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Comprehensive Solutions for the Water Crisis in Gaza Strip

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Abstract

Gaza Strip is one of the most scarce water resources areas in the region. The coastal aquifer is the only water resource in Gaza Strip and it suffers from rising deficit in the water budget because of continuous increase in water demand for different uses which has been leading to fall in the quality and quantity of groundwater. The problem include inefficiency of infrastructure facilities, and water distribution networks that facing deterioration, illegal connections and leakage. This paper aims at reviewing the current water situation in Gaza Strip and suggestions quantities technical, legal and managerial solutions taking into considerations the current conditions and the approximate costs of applying these solutions. If the suggested solutions are applied within the same period of time, it will save huge quantities of water and utilize alternative resources to cover some of the consumption. These quantities are estimated to be about 35 MCM/yr of water initially and will reach 55 MCM/yr within the next years if solutions are applied on a large scale. The reserved water quantities equals a water production of regional desalination plant (as planned within PWA strategy) with capital cost of 200 million dollar and high operational cost.

Keywords:

Water resources, Aquifer, Infrastructure, solutions, Gaza Strip.

1. Introduction:

According to last reports and national plans of Palestinian Water Authority, the water situation in Gaza strip is facing critical condition. The only source of water is the ground aquifer, where the water level is decreasing, with increase in water demand for different uses. the Coastal Aquifer receives an annual average recharge of 55 -60 MCM/y mainly from rainfall, while the annual extraction rates from the aquifer is about 200 MCM. This unsustainable high rates of extraction has led to lowering the groundwater level, the gradual intrusion of seawater and up conning of the underneath saline groundwater. All of these conditions made the aquifer unusable in 2016, and the damage to it will be irreversible by 2022.

Water national plans included many effective projects that help to improve the situation, but by the year of 2016, most of these projects haven't implemented yet, which reflected on the water situation and the aquifer in the strip negatively. These projects are such as construction regional seawater

desalination plants, upgrading the current wastewater treatment plants and establishment of new wastewater treatment plants to increase the wastewater reuse (PWA, 2000a).

Therefore, and based on previous studies that have been published such as coastal aquifer management plan (CAMP), national water plans (NWP), Palestinian Water Authority studies and several academic and technical related studies (PWA, 2016 and MOA, 2010), this paper browsed the current water situation and infrastructure conditions, based on last recent measures, and suggested solutions under current circumstances (e.g blockade of Gaza, energy issues, low affordability,..etc) taking into consideration the delay and the ability to implement the major projects, and the capital and operational costs of these project from practical aspects.

2. Problem Identification:

A. Study Area:

The Gaza Strip, as one of the most densely populated areas in the world with more than 2 million people live in 365 km² (PCBS, 2016). It is located at the eastern coast of the Mediterranean Sea (at 31 25 N, 34 20 E), and its borders is Egypt on the southwest and POT on the south, east and north (as shown in Figure 1).

Gaza Strip suffers from limited resources, has already started to suffer the outcomes of environmental quality deterioration. The study area is a part of the coastal zone in the transitional area between the temperate Mediterranean climate to the east and north and the arid desert climate of the Negav and Sinai deserts to the east and south.

Rainfall amounts increased in the last ten years above the average and reached maximum in 2015-2016 session, reached and average of 500 mm and total amount of 176 MCM.



Figure (1): Location of Gaza Strip

only water resource (ground aquifer) including rainfall discharge, lateral inflow, and return flow . While outflow include domestic agricultural and industrial abstraction. The net deficit in 2016 is about 90 MCM and predicted to reach 180 MCM by 2035 as shown in Figure (2) (PWA,2012).

In addition to that, more than 95% of the water pumped is far from WHO standards (PWA,2016). where chloride concentration reached 4500 mg/l and water level is 14m below sea level in some areas of Gaza Strip (Figure 3).

Water distribution networks covers more than 97% of Gaza population with pumping rate 120 l/c/day, but due to leakage and illegal connections, the rate dropped down to 55 l/c/day. Wastewater networks covers about 84% percent of population. But due to low water per capita rate, the produced wastewater has high concentrations of salinity (Figure 4), nitrate, and heavy metals, which require more effective treatment methods to achieve successful reuse (PWA,2012).

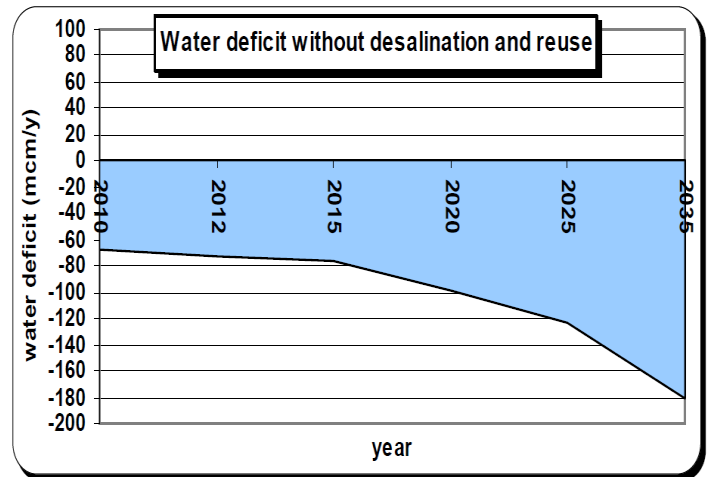


Figure (2): The Cumulative deficit across the years. (PWA, 2012).

For wastewater treatment facilities, Gaza Strip produced about 81.2 MCM of wastewater in 2015, which is treated partially. Only 10 MCM of treated wastewater is discharged to the ground aquifer, 61 MCM is pumped to the sea, and the rest is leaking through percolation pits without any treatment (PWA,2012).

Gaza Strip also suffers from the absence of effective stormwater collection system, where most storm

water runs off in the streets, and a few drains exist in the lower areas. However, there are five infiltration basins located in different area including Sheikh Redwan basin and Waqf basin in Gaza, Abu Rashed pond in the north, and El-Amal pond in Khanyounis

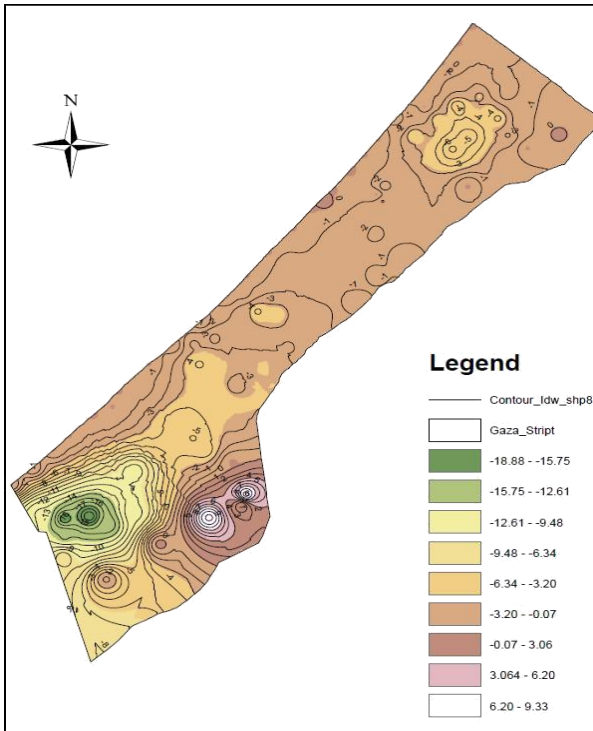


Figure (3): Ground Water levels of the aquifer in 2015 (PWA, 2016)

the total amount of rainwater losses due to urbanization as surface run-off is estimated of 40 MCM/yr, more than 33 MCM is lost either by pumping it directly to the sea or by evaporation (Khalaf,2006).

The economic situation in the Palestinian Territory and the living conditions of the Palestinian people have worsened over the last ten years, due to high unemployment rates and siege of Gaza , which affected the affordability of Palestinians to pay for water services. The GDP for Gaza Strip has been dropped from 1199 USD in 2000 to 970 in 2014. The Palestinian Central Bureau of statistics over the period 2004-2010 reveal that real GDP growth in Gaza has been negative, with real GDP per capita falling by 23.7%. The accumulated inflation for Gaza over the same period was 33.6% (PCBS, 2016).

Furthermore, the budget deficit of the Palestinian National Authority is increasing and accompanying social and political problems are on the rise, since the population of Gaza strip has increased to 2 million in 2016, and predicted to reach 3 million by 2020.

3. Suggested Solutions for the Water Crisis in Gaza Strip:

Solutions for water situation in Gaza is based on the current view of economic , political, and social conditions of Gaza. It is divided into two categories: technical solutions, and legal (water policy) and managerial solutions.

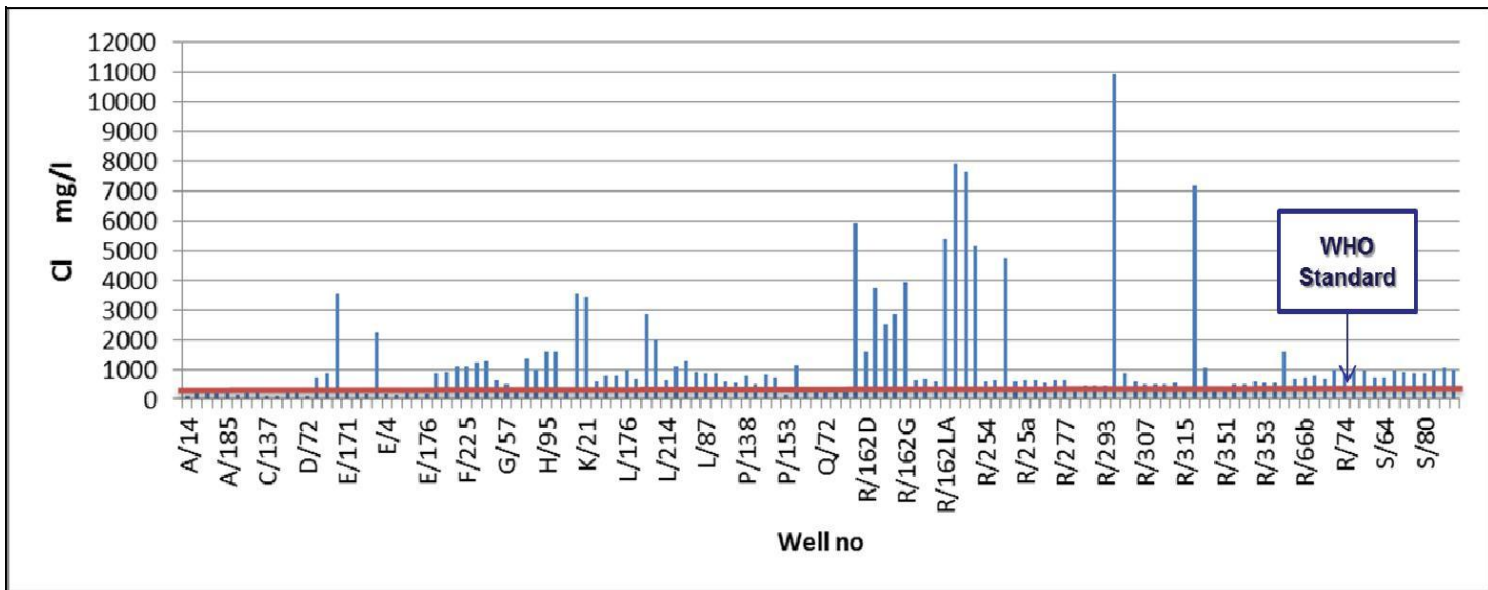


Figure (4): Chloride concentration in water from Wells

I. Technical Solutions:

1. Implementation of home based storm water collection system from the rooftops of the houses and reuse it by infiltration system to discharge the water to the ground aquifer, or for irrigation purposes. Runoff from roofs is estimated about 5.3 MCM/yr (Hamdan, 2012), and it's quality near WHO standards. These quantities is currently either going through wastewater systems and or discharged to the streets and collected to be pumped from ponds to the sea. Figure (4) illustrates the components of suggested system.
2. Implementation of storm water collection systems in the current and future highways projects, and treat the collected water and discharge it to the ground aquifer. This solution can reclaim more than 6 MCM/yr (Khalaf, 2006; Hamdan, 2012; and Aiash, 2012).
3. Applying new technologies for leakage detection in water distribution networks. These procedures could be applied within short periods and reasonable cost. Using these leakage detection techniques could help in lowering the leakage quantity from 53% to 30% and save more than 11 MCM (CMWU, 2016), (Aiash,2012).
4. Increasing the treated wastewater quantities to be reused for irrigation purposes (as shown in Table 1). This can be achieved through upgrading the current wastewater treatment plants and building new ones to cover the future needs as scheduled in Palestinian water authority plans. Applying this solution can provide more than 8 MCM/yr either for irrigation reuse or for aquifer discharge.

Table (1): The treated wastewater for irrigation purposes (PWA, 2003)

Type of Treatment	Comparable Israeli Class	Quality Requirements and Permissible Crops		Treatment Methods
		Quality Characteristics*	Uses in Irrigation	
Primary				Not allowed • Preliminary and Primary • Settling Tanks
Secondary Low	A	Total BOD ₅ TSS DO	60 mg/1 50 mg/1 0.5 mg/1	Cotton, sugar beets, cereals, dry fodder, seeds, forest • Anaerobic ponds, seasonal storage • Regular oxidation ponds, seasonal storage • Aerated ponds
Secondary, High	B	Total BOD ₅ TSS DO	45 mg/1 40 mg/1 0.5 mg/1	Green fodder, olives, peanuts, citrus, bananas, almonds, nuts • All of the above • Activated sludge • Biological trickling filters
Secondary, High Disinfected	C	Total BOD ₅ Dissolved BOD ₅ TSS DO Coliform Residual available chlorine	35 mg/1 20 mg/1 30 mg/1 0.5 mg/1 250 units per 100ml 0.15 mg/1	Gardening, vegetables for cooking, fruits for canning, deciduous fruit trees, groundnuts, sports grounds • All of the above • Chlorination
Tertiary	D	Total BOD ₅ Dissolved BOD ₅ TSS DO Coliforms Residual available chlorine	15 mg/1 10 mg/1 15 mg/1 0.5 mg/1 12 units/100ml ¹ 0.5 mg/1	Unrestricted use in Irrigation, including vegetables for fresh consumption, public parks and lawns • All of the above • Filtration • Additional chlorination

5. Upgrading of storm water collection system and infiltration basin with advanced systems will improve the infiltration rates to the ground aquifer instead of pumping the collected storm water to the sea. This solution will provide about 6 MCM/yr of water that will discharged directly to the aquifer.
6. Farming salt tolerant crops which can grow when of high salinity water is used. Reducing the use of crops that require high water consumption rates. This solution will enhance the agricultural production and utilize saline water consumption for irrigation, and saves more than 3 MCM/yr (PWA, 2003).
7. Implementation of effective monitoring and evaluation system for water resources and its implications on health and community as shown in Appendix B. This will help in reducing the diseases related to the water and developing a better future water plan in Gaza Strip.
8. In spite of the Palestinian Authority decision to establish regional desalination plants with high production rate (55 MCM/yr), such projects may fail practically due to many reasons:
 - A. **A high establishment cost for the implementation of seawater desalination projects:** and without availability of external funding (international donation) to implement these plants, it will not help as solution for water problem in Gaza (as happened previously according to the Integrated Aquifer Management Plan (IAMP) .
 - B. **A high operational cost of the plants:** since the cost per cubic meter of desalinated water equal one USD (PWA, 2013). As mentioned previously about the economic situation in Gaza, it will be difficult for the Gazans community to pay for it, which would reflect negatively on covering the operational cost (Aiash, 2012).
- C. **Planned desalination plants requires enhanced electrical energy supplies to operate efficiently:** Due to the current electricity situation, energy available in Gaza at the present time does not meet the demand, and there are always difficulties either to provide power or fuel to operate these plants continuously and efficiently as planned.

D. **Taking the current political situation of Gaza into considerations**, where the blockade of Gaza existing from 2007, and comparing it with similar existing projects, such as Gaza power generation plant, which facing more than 10 years of inefficient work with low performance and hard maintenance. The desalination plant will face similar difficulties including the importation of construction materials, maintenance equipment, and fuel or energy through its borders with Palestinian Occupied Territories (POT) and Egypt.

Due to these reasons, the option of importing water from abroad (either from Turkey, Egypt) with adequate cost will be the most economic, guaranteed and feasible solution.

9. Integrated aquifer plan has been prepared with detailed programs and projects within previous research (Aiash, 2012) (Plan summary is shown in the Appendix A).

Advanced Technologies and Procedure that can be applied:

- **Forward Osmosis (FO) Technology (Figure 5):** one of the new desalination systems that is used to achieve low capital and operational costs. Forward osmosis requires very low hydraulic pressure and delivers many potential advantages including less energy input, lower fouling tendency, easier fouling removal and higher water recovery. New reverse osmosis – forward osmosis hybrid system has been tested and prove challenging efficiency (USIR, 2013).

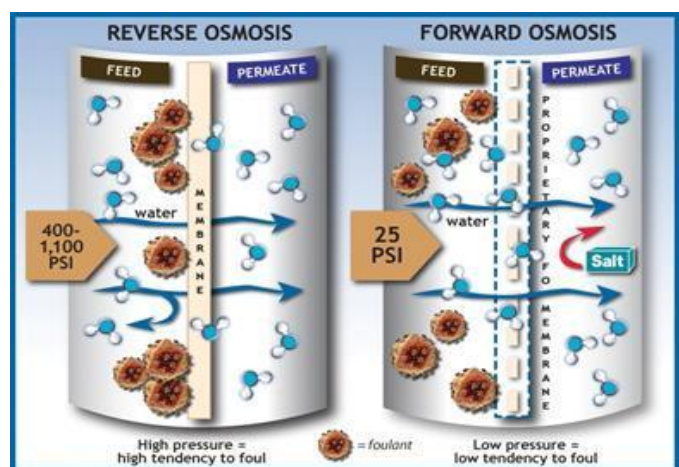


Figure (5): Forward osmosis and reverse osmosis

comparison (USIR, 2013).

- **Water leakage detection systems (Figure 6):** such as highly sensitive microphone instruments, which is placed on or near the suspect water pipe, any leak noise is amplified and an experienced engineer can normally determine very near or sometimes the exact position of the water leak. Also, smart ball technology can be applied by placing the ball inside the pipes to detect leakage. And using robot diagnosis system is utilized to draw inside pipe surface and locate deterioration sections (pure, 2013).

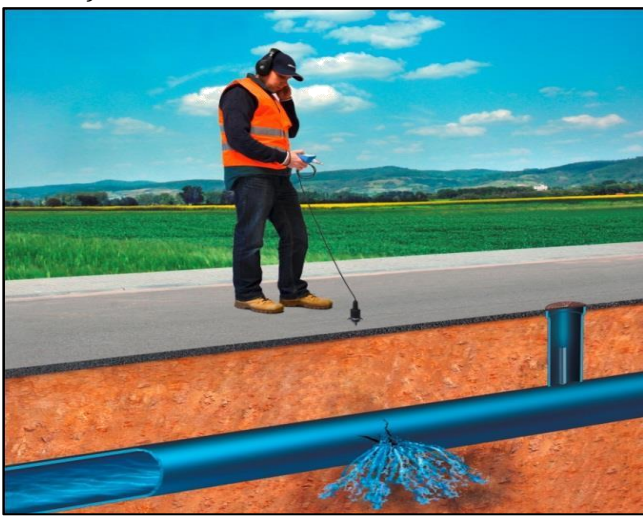


Figure (6): Water leakage detection technologies (smart ball, microphone) (USIR, 2013).

- **Storm water best management practices:** including improved infiltration drain fields, which help in controlling storm water quality and increasing the infiltration efficiency.
- **Recent wastewater treatment technologies:** such as Solar Photocatalytic Treatment, Anaerobic Fluidized Bed Reactor, and other new technologies which utilize sludge by reuse it to generate power that is needed to operate treatment plants (Bui, 2016).

II. Legal & Managerial Solutions

1. Execution of new campaigns by local authorities (Municipalities) in cooperation with the Coastal Municipalities Water Utility (CMWU) to close illegal connections from houses and buildings. If this step is fully implemented, unaccounted for water will be reduced by 15 MCM/yr (PWA, 2003; CMWU, 2012).

2. Implementing of wells closure law for unauthorized wells. There are more than 8000 unauthorized wells. Decreasing the number of unauthorized wells will reduce the abstraction about 7 MCM/yr.
3. Implementing of mandatory law by municipalities for storm water harvesting from rooftops, and consider it a primary requirement for giving buildings licenses for existing and new buildings.
4. Enabling the farmers to use the lands which are close to the wastewater treatment plants for agriculture. This solution makes it easier to the wastewater treatment plants connections to ensure that the treated wastewater is delivered to these lands and reused for irrigation.
5. Suggesting new tariffs for domestic consumption, taking into consideration higher paying rates for higher consumption quantities (PWA, 2009).
6. Encouraging using water consumption saving tools and fittings, by launching campaigns that aim to market it to the Palestinian residents, public authorities and private companies, and add it as condition in current and future construction and housing projects. This solution requires involvement of many parties such as the Ministry of Public Works and Housing, Palestinian Contractors Union, and Association of Engineers and Municipalities. If this solution applied in a large scale, it will reduce the water consumption by more than 18 MCM/yr.
7. Launching public awareness campaign targeting students at secondary schools, to increase the public awareness about the importance of water saving. This includes preparing publications and media programs. This solution can save more than 2 MCM/yr if it is applied successfully.
8. Issuance a new law that prohibits using ground water for irrigation in public parks and green areas, and use treated wastewater instead. Also, develop a new law that forbids draining water from private swimming pools to wastewater network and reuse this water for irrigation.

4. Effect of Applying Suggested Solutions and Estimated Costs

According to the suggested solutions for the water crisis in Gaza, they will help in maintaining a better water resources situation and provide alternative water resources. The water return from these projects and the estimated costs is analyzed as shown in Table 2 and 3. Technical solutions require high costs for

implementation and operation, in addition to a construction time in order to contribute in mitigation of existing crisis. However, it represents solid step towards improving water resources in Gaza. On other hand, legal and managerial solutions will provide immediate actions toward preserving the pumped water from the aquifer and will help in promotion of water saving culture.

Table (2): Technical solutions summary with estimated cost.

No.	Suggested Solutions	Annual WaterReturn (MCM/yr)	Estimated Costs (USD)	Period (Years)
Technical Solutions				
1	Water collection system for houses rooftops	5.3	1000/500m ² building	5
2	Construction of stormwater collection networks in the main highways	6	-	Continuous
3	Applying new water leakage detection technologies	11	50,000 – 150,000	0.5-1
4	Upgrading of current stormwater collection network and infiltration basins, and construction of new infiltration wells	6	1,000,000-5,000,000 Initially	Continuous
5	Increase the quantities of treated WW that reused for irrigation purposes	8	-	3-5
6	Farming Salt –Tolerant crops	3	250,000-500,000 initially	1-3
7	Applying effective monitoring and evaluation system	-	150,000	1
8	Importing Water	30-20	25,000,000-construction 12,000,000 /year -Water	5

Table (3): Legal and Managerial solutions summary with estimated cost.

No.	Suggested Solutions	Annual WaterReturn (MCM/yr)	Estimated Costs (USD)	Period (Years)
Legal and Managerial Solutions				
1	Execution of new campaigns by local authorities to close illegal connections from houses and buildings.	15	500,000 Initial Cost	1-2
2	Re applying of Wells closure law for unauthorized wells	6	100,000	Continuous
3	Applying mandatory law for stormwater harvesting from rooftops	2	-	Continuous
4	Enabling the farmers to use the lands which is close to the wastewater treatment plants for agriculture.	6	-	Continuous
5	Suggesting new tariffs for domestic consumption	3	-	Continuous
6	Encouraging using water consumption saving tools and fittings,	18	100,000	Continuous
7	Launching public awareness campaign	3	150,000- 300,000	1
8	Issuance new law that prohibit using ground water for irrigation in public parks and green areas	0.5	50,000	5

Importing water are medium and long term projects that require more studies and planning. These quantities are estimated to be about 35 MCM/yr of water initially and will reach 55 MCM/yr within the next years if solutions are applied on a large scale. The reserved water quantities equals a water production of regional desalination plant (as planned within PWA strategy) with capital cost of 200 million dollar and high operational cost.

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الحلول الشاملة لقضية المياه في قطاع غزة

كلمات مفتاحية:

الخزان الجوفي، قطاع غزة،
الوضع المائي، البنية التحتية،
الحلول المقترحة

يعتبر قطاع غزة واحد من أكثر المناطق التي تعاني من ندرة المصادر المائية، حيث أن المصدر المائي الوحيد وهو الخزان الجوفي يعاني من عجز متزايد في الموازنة المائية بسبب زيادة السحب المستمرة للمياه للاستخدامات المختلفة، والذي بدوره أدى إلى تراجع في كميات ونوعية المياه الجوفية. تشمل المشكلة أيضاً عدم كفاءة شبكات توزيع المياه و البنية التحتية التي تعاني من الإهتراء والوصلات غير الشرعية والتسريب. تتناول هذه الورقة مراجعة لما وصل إليه الوضع المائي خلال السنوات الأخيرة في قطاع غزة والحلول المقترحة الفنية والقانونية والإدارية، حيث تم الأخذ بعين الاعتبار الوضع القائم والتكلفة التقريبية لتنفيذ هذه الحلول. إذا ما تم تنفيذ هذه الحلول بالالتزام مع بعضها، فسيتم توفير ما يقارب 35 مليون متر مكعب في البداية وستصل الكمية إلى 55 مليون متر مكعب خلال السنوات المقبلة إذا ما تم تطبيق الحلول على نطاق أوسع. هذه الكميات التي سيتم توفيرها تعادل إنتاج محطة التحلية الإقليمية المخطط إقامتها كما في خطط سلطة المياه، بتكلفة تنفيذ تقارب 200 مليون دولار وبتكاليف تشغيلية عالية.

Appendix

Appendix (1) : Programs and projects recommended by Integrated aquifer plan and based in International Water Poverty index (Aiash,2012)

Component	Projects
Resources	Regional Desalination plants (55 Mcm/yr) (GETAP) (IAMP)
	Regional desalination plant (22 Mcm/yr) (GETAP)
	STLV Desalination unit (13 Mcm/yr) (GETAP)
	WW reuse (quantities are managed in 2035 plan) (GETAP)
	Importing water from Israel (quantities will rise from 10 to 21 MCM/yr though 25 yrs). (GETAP)
	WW storage by infiltration to the aquifer (IAMP)
	<p style="text-align: right;">Utilization of storm water by:</p> <ul style="list-style-type: none"> • Enhanced storm water collection and recharge from existing and future control projects. (very very important) (IAMP) • Regulation to provide for storm water recharge at new construction. (IAMP)
Access	New domestic distribution systems and upgrading the existing ones (IAMP & GETAP)
	Gaza Strip N-S pipeline system (IAMP & GETAP)
	Access to safe water require existence of desalination plants (Repeated)
	New sewage systems and more areas coverage (IAMP)
	<p style="text-align: center;">Upgrading and construction new treatment plants</p> <ul style="list-style-type: none"> • Three Regional WWTP of increasing Capacity: • Northern WWTP (under construction) with phases: <ul style="list-style-type: none"> ✓ 2015 - 12 Mcm/yr. ✓ 2025 - 22 Mcm/yr. • Central WWTP in 2025 with capacity 72 Mcm/yr. • Southern WWTP in 2025 with capacity 16 Mcm/yr.. <p style="text-align: center;">Treatment to provide irrigation water acceptable cropping through drip distribution system, and for safe aquifer recharge through infiltration basins.</p> <p style="text-align: center;">Note : the capacities approximately the same in IAMP and GETAP.</p>
	From Regional WWTP by pipeline to integrated infiltration System and/or farm distribution system for irrigation demand (IAMP)
	50% Daily demand Storage to increase the water quantities per capita per day (IAMP)
Capacity	Water and health monitoring programme (GETAP)
	Redesign/ Improve new marketing (GETAP)
	Improve the education situation
	Public Awareness especially for value of water
	Introduction of water tariffs in Municipal and agriculture Sectors.
	Applying Programs to strengthen GDP

Use	Enhance the distribution systems to minimize losses and the domestic consumption. (Repeated)
	WW reuse (Repeated)
	Improve seed and strain selection/use (GETAP)
	Improved Irrigation efficiency
	Regulation of low consumption fixtures
	Reduced agricultural pumping
	Improve the rule of Agriculture and Industry to increase their share in GDP
	Storm water systems improvement and use (Repeated)
Environment	<p style="text-align: right;">Giving Rest of the aquifer by:</p> <ul style="list-style-type: none"> • minimizing the quantities abstracted from the ground aquifer • Using alternative water resources (Desalination, WW reuse, Storm water collection) (Repeated)
	Improve Wadi Gaza to become wetlands infiltration area and to improve Biodiversity
	Salt tolerant crops (IAMP)
	Pretreated M&I Supply.
	Training for farmers in fertilize, herbicide and pesticide use. (CAMP)
	Sanitary Landfills (IAMP)
	Oil and Hazardous waste incineration (IAMP)
	Increase the studies on the threatened mammals and threatened birds across the strip.

Appendix (2) : Suggested Monitoring and Evaluation System in Gaza Strip (Aiash,2012)

Constituent	Parameters	Unit	When	Method
Water Balance	• Total inflow	MCM/y	Per year	Calculated
	• Agricultural Consumption			Measured
	• Municipal and industrial Consumption			Measured
	• Total outflow			Calculated
	• Desalination Production			Measured
	• WW reuse amounts			Measured
	• Any future External Water Resources or Surface Resources should be Considered.			
Water Resources Quality (% Accepted by WHO)	• Percentage of water from the ground aquifer with accepted quality according to WHO.	(%)	Measured Per month Percentages are taken per year as average	Measurements and sampling Required Percentages
	• Percentage of water abstracted from the ground aquifer from total consumed water			
	• Percentage of water from desalination plants accepted according to WHO Standards (samples should be tested and the percentage should be 100%).			
	• Percentage of desalinated water volume from total consumed water.			
Access to safe water	• Percentage of domestic network coverage. (network has been chosen due to the elimination of the existence of bacteria due to disinfection).	(%)	Per year	Calculated
	• This percentage is multiplied by (% of water resources quality).			
Access to sanitation	• Percentage of WW networks and facilities coverage.	(%)	Per year	Measured
National Accounts	• Gross Domestic product (GDP/Capita).	USD	Per year	Calculated
	• Gini Coefficient (Calculated based on Lorenz curve).	No.	Per year	Calculated
	• GDP Index (calculated using UNDP Human Development Report method).	No.	Per year	Calculated
	• Percentage of GDP From Agriculture and Industry	(%)		
Health Statistics	• Reports of illness due to water Index, Calculated based on percentage of certain diseases due to water to the total communicable diseases. Diseases included are:	No.	Per year	Calculated
	✓ Hepatitis A	(%)		Counted
	✓ Diarrhea > 3 years	(%)		Counted
	✓ Diarrhea <3 years	(%)		Counted
	✓ Ameba & Guardia	(%)		Counted
	✓ Bloody Diarrhea	(%)		Counted
	✓ Shigila	(%)		Counted
	✓ Blue Babies	(%)		Counted
	• Under five mortality rates	(%)		Per year

Constituent	Parameters	Unit	When	Method
Education Statistics	<ul style="list-style-type: none"> Education index (calculated using UNDP Human Development Report method) Adult Literacy rate Gross Enrollment ratio 	No. (%) (%)	Per year	Calculated Measured Measured
	<ul style="list-style-type: none"> Tests should be performed in all existing wells (as more as possible of agricultural wells and all municipal wells). Same named wells data should be used along the future years and the index should be calculated based on them. The required parameters are: <ul style="list-style-type: none"> For Ground Water: <ul style="list-style-type: none"> ✓ Electric Conductivity (Standard of 1600 Micro-Siemens per centimeter) ✓ Chloride Concentrations (WHO Standard (250mg/l)) ✓ Nitrate Concentrations (WHO Standard of 50 mg/l) ✓ Fluoride Concentrations (WHO standard of 1.5 mg/l) For Surface water (If it existed in the future): <ul style="list-style-type: none"> ✓ dissolved oxygen concentration, ✓ phosphorus concentration, ✓ suspended solids. ✓ electrical conductivity. WW reuse should be assessed for any future environmental impaction (EIA) 	Microsiemens per centimeter Mg/l Mg/l Mg/l Mg/l Mg/l Mg/l	Measured Per 6 month Percentage is taken per year as average Per year	Measurements and sampling Required Percentages are calculated
Water Quality Index	<ul style="list-style-type: none"> Fertilizer consumption per hectare of arable land. Fertilizer products cover nitrogenous, potash, and phosphate fertilizers. 	0.1Kg/hectare	From July to June	Calculated
	<ul style="list-style-type: none"> Pesticide use per hectare of crop land, Pesticides are organized into eight categories, the sum of which is used to determine total pesticide consumption. The eight categories are: insecticides, mineral oils, herbicides, fungicides and bactericides, seed treatment - fungicides, seed treatment - insecticides, plant growth regulators and rodenticides. 	Kg/hectare	Per year	Calculated
	<ul style="list-style-type: none"> Industrial organic pollutants per available fresh water. is the amount of oxygen that bacteria in the water will consume in breaking down waste. This is a standard water-treatment test for the presence of organic pollutants. Recently, Water Gap Model Program used for this purpose (from University of Kassel,UK) the percentage of country's territory under severe water stress The modelers 	(Tons BOD/km2)	Per year	Calculated
Water Stress				

	<p>derived gridcell by gridcell estimates of where water consumption exceeded 40 percent of the water available in that particular grid cell. These were then converted to land area equivalents, and the percent will calculated.</p> <ul style="list-style-type: none"> Drop of water level should be measured based on reference year. This point is added by me because it represent clearly the water stress in addition with previous points . 	(%)	Per year	Calculated
		(%)		Calculated
Regulation and Management Index	<ul style="list-style-type: none"> Environmental regulatory stringency, Environmental regulatory innovation, Percent of land area under protected status The number of sectoral EIA guidelines; 	(%)	Per year	Measured
Biodiversity Index	<p>Percentage of threatened birds: The number of bird species threatened divided by known breeding bird species in the country, expressed by percentage. Threatened species include those that are listed as "Critically Endangered, Endangered, or Vulnerable," but excludes sub-species, introduced species, species whose status is insufficiently known.</p>	(%)	Per year	Calculated
	<p>Percentage of Threatened mammals: same calculated as threatened birds percentage Threatened species include those that are listed as "Critically Endangered, Endangered, or Vulnerable," but excludes sub-species, introduced species, species whose status is insufficiently known. Total numbers include both endemic and non-endemic species with excluding of cetaceans data.</p>	(%)	Per year	Calculated