the thirstiest region in the central coastal plain, where most of its population resides and where use of local water resources has been overstretched for many decades. In other words, there is currently a water surplus in the South, right at the doorstep to the Gaza Strip. Hence it is financially by far the most feasible option to channel this surplus to Gaza. Mekorot bulk water supply in Israel (and in the West Bank) comes at 2.863 NIS/m^3 (including the Value Added Tax or VAT – WBWD: 2010).[56] Inside Gaza, municipalities have consumer end prices for piped network supply between 0.5 and 2 NIS/m^3. This is a considerable difference in price. However, it is still much cheaper than the current practice of

[55] The term "marginal water" in Israel usually is associated with the non-conventional water resources, such as brackish water (usually desalinated at much lower costs than sea water), collected storm-water, treated waste water effluents, etc.

[56] 2.468 NIS/m^3 excluding VAT, according to the West Bank Water Department Water Bills from Mekorot-Water Co. Ltd. through the Civil Administration (Bet El, February, 2010) – (WBWD 2010).

purchasing "desalinated" brackish water from private flying water tankers at a cost of 1 NIS per 'gallon',[57] 50NIS/m^3 (see **Fig 18**: *Kitchen in Gaza*).

For the time being, or for the interim period, it would also be much cheaper to have international donors pay the difference in price between Mekorot and local network water prices. This has the additional political advantage that donors would be encouraged to support a long-term solution under which it is mainly the price of this water that is negotiated, rather than promoting the unfeasible options of Gazan desalination or West Bank water transfer.

Among many Palestinian water professionals, as well as in the rather embryonic public discourse on this matter, frequently used arguments against the proposed supply from within Israel are as follows:

"Why should we depend on Israel?"

It is of course true that Gaza would be dependent on Israeli supply, as much as the West Bank already is, in both water and electrical power supply.[58] There is also no doubt that currently, the supplied villages in the West Bank cannot rely on Israeli delivery during every summer. This, however, is technically mainly due to the fact that they share the same (finite) network, and settler consumption doubles each summer (compared to the winter months), thus drying out the villages down the line. The deal with Gaza, technically, would be of a different nature – where Gaza would directly tap into the above-mentioned surplus of water in the south.

"Surely we cannot depend on Israel and make ourselves hostage to Israeli collective punishment at will?"

True as well, collective punishment of villages in the West Bank by reducing water supply has happened in the past (during the second Intifada), does happen and is likely to continue in the future, although as the exception rather than the rule.[59]

However, it should not be underestimated: If an internationally brokered (sponsored) interim agreement with Israel could be struck to secure a certain amount of regular water supply – and as long as Palestinians do not violate this agreement by not paying their bills – it will not be all that easy for Israel to one-sidedly cancel or violate this interim economic arrangement for such a vital and basic resource as drinking water!

[57] Not the Anglo-Saxon volumetric unit, but the Arabic word for a canister of about 20 litres.

[58] The West Bank, under the Palestinian Authority, already IS the single largest customer for water as well as for electricity, and so also the single most important customer and source of income of these institutions.

[59] Official overall supply statistics to the West Bank show an almost steady increase in annual amounts during the past decade and a half, and also during the worst years of the Intifada.

Another argument goes like this:

“Gaza has to become independent from Israel. Gaza should be self-sufficient in water supply.”

Most of the proponents fail to answer how exactly Gaza WILL become independent from Israel – other than desalinating or importing from the West Bank. From a technical, hydrological, economic and developmental point of view, such a standpoint looks rather delusional than realistic. To state it as clearly as possible: *Gaza is not self-sufficient in water supply, cannot be, and will never be!* It is as simple as that. Gaza cannot, and will never, supply itself with sufficient clean water, by itself. Gaza is the most crowded and deeply impoverished place on earth where water is a desperately scarce per-capita resource.

To illustrate this situation, a surprising metaphor should be introduced here:

Gaza is New York, Gaza is Manhattan!

Not only does Gaza resemble Manhattan in size. More importantly, almost any densely populated city on the planet depends on outside supplies. To tell Gazans to become self-sufficient in water supply is like telling the average New Yorker in Manhattan, “Go and drill in Central Park, build rainwater harvesting cisterns under the Empire State Building or otherwise desalinate all the rest of the water you need.”

New York City brings its water from far away, the Catskill/Delaware and the Croton watersheds. Their approximate distance is 125 miles (200km) – similar to the distance as the crow flies from the Gaza Strip to Lake Huleh.

12. Tables

Table 1: CAB Water budget for Gaza and Israel (in- and outflows)

Item	Israel	Gaza [3]	SUM
Recharge from rain [1]	247 [5]	35	**282**
Artificial recharge			
Artificial recharge from wells	*0.01* [5]	*54.2* [3]	***231***
Artificial recharge from reservoirs	*17* [5]		
Artificial recharge, treated sewage	*129* [5]		
Agricultural return flows	*31* [5]		
Lateral (vertical) groundwater inflow	-	36.4	**36**
Seawater intrusions	3 [5]	20	**23**
Total Recharge	**426**	**146**	**572**
Municipal supply	243 [5]	94.2 [7]	**337**
Agricultural supply	200 [5]	80.4	**280**
Gross outflows to Sea	*23* [6]	2 [4]	**25**
Pumpage/outflows	**466** [2]	**176.6**	**643**
Over-abstractions (mcm/yr)	39	31	**70**
Over-abstractions (%)	9%	21%	**30%**

All Israeli figures (except long-term average rainfall recharge) refer to the year 2006/07 (HSI, 2008)

SOURCES: Refers to the years 1971-2007; Avg. since Oslo (1995-2007): 437mcm/yr; Gaza-values for 2008/09 (HWE 2010); (CAMP 2000) and Vengosh et al. (2005, 4); assumed and A. Ya'qoubi – oral communication; (HSI 2008, 107-10); calc. after HSI (2008, 107-10); (PWA 2010, 8, 10).

Table 2: Damage to the water and sanitation network:[60]

Damaged items during 'Cast Lead'	Itemized amounts
Wells (damaged or destroyed)	11
Reservoirs	4
Water pipes	19.3 km
Sewage pipes	2.4 km
Waste water network & pump stations (locations)	4
Electrical network (many)	-
Household water connections	6,090 (840 households)
House roof tanks	37,700 (5,200 households)
Other water tanks	2,355
Population lacking sufficient supply	**Number of persons**
One month after cease-fire	150,000
Three months after cease-fire	30,000
18 months after cease-fire	3,000 [1]

SOURCE: Table compiled after UNEP (2009, 78).

OCHA-CAP (2009, 17) reports 30km of damaged water network and 6,000 households with destroyed house roof tanks.[61]

The costs only for a short term emergency water supply,[62] 2 litres water in drinking water quality per day (at 20 $/m^3$) and 100 litres in domestic water quality (2 $/m^3$), sums to US-$ 3 million.

[60] Sources: UNEP (2009, 78) and FAO (2009), quoted after: (UNEP 2009, 81, 86).

[61] EWASH fact sheet No. 1.

[62] 150,000 people for one month and 40,000 people over 200 days (UNEP 2009, 79, Box 4).

Table 3: Environmental costs of damage directly linked to the escalation of hostilities in December 2008 and January 2009

Damage and Repair Costs	Cost	Subtotal
Damage to water & sanitation networks (T24)	6.17	10
Sewage damage to groundwater (T25)	3.83	
Crops loss, land contamination (T26)	11.72	34
Rubble clean-up	17.50	
Restore solid waste system	4.80	
S U M	**44 million USD**	

SOURCE: UNEP (2009, 83, Table 27)

Table 4: Itemized list of trucks with emergency and priority WaSH materials entering Gaza in summer 2010[63]

Month	Chlorine Trucks	Other trucks of WaSH materials (itemized)	SUM WaSH-trucks
Dec	**11**	**7** gravel + **3.5** plastic pipes and fittings	**21.5**
Jan	**12**	**1** equipment and fittings for infiltration basin and pump station (PWA) + **3** pipes and fittings (ICRC)	**16**
Feb	**9**	none	**9**
Mar	**15**	**2.5** gravel (UNRWA)	**17.5**
Apr	**8**	**6** nine generators and spare parts + **3.5** water containers + **0.5** forklift	**36.5**
May	**9**	**25** trucks with utility vehicles for CMWU (after 3 years of negotiation)	**14**
June	**7**	**25** Plastic pipes + **4** water tankers (UNICEF)	**36**
July	**7**	**1** PVC pipes and computers + **1** with six UNICEF desalination generators + **1** truck with test kits and hygiene material	**10**
August	**6**	**7** ICRC material for Rafah treatment plant + **2** high capacity storm drainage pumps for PHA (half year negotiations) + **0.5** operational maintenance spare parts + **1** mechanical and electrical repair and refurbishment + **1** water treatment chemicals for CMWU & UNICEF + **1** remaining chemicals for desalination at Rafah & Bani Suhila wells (since 2009)	**18.5**

Compiled from WASH Cluster oPt Monthly Situation Reports (Nos.19-26)

[63] Compiled from WASH (2010b, 2010c, 2010d).

Table 5: Long-term action plan (20 years) for the environmental sector and respective costs

#	Damaged Sector	Action	Investment + operation and maintenance costs	Sub-total [million USD]
1	**Coastal Aquifer**	Seawater Desalination plants (build & *operate*)	400 + *600*	**1000**
2	**Groundwater pollution**	Clean-up / stop sewage ponds Clean-up / restore infiltration ponds Efficient irrigation systems New sewage treatment plants (build & *operate*) Temporary wastewater offshore disposal	10 2 - 265 + *200* 25	**502**
3	**Land degradation**	Decommission landfills New solid waste facilities (build & *operate*)	20 23 + *40*	**83**
4	**Wadi Gaza**	Clean up, rehabilitate	5	**5**
5	**Governance in decline**	New EQA building Training staff Groundwater monitoring (build & *operate*) Marine monitoring (build & *operate*)	10 1 5 + *20* 1 + *10*	**47**
	S U M		**1,637 million USD**	

SOURCE: UNEP (2009, 84: Table 28).

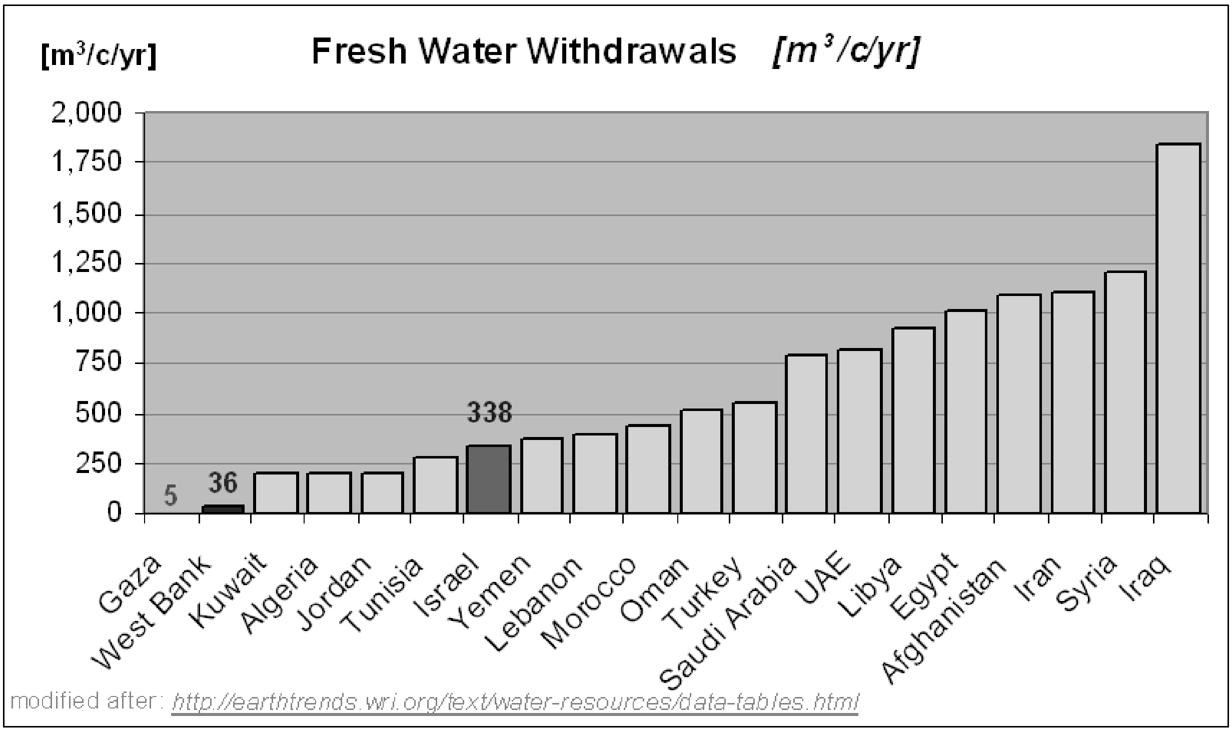
Table 6: Recharge figures for the Coastal aquifer (Gaza and Israel)

	Gaza Strip *[mcm/yr]*	Israel *[mcm/yr]*	CAB *[mcm/yr]*	Gaza share *[%]*
Freshwater recharge from rain	35	246.5	281.5	12%
Total recharge (sweet and brackish)	124	442.7	566.7	22%

SOURCE: (Table 1)

13. Figures

Fig.1: the driest place on earth…[64]



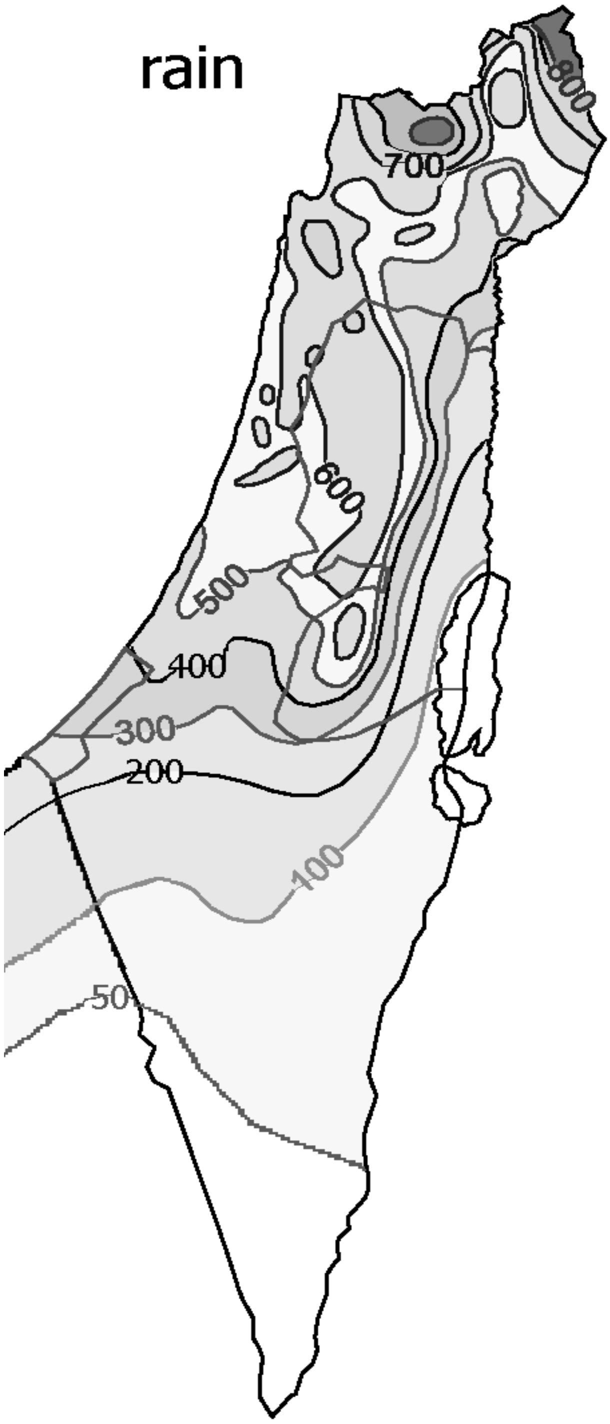
Per-capita freshwater withdrawals in the MENA region.

Note: Brackish water use in Gaza not included

SOURCE: modified after: <http://earthtrends.wri.org > with data for the oPt: PWA (2009).

[64] Figures for the West Bank & Gaza Strip are added to the original "earthtrends" graph (after PWA 2009) – excluding brackish water production.

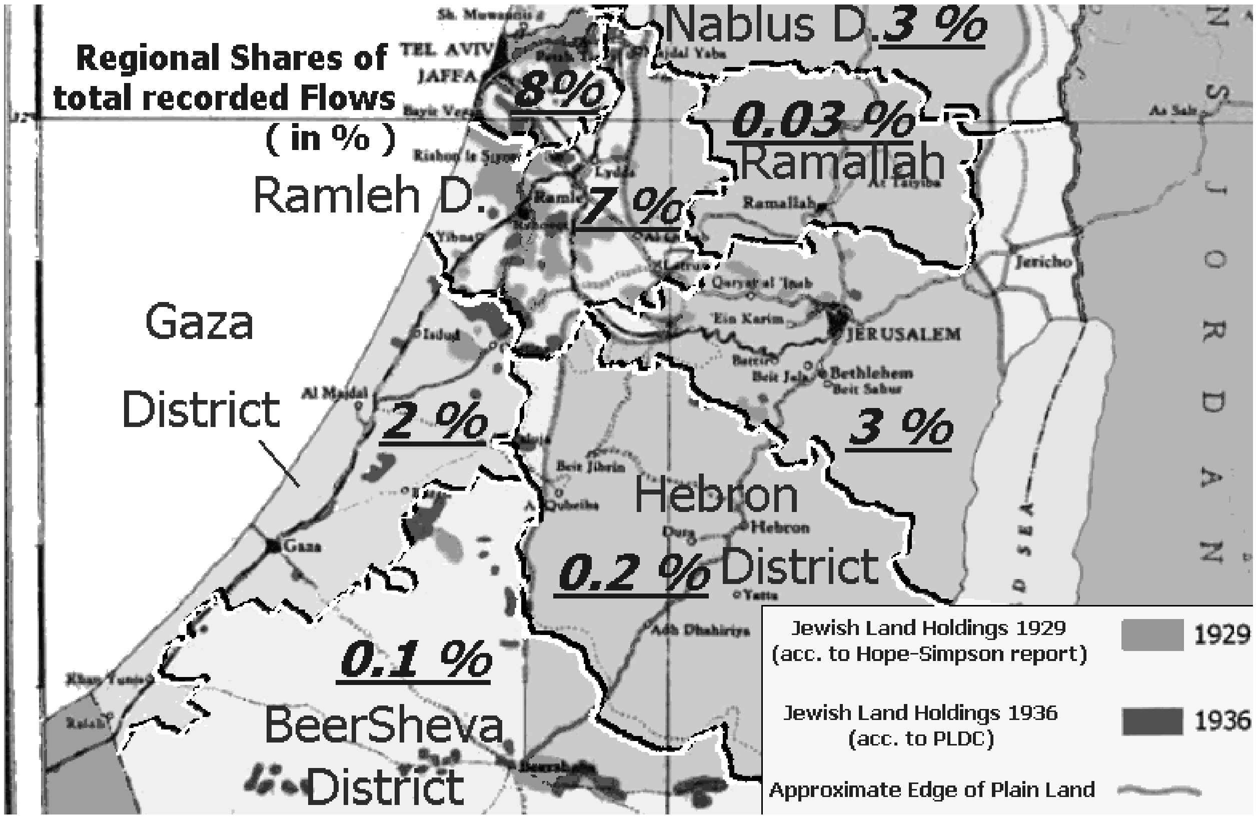
Fig.2: Isohyets in Palestine/Israel



SOURCE: EXACT (1998, 4), Vengosh et al (2005, 13)[65]

[65] Compiled from several sources: For Israel/Palestine: modified based on **EXACT** (1998, 4). For Gaza: Vengosh *et al*. (2005, 13 and Fig. 1A – page 2).

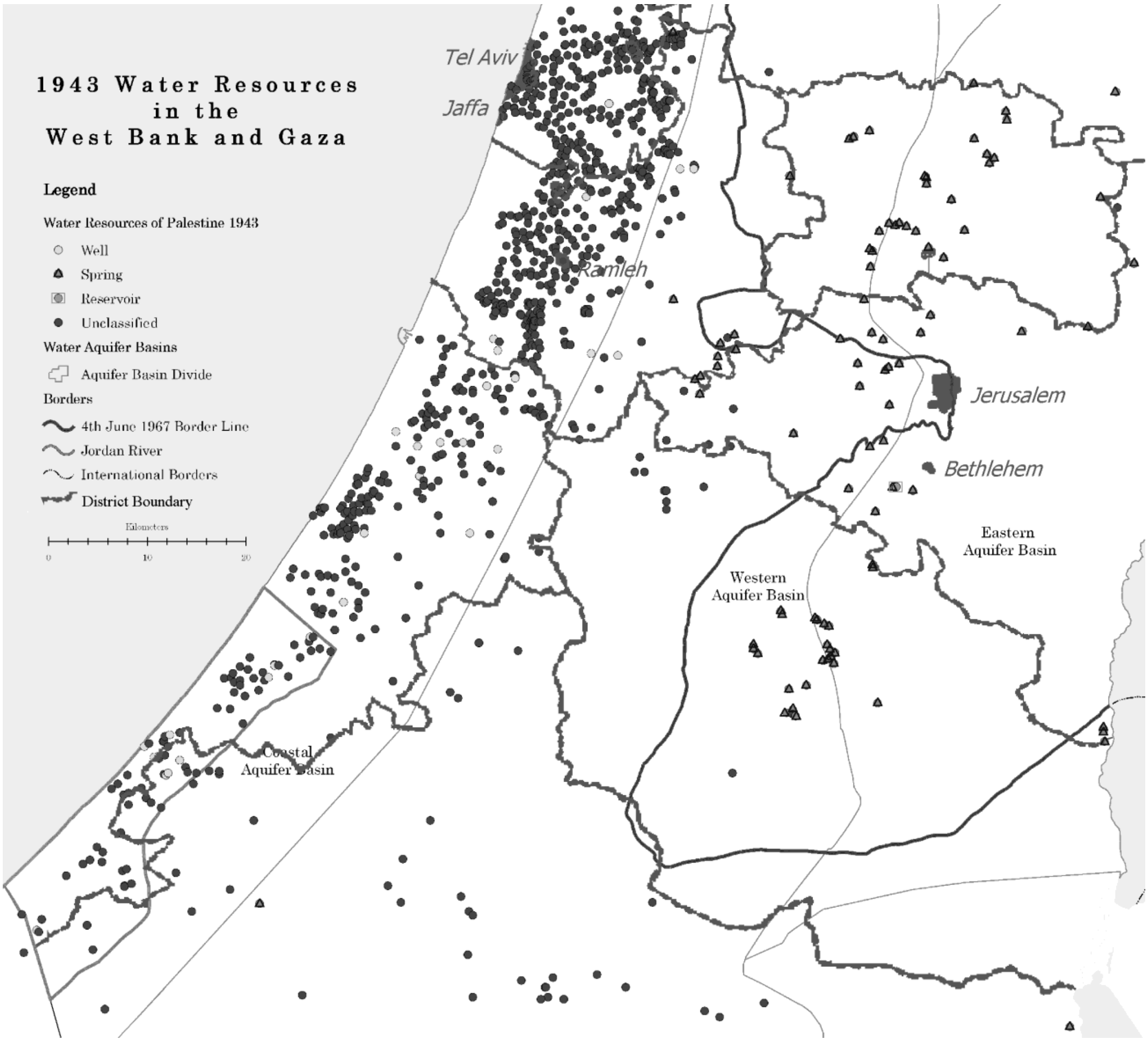
Fig.3: Total recorded flows by district in 1943 & Jewish Land holdings in 1929, 1936.



(2% percent of 1168mcm are equivalent to ~ 27mcm/yr) –

Source: Messerschmid (2008a, 10)

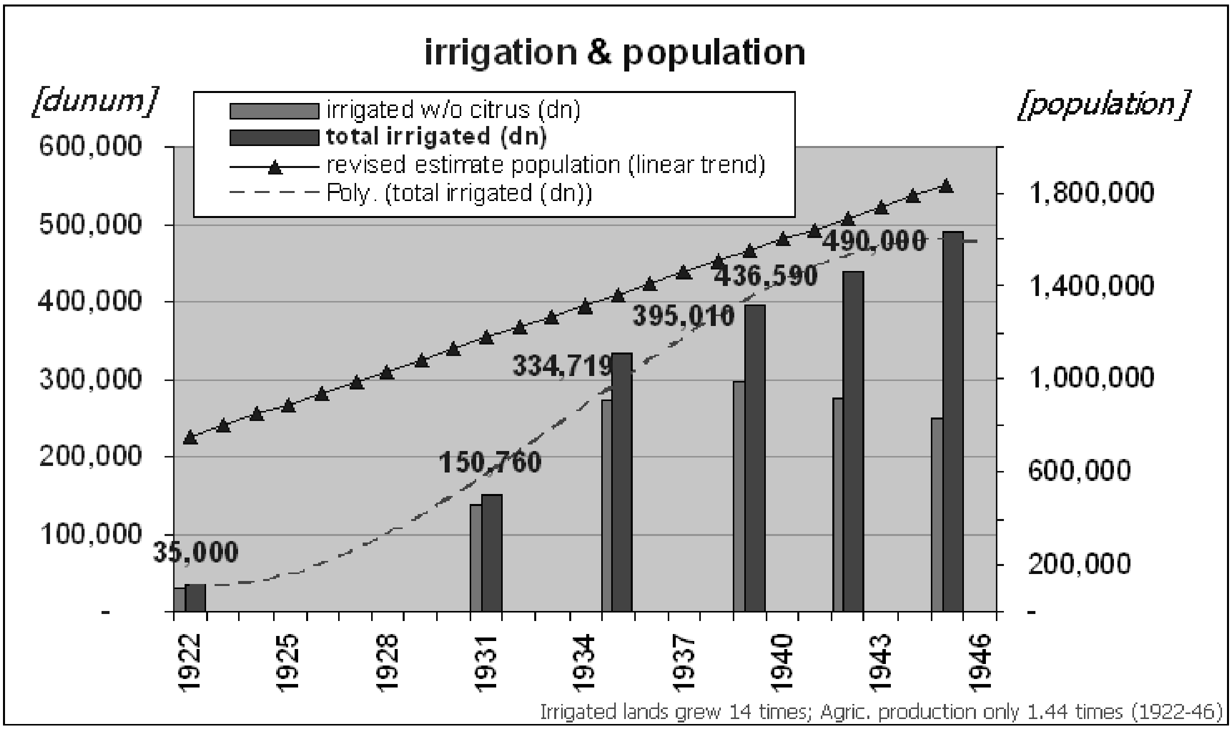
Fig.4: Well distribution in Palestine (1943) – *districts in red* –



SOURCE: Messerschmid (2008b, 9, Annex III).

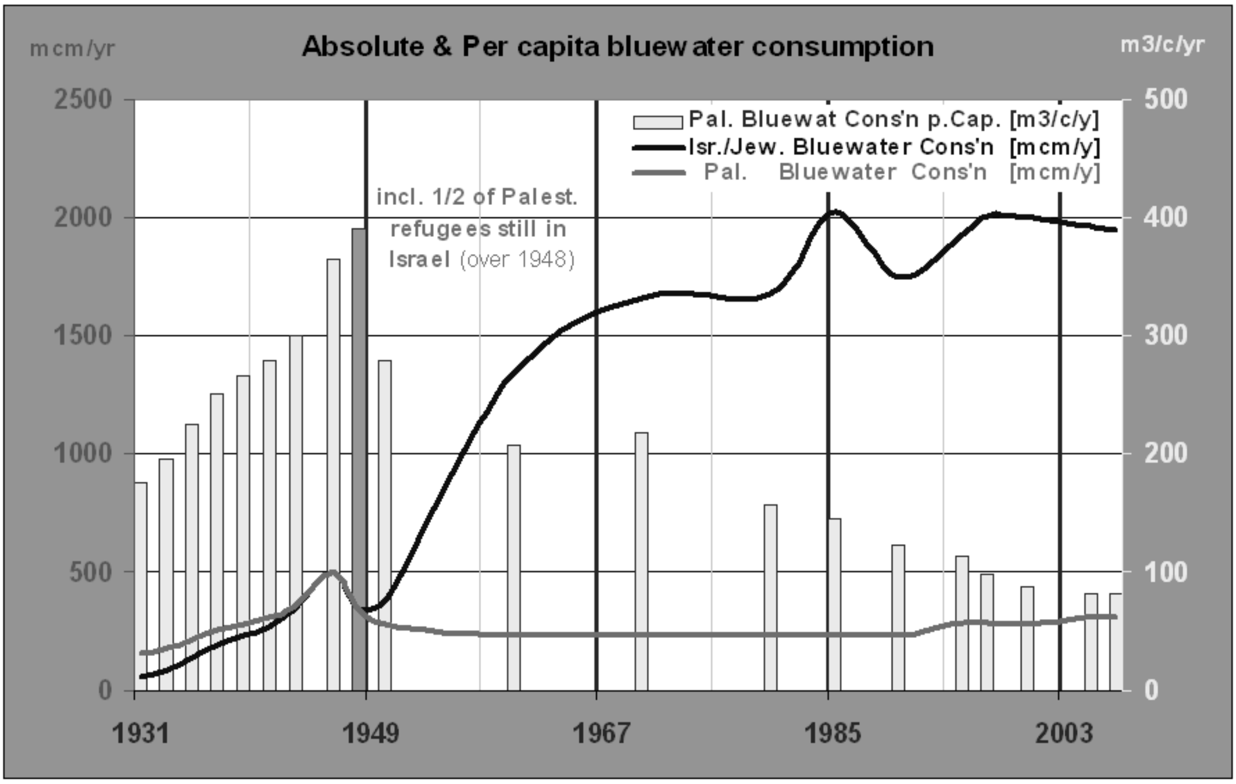
Fig.5: Growth of irrigation & population (*linear trend*) under the British Mandate

SOURCE: Excel-graph, modified after: Messerschmid (2008a, 13, Annex VIII)



Note: Palestinian consumption before 1948 refers to all Palestinians; after 1949 it refers to the oPt. Israeli/Jewish consumption refers to Jews before 1948, and to all Israeli citizens after 1949

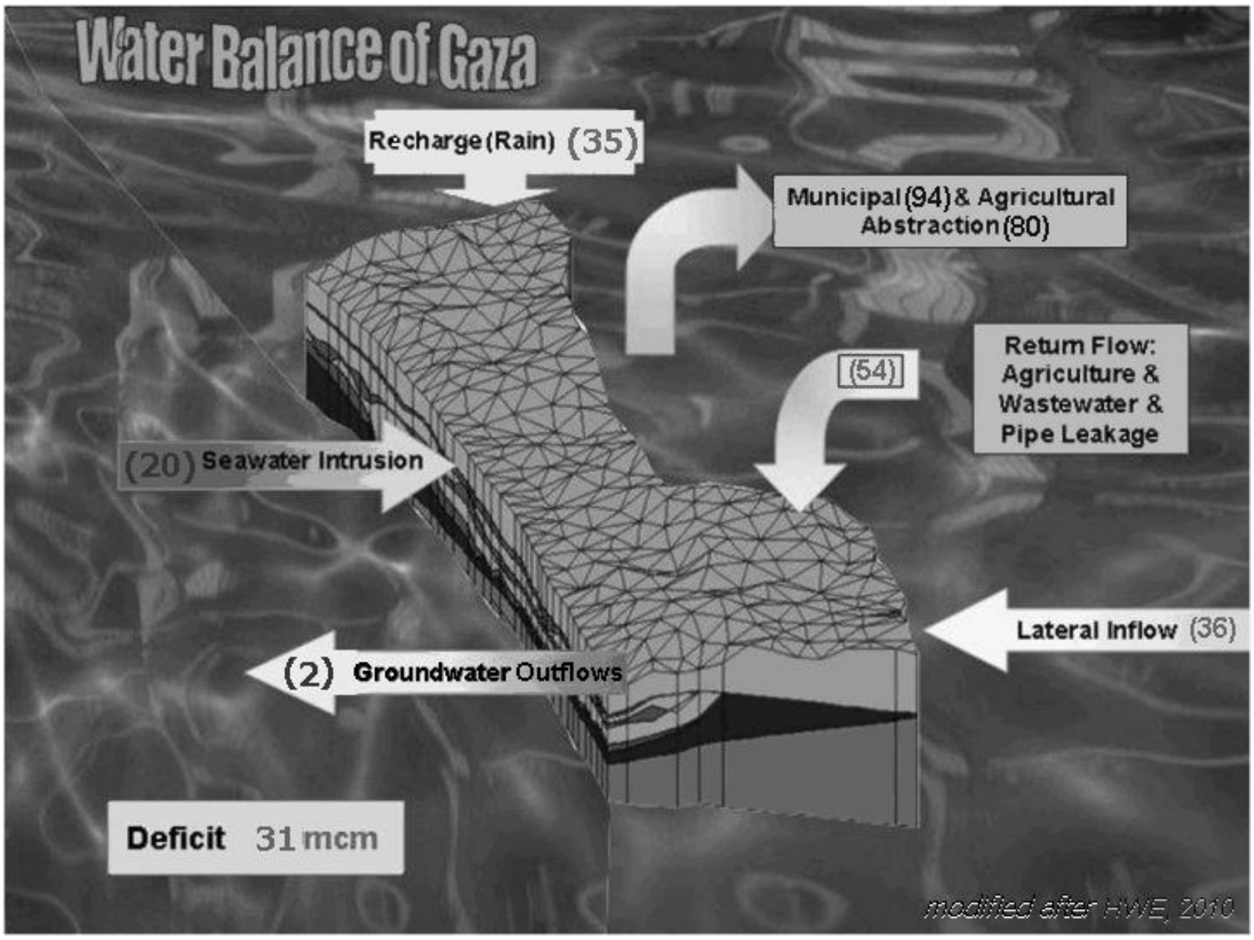
Fig.6: Overall Palestinian and Israeli (Jewish) Blue-water Consumption and Palestinian per-capita consumption (domestic & agricultural) in columns[66]



SOURCE: Messerschmid, C. (2010, 4)

[66] Palestinian consumption before 1948 refers to all Palestinians, after 1949 refers to the oPt. Before 1948 Israeli/Jewish consumption refers to Jews; from 1949 on it refers to all Israeli citizens.

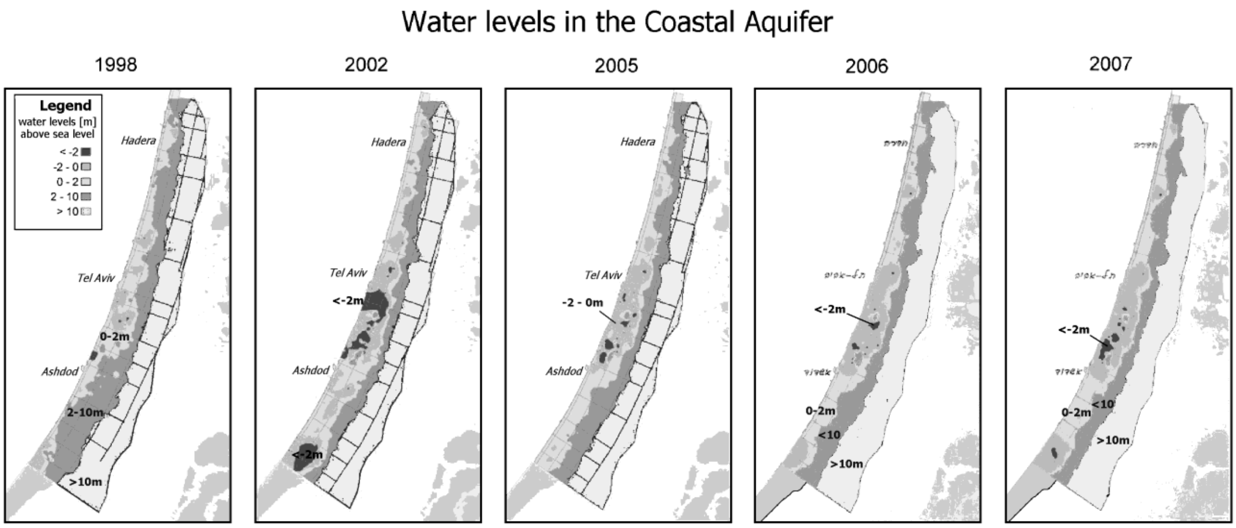
Fig.7: Gaza Water balance



SOURCE: Vengosh et al (2005, 4); HWE (2010, 42); PWA (2010, 8, 10) and CAMP (2000).[67]

[67] Data from PWA, 2000; modified with data according to Vengosh (2005, 4); HWE, (2010, 42), PWA (2010, 8,10).

Fig.8: Water level fluctuations in the Israeli part of the Coastal Aquifer *(below sea level in red)*

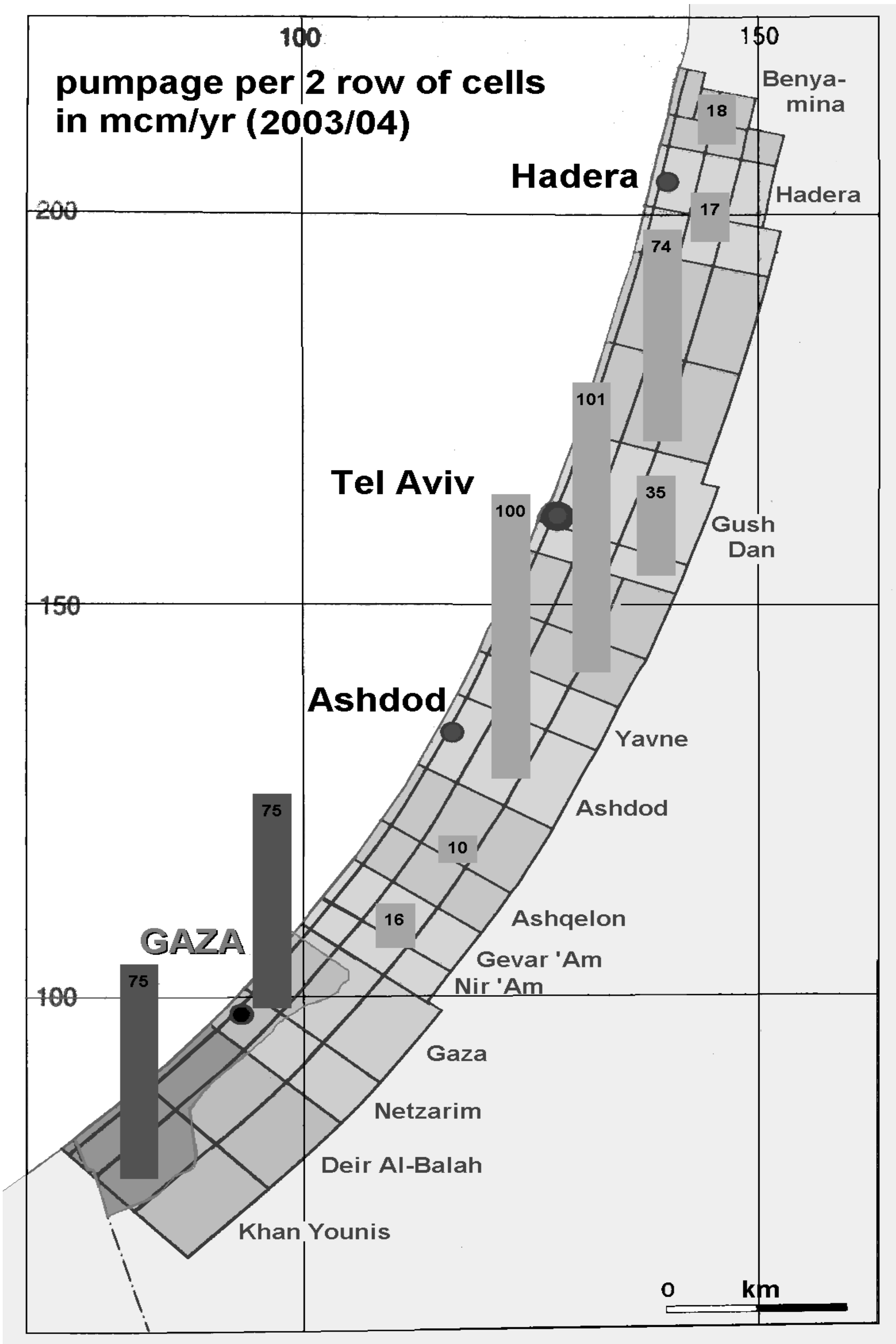


SOURCE: (HSI 2006, 79, 2008, 69)

Note: The amounts shown in the bars refer each to two West-East stretching rows of cells on the ground (and in the map[68]).

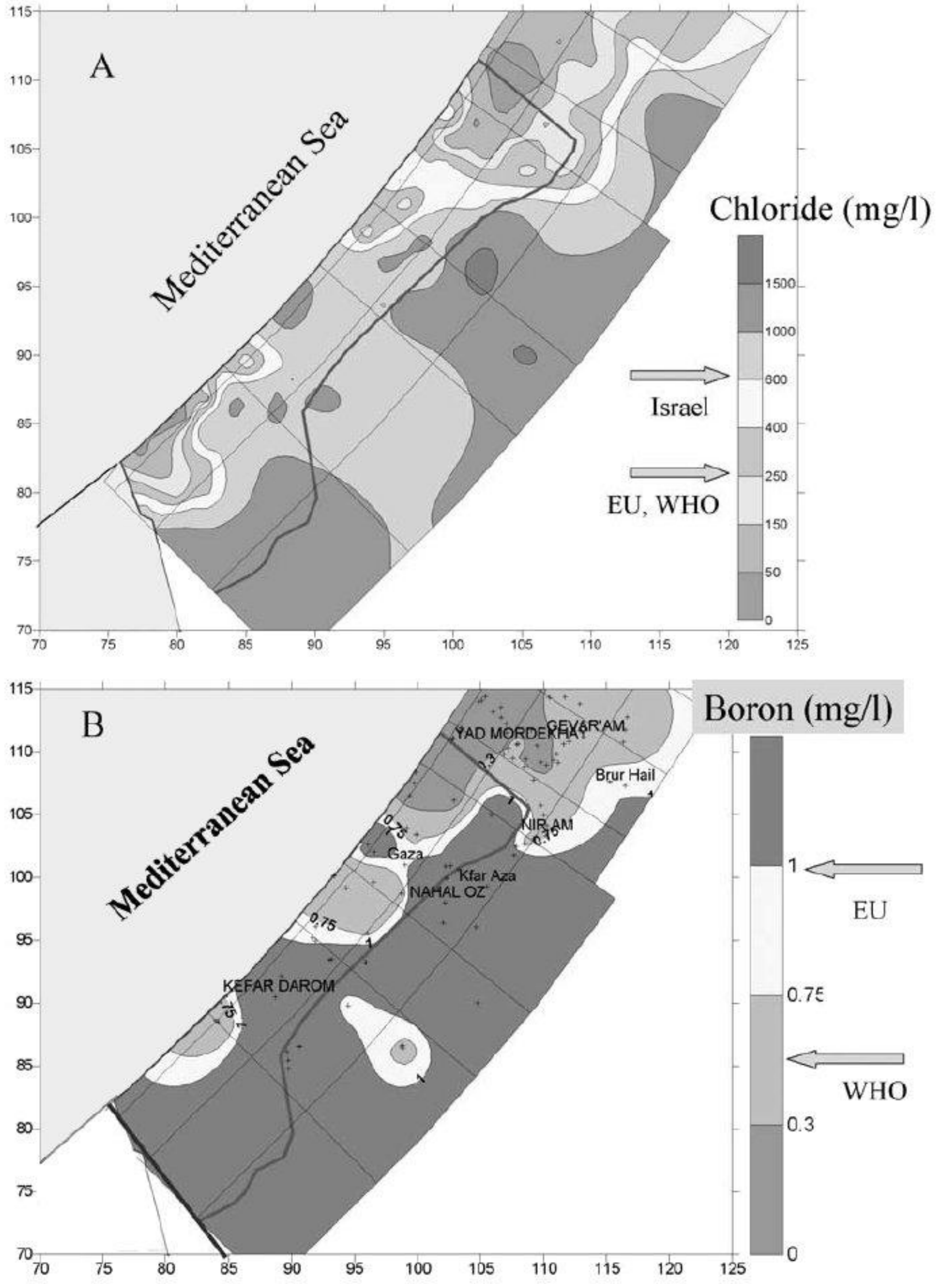
[68] The Israeli management system of the Coastal Aquifer Basin (CAB) subdivides the entire area into West-East running rows and North-South running columns of cells (HIS 2008, 61) – altogether 16 rows of 4 cells each, in total 64 cells.

Fig.9: CAB pumpage (per two rows of cells) in Gaza & Israel



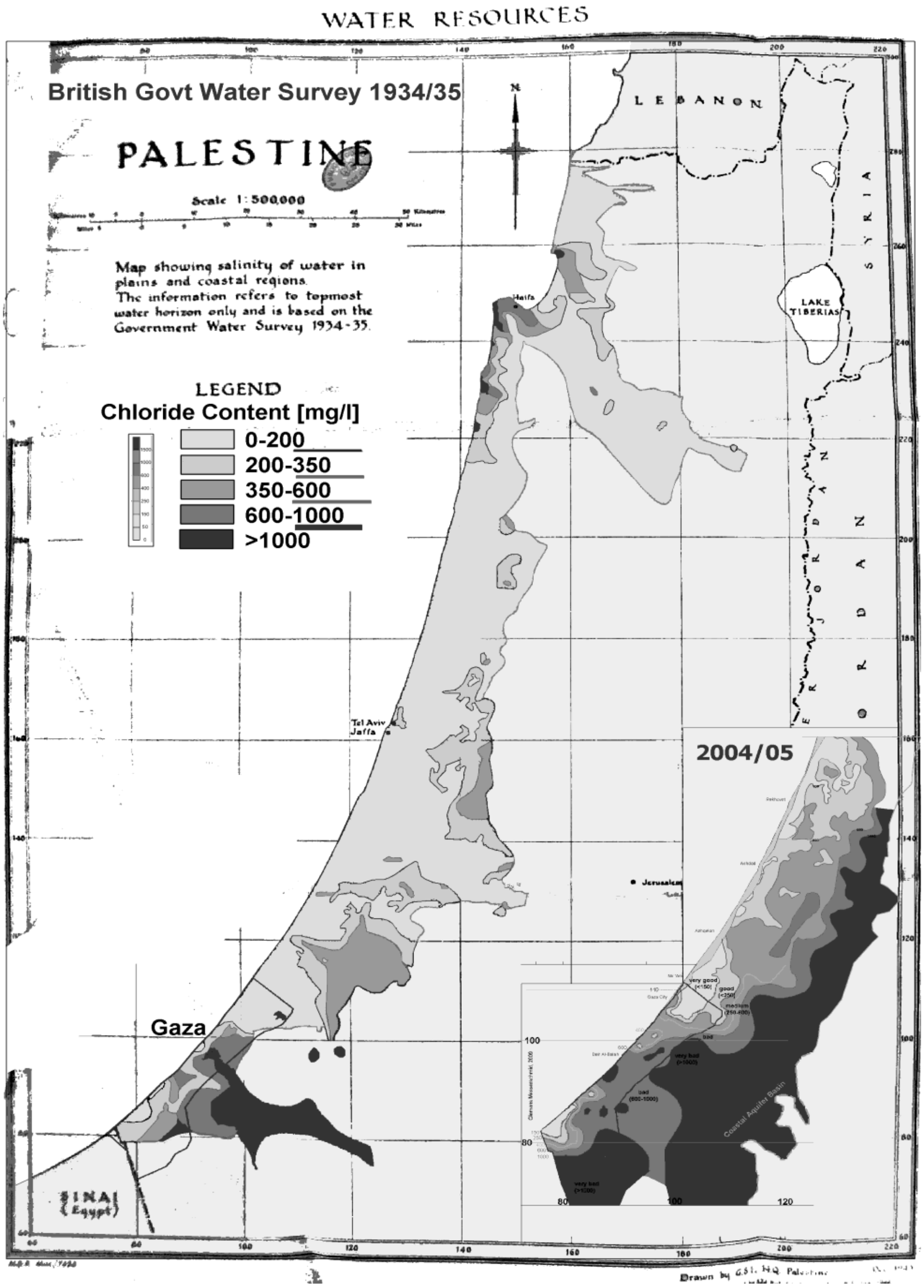
SOURCE: HSI (2005, 96).

Fig.10: Chloride and Boron levels in and around Gaza



SOURCE: Vengosh et al. (2005, 3).

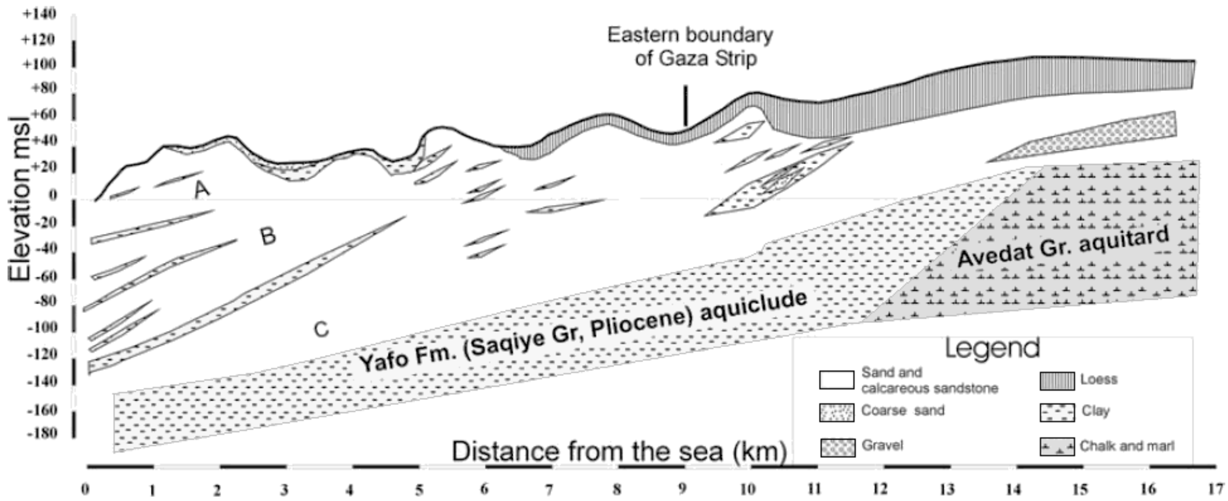
<u>Fig.11: Coastal Aquifer Salinity – 1934/35 and 70 years later – 2004/05</u>



Source: Messerschmid (2009, 9, 21, 22, AnnexIII), modified after: G.S.I. H.Q. (1934, 128) & HSI (2006, by-map - Chloride levels).[69]

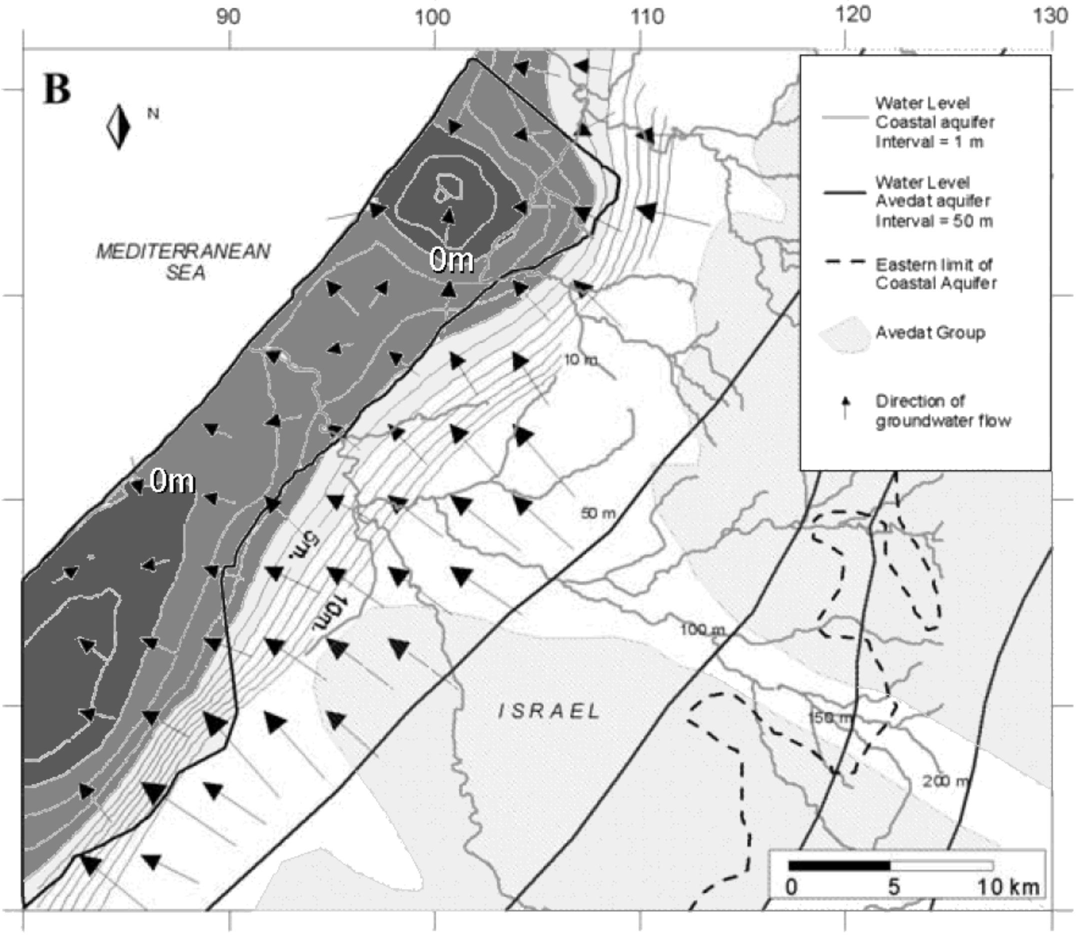
[69] G.S.I. H.Q. (1943, 128) and HSI (2006, by-maps: Cl-level map '*Mapat Rikuz Chlorid*' (*hebr.*). See also Messerschmid (2009, 9, 21, 22 – Chloride map).

Fig.12: Cross section through the Gaza strip (Coastal and adjacent aquifers)



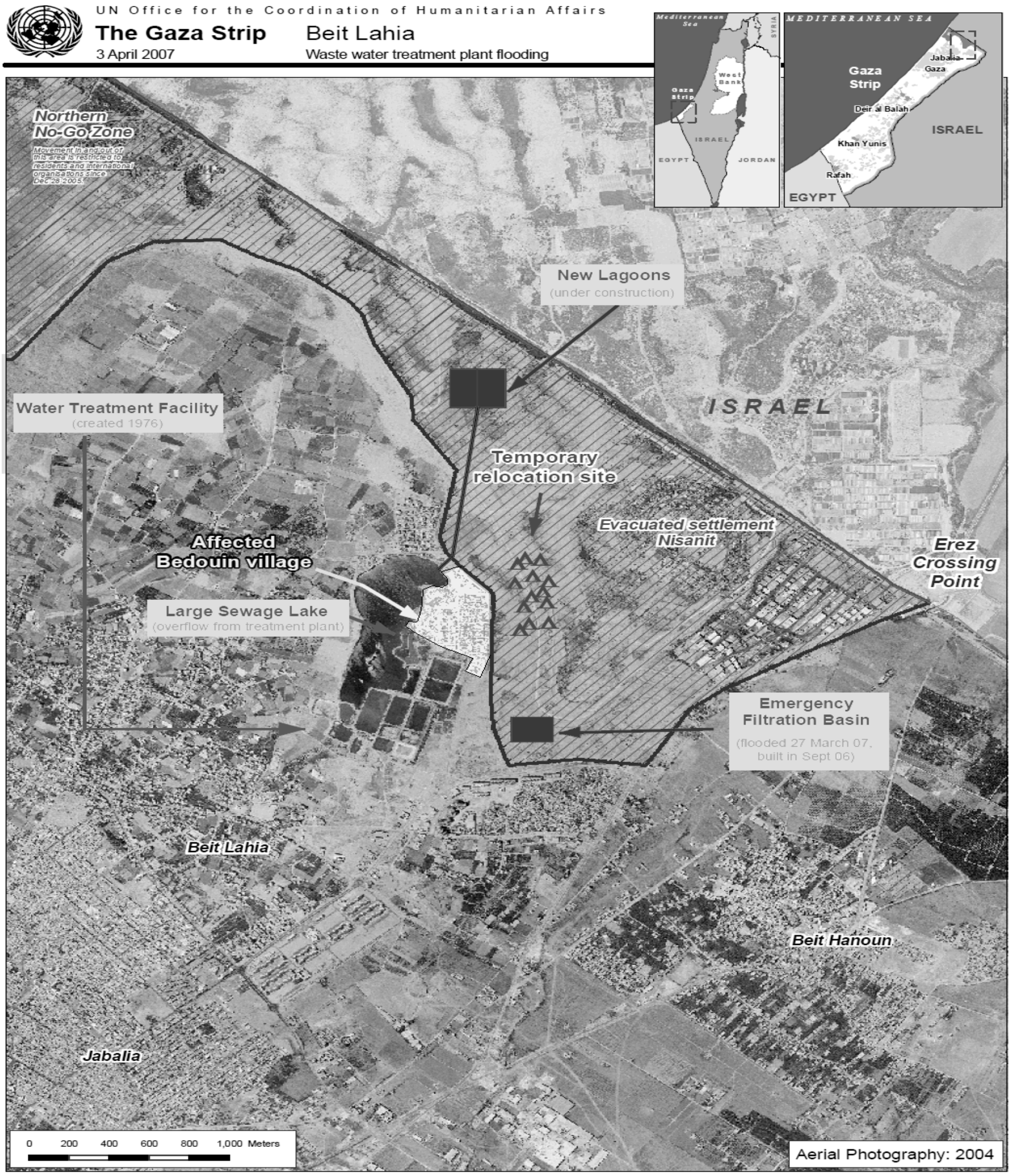
SOURCE: Vengosh et al. (2005, 4).

Fig.13: Water levels in the S Coastal aquifer – contact with saline 'Avedat group



SOURCE: Vengosh et al. (2005, 2).

Fig.14: OCHA-map of N Gaza strip – Beit Lahiya waste water lagoon



SOURCE: OCHA (2007b)

Fig.15: Um El-Nasser 27 March 2007

Source: Messerschmid (2008c, 48).

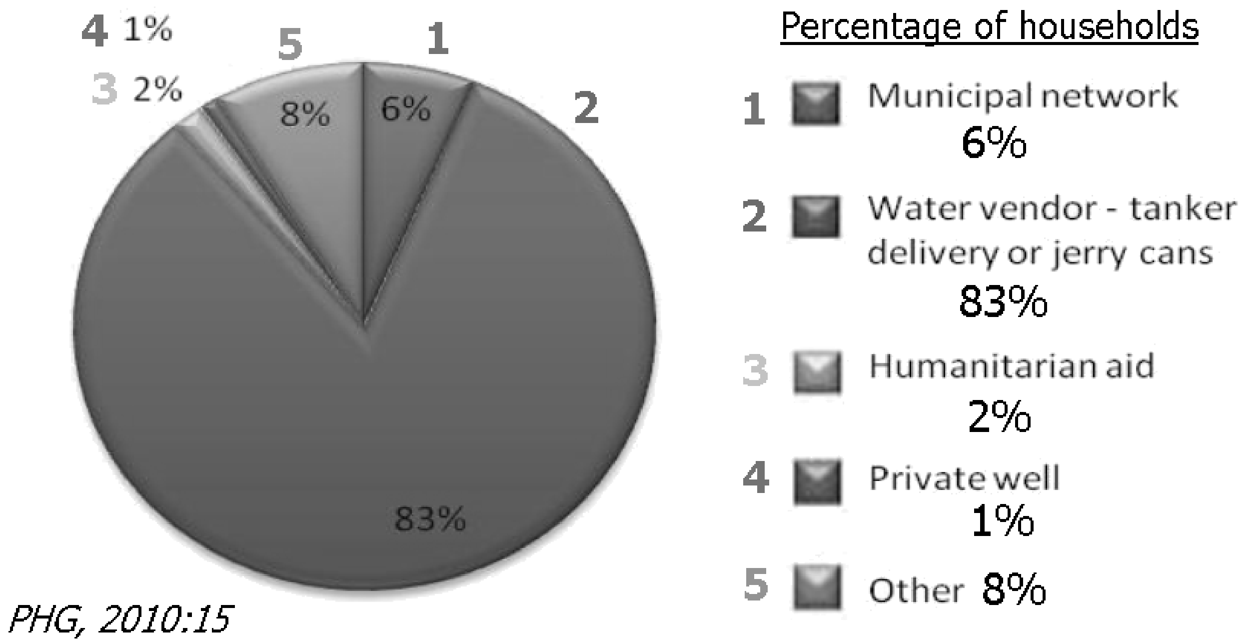
Fig.16a,b: New wastewater lagoons in Gaza

SOURCE: Bardawil (2007, 6, 12).

Fig.17: One horsepower Water Tanker - Gaza style, 2007

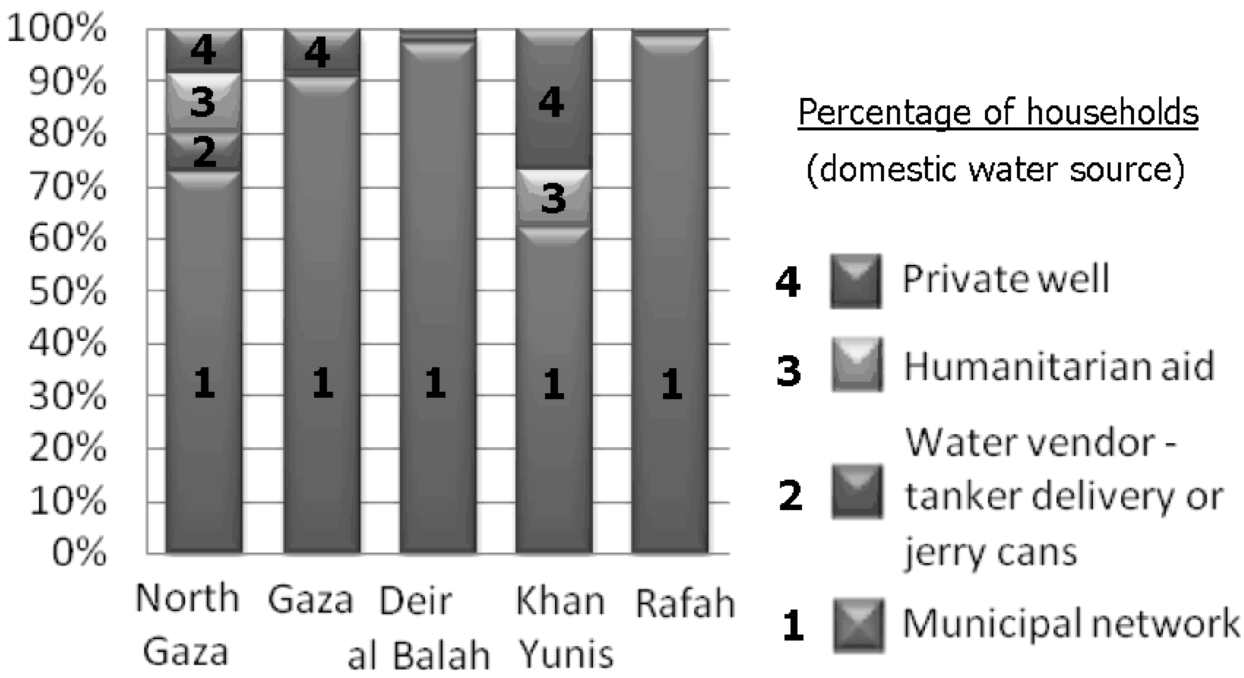
(Photo – Laura Brav, Médécins sans Frontières) Source: Messerschmid (2008c, 48).

<u>Fig. 18: The alternative: Israeli mineral water or "gallon" with desalinated groundwater (Gaza, October 2007)</u>



SOURCE: Photo by Author (Gaza, 2007).

Fig. 19: PRIMARY SOURCE OF DRINKING WATER



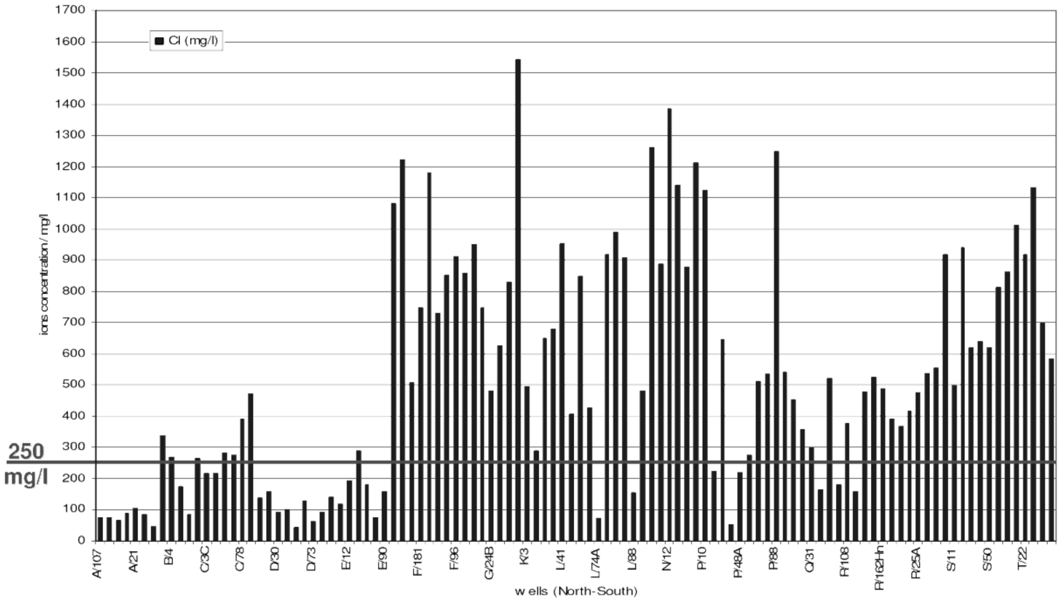
PHG, 2010:17

SOURCE: PHG (2010, 15).

Fig. 20: PRIMARY SOURCE OF DOMESTIC WATER

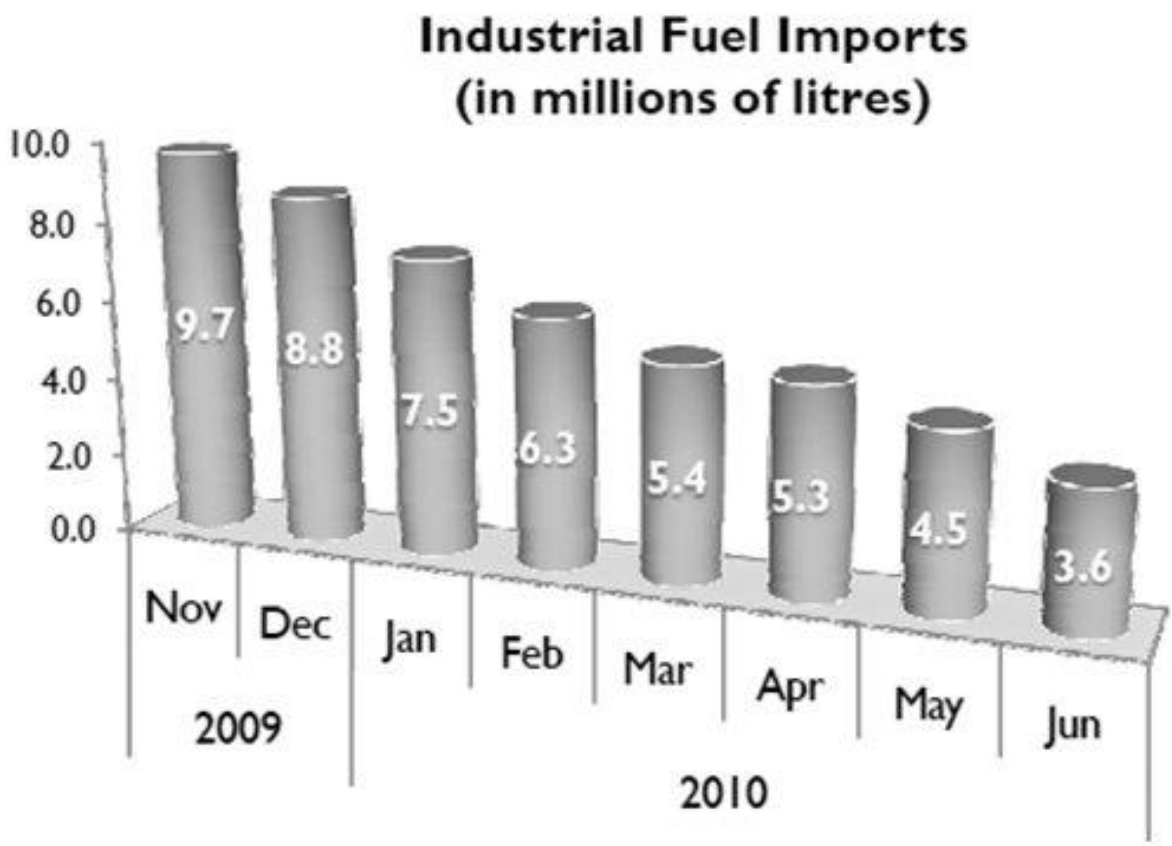
SOURCE: PHG (2010, 17).

Fig. 21: Chloride content in Municipal wells of Gaza *(above WHO level of 250mg/l)*



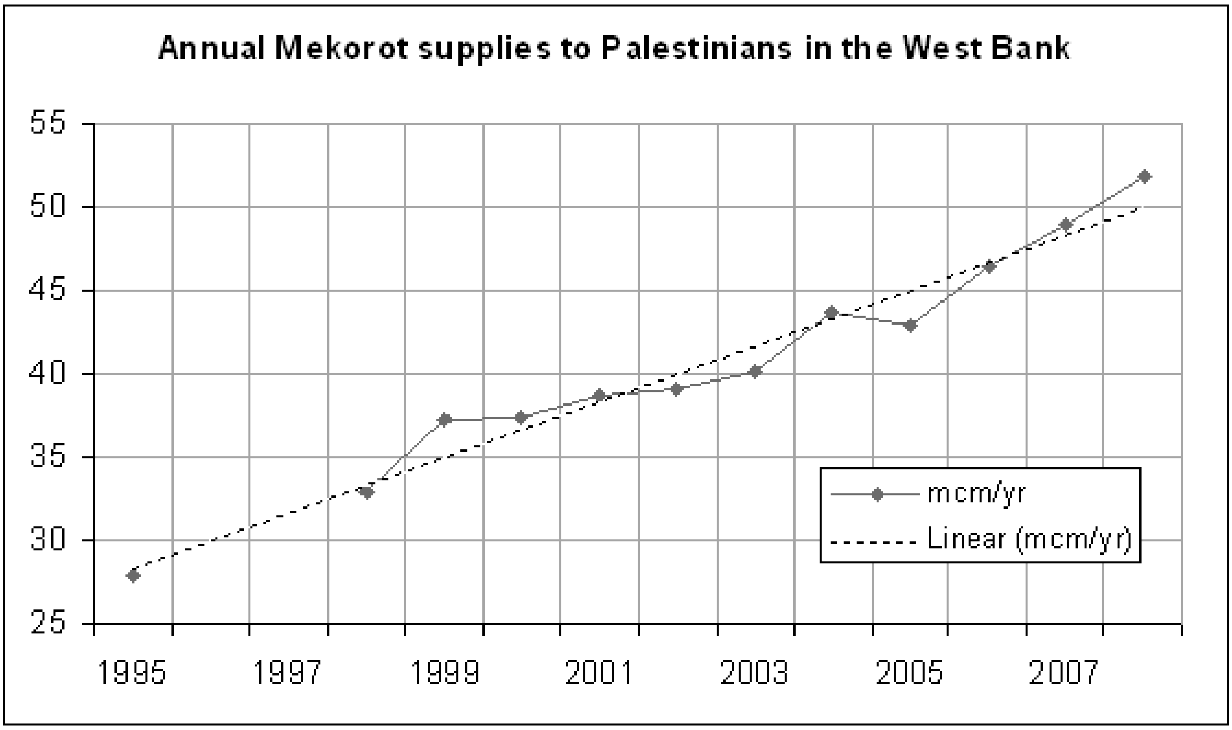
SOURCE: Yaqubi (2006, 6).

Fig. 22: Industrial Fuel Imports



SOURCE: OCHA (2010b, 11).

Fig.23: Annual Mekorot supplies to Palestinians in the West Bank (mcm/yr)



Excel-file with data after: IWA (2009, 35).

Fig.24: Gaza – Manhattan (200km distance to Lake Huleh)

SOURCE: modified after: DEP (2009, 19, Fig.2.1)

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