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TOWARDS SUSTAINABLE USE OF SOIL AND IRRIGATION WATER IN GAZA GOVERNORATES

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ABSTRACT

The Gaza Strip is described as the most exploited place in the world where the level of demand on resources exceeds the capacity of the environment. This is especially true for water and land resources, which are under high pressure and subject to severe over-exploitation, pollution and degradation in the very densely populated Gaza Strip. In addition to the fact that water resources in the region are extremely scarce and disputable, in the near future less water will be available and water saving techniques will need to be explored and introduced. Pressure on agriculture will certainly increase strongly during the next decades.

As response to the urgent and imperative needs in Palestine, the Water Sector Strategic Plan (WSSPS) has been compiled to develop and present detailed steps and actions plans within a 20 year-horizon, in order to influence the sectoral vision. Due to intensive water scarcity in the region, the Palestinian Water Authority (PWA) has adopted in its strategic plan a proper demand management as a tool to bridge the gap between demand and supply and has acknowledged a series of recommended actions that will augment the efficient use of water in the domestic area, wastewater reuse and agriculture in terms of technical, legal, economic and institutional reforms in order to encourage water saving technologies and minimize pollution control in the Palestinian regions. Furthermore, the limited availability of water resources to the Palestinians, combined with the associated political complexity related to these resources, have urged PWA to formulate the main principles of National Water Plan (NWP) which lay down the basis for efficient and equitable water management in Palestine.

Given that domestic water is the first priority for the Palestinians, PWA adopted the minimum scenario for municipal and industrial demand management to secure 100 and 150 l/c/d integrated with WHO quality standards for household connections in small communities and urban areas respectively. PWA in cooperation with the World Bank launched a four year project to improve water and wastewater services in Gaza and the West Bank to build an appropriate infrastructure to match increasing and expanded needs. The operator (LEKA) has already improved the efficiency of water supply distribution networks through installation of more than 1200 km of main and lateral pipes in addition to about 30,000 water meters for houses which were installed or repaired and 20,000 houses have been newly connected to the main network, which is completely disinfected.

Concerning wastewater treatment and reuse, which is identified as a promising and potential solution for the shortage of water in the region, PWA has successfully completed the development and upgrading of all electro-mechanical equipment for sewerage wastewater collection in Rafah, Gaza, Beit Lahia, and Al-Beira.

It is stated in the National Water Plan that in the agriculture sector, which is the largest water consumer in Palestine, water demand can be sustainably managed through the more efficient use of water, adopting new crop patterns and utilization of alternative water resources (low quality water and treated wastewater). It should be born in mind that irrigation nowadays is not a dimensionless process; it has a strongly environmental sound. Water quality issues have plagued irrigation projects for centuries. Clearly salinity and nitrate leaching will continue to receive high research priority in irrigation agriculture, particularly in areas with known problems.

In terms of legal and economic consideration, as part of the scope of services of the Improvement Program, PWA completed a tariff study specifically oriented towardsdetermining the average level of cost recovery per unit of water delivered to the users. In addition, PWA launched a campaign to install water meters on the agricultural wells in Gaza and had ready plans to extend the campaign to other districts.

Institutionally, and through the National Water Plan, the organization of the water sector has been established in such a way as to provide clear separation between the regulatory and delivery functions

and to emphasis that PWA is the sector regulator and guardian of the nations water resources. In an unprecedented step towards the restructure of water sector, PWA acknowledged the establishment of the regional Water Utilities that would deliver retail and all water services to customers.

Finally, PWA set up a series of actions through the ongoing and planned projects to protect the groundwater from contamination and regular deterioration of water quality and its associated problems like salinity, nitrate resulting from overapplication of nitrogenous fertilizers, pesticides and infiltration of wastewater.

1. INTRODUCTION

Agriculture is the main water consumer in the Gaza Strip (more than 70% of the total consumption). Rainfall is insufficient for the cultivation of most crops and supplementary irrigation is needed in order to meet the crop water requirements.

The role of agriculture is particularly important in the economy of Palestine due to its high contribution to GDP and to its role in employing Palestinian workers. Irrigated agriculture contributes more than 37% of total agricultural production compared to only 24% of agricultural production from rainfed agriculture. Agriculture plays a major role in national trade, as agricultural products constitute 23% of the national commodities export. In the Gaza Strip, most of the agricultural crops are grown under irrigation. Since irrigation water in the Gaza Strip contains significant amounts of dissolved salts, a closely related objective of irrigation management is salinity control.

The quality of irrigation water may influence crop yield and soil properties and thus have major effects on agricultural practice. Considering these soil characteristics, the high crop water demand and water scarcity in the Gaza Strip, drip irrigation systems are the most appropriate irrigation systems. These systems are efficient, well controlled and can supply small doses of irrigation water with high frequency. Since there is a great variety in water quality, rainfall, crop and soil type, big differences in soil salinisation can be expected throughout the Gaza Strip. Many problems associated with soil can be reported here. The most important ones are the degradation of soils through salinity, losses of agriculture lands because of uncontrolled land use and sand dune quarrying.

2. PRESENT STATUS OF WATER USE IN PALESTINE

Currently, water volumes for Palestinians use are partially determined by the Oslo Accords although it is recognized that additional volumes may be available for future exploration. The table below provides an indicative view of regional water volumes that exist within the Palestinian lands.

Table 1. Present Water Consumption in Palestine.

Region	**Sector**	**Water supply Mcm/year**
West Bank	Agriculture	89
Gaza Strip		85
West Bank	Municipal & Industrial	57
Gaza Strip		50
Total		**279**

Source: National Water Plan, 2000.

The present situation in the water sector in Palestine is characterized by:

- Water resources in the region are extremely scarce and disputable;
- Water demand is continuously growing;
- Water supply and sanitation services are inefficiently delivered and inadequate;
- Tariffs are generally inadequate;
- Consumption and water losses are excessive;
- Insufficient water harvest activities;
- Wastewater is unavailable, inadequate or not functioning properly.

Beside the general and political problems facing water resources in Palestine, the main challenge facing the irrigation sector is to improve water conservation through policy, technological and management interventions. Perhaps the most important areas of challenges are:

Reallocation of water between the competing sectors. Such allocation can have serious legal, equity and social considerations;

Improving operation and maintenance of existing system with reduced chances of new constructions;

Managing water demand through efficient pricing, cost recovery and regulatory measures, and related education and training;

Ensuring widespread user participation no longer can governments continue to subsidize water and meet all the capital and operating budgetary requirements;

Adopting adequate steps to enhance water and land quality measures-environmental assessments, reuse;

Adopting improved water-efficient technologies. This is necessary if continuing to meet the needs of the competing sectors from agricultural wells.

As shown in table 2, ground water is the only resource of water for irrigation of crops in the Gaza Governorates. Irrigation practices are only based on the farmer's own experience. They determine when and how to irrigate crops based on the appearance of the soil and the climatic conditions.

Table 2. Water Resource Development for Agriculture in the Gaza Strip, 2000 to 2020.

	2000	2005	2010	2015	2020
Fresh water	40	34	22	18	17
Wastewater re-use	0	23	34	48	63
Breckish	51	35	32	20	0
Rainwater harvesting	(0)	(0)	(0)	(0)	(0)
Total	91	92	88	86	80

Source: National Water Plan, 2000.

By 2005 utilization of wastewater is planned to contribute 25% of the total required for agriculture and the utilization of brackish water will have been reduced to 38%.

By 2020 the utilization of wastewater is planned to provide 78% of the total required by agriculture, with the remainder being provided by the freshwater aquifer in order to maintain the balance of salts in the soil and provide the quality necessary for certain crops. Improvement in the quality of the aquifer, which is planned to have taken place by this time under effective aquifer management, will have reduced the quantity of brackish water in the aquifer.

3. PALESTINIAN WATER POLICY

The Palestinian water policy becomes the basis for decisions on the structure and tasks of water institutions and PWA emphasized the use of appropriate technology in water saving practices and conservation and optimum utilization of water resources should be promoted and enhanced as stated in the General Policy Principles of PWA shown in Annex 1. The objectives of the Palestinian water policy are the followings:

Managing water as an economic commodity is an important way of achieving efficient use, encouraging conservation and protecting water resources. This management can save about 30-50% of the water on the farm and together with better agronomic and cultural practices can at the same time optimistically double yields per water unit ;

Save water and reduce wasteful rate;

To improve the efficiencies of water use in irrigated agriculture through adopting proper technologies and strategies;

To develop improved water supplies and cropping systems to better utilization of water resources;

To develop legislation system aims at restricting water extraction;

To protect the aquifer from non- point pollution resources.

The elements of water policy are reflected in the development objectives for irrigated agriculture in Palestine, which are consistent with the overall agricultural policy that includes:

Optimal exploitation of agricultural resources, particularly, land and water to ensure its sustainability and to preserve the environment and to contribute to achieving food security;

Development of the Palestinian rural areas through an integrated rural development approach, where agriculture constitutes its backbone. Special consideration for people's participation and coordination and harmonization with the civilian societies, integration of gender issues and the encouraging of establishment of farmers and other target groups organizations;

To increase and to improve the competitiveness of agricultural production in local and foreign markets.

4. AGRICULTURAL WATER DEMAND ELEMENTS IN PALESTINE

As stated in the National Water Plan, there are many elements considered in determining agricultural water demand:

Incorporation of sufficient water resources in planning to ensure food security (Calculated as requiring 0.14 dunums per capita gross area or 0.09 dunums per capita net crop area). Only minimal fresh water to be provided for eventually in order to allow for satisfactory soil flushing and specific crop requirements the further supply required to be provided from re-use of wastewater and other lower quality alternative sources in accordance with policy;

Adjustment of cropping patterns to take account of water availability, both in respect of quantity and quality, land and climate suitability, food security and economic return, all in co-operation with the Ministry of Agriculture;

Implementation of modern irrigation and farm management techniques to minimize on water utilization and maximize on output;

Farmers and relevant institutions to plan for maximum use of wastewater re-use in future including provision for the necessary storage, health precautions and crop pattern;

Establishment of an appropriate tariff system, which reflects the economic value of the water provided and the need to encourage water conservation, including the effect of incentive for low water consumers and penalty for high consumers;

Strengthening of the legal and regulatory framework for determining water demand through water meters, licensing system and an appropriate solution for illegal wells;

Improvement of the environmental impact of irrigation projects through the establishment of fertilizer control programs and reduction of the effects of pesticides;

Launching public awareness programs to educate on the economic value of water and future use of treated wastewater;

Supporting institutional and regulatory developments;

Development of water quality laboratories suitable for monitoring agricultural water use and discharges in regard to health and the environment;

Extending research to provide regular improvement and efficiency in the use of water in the agricultural sector, including the involvement of research organizations and NGOs;

Supporting capacity building and satisfying training needs in the water-related areas of the sector, technically, administratively and financially.

5. SUSTAINABLE IRRIGATION WATER MANAGEMENT IN GAZA GOVERNORATES

In the light of aforementioned strategies, conservation measures such as metering, leakage detection and improving agricultural techniques will be implemented to ensure the economic use of water saving in the agricultural sector. It is advisable that agricultural water abstraction must be part and parcel of an integrated agricultural & water policy towards comprehensive soil and water conservation management and the comprehensive management measures.

Responding to urgent needs, PWA in cooperation with Ministry of Agriculture launched an impetuous program supported by the Austrian Government called " Development of Sustainable Institutional and Technical Capacity in Agricultural land and Water Resources Management in West Bank and Gaza Strip". It aims at increasing institutional capacities for land and water use assessment and management in the PWA and MoA. The ultimate objective is that the enhanced capabilities will lead to an improved water management through optimizing agricultural land use planning and for further development of Palestinian water planning and management. The proposed project is intended to provide decision makers with recommendations and a set of alternative scenarios for agricultural land and water resources

management options. The following practices are partially applied and involved at different levels in the Palestinian regions.

5.1. On Farm water conservation methods

The following practices may be successfully involved at the farm level:

5.1.1. Only the required amount of water should be applied

Irrigation water management involves controlling the rate, timing and amount of irrigation water, so crop moisture requirements are met while minimizing water losses. On the other hand, water allocation for different crops needs a review. For instance, the water allocated to farmers depends upon soil conditions and the type of crop cultivated. On the latter basis the allocations are as follows:

Table 3. Water allocations for crops in Gaza Governorates.

Crop	**M^3/dunam/year**
Citrus	1000
Strawberry	1000
Vegetables	700
Olives and Almonds	300
Cut- Flowers	1800

Source: (Khana, 1991).

Recently, net irrigation requirement for the major field crops in the Gaza Strip has been calculated by D, Haeyer, T. (June 2000) using *the reference evapotranspiration* (ET0) following the new procedures proposed recently by FAO (1998). The seasonal crop evapotranspiration is calculated for crop under sprinkler and drip irrigation. It is obvious that the net irrigation requirements differ with the irrigation method applied and the area which the crop cultivated in.

5.1.2. The water should be of appropriate quality

The irrigation process can degrade water quality and soil characteristics by increasing salt concentration and adding toxic materials. Water quality problems associated with irrigation can in part be alleviated through

Reduced fertilizer application;
Reduced pesticides application;
Irrigation scheduling to reduce excess drainage.

The use of saline water in irrigation practices can cause soil salinization if the supplied salts of the irrigation water can not be leached out properly by winter rainfall or additional irrigation water. The salts will be accumulated and limit crop growth.

Selection of certain crops in terms of soil, the availability of water, adaptation of the irrigation systems to crop, and the climatic and soil conditions remain a point to be taken into account in local and overall strategies involved in recycling the water resource.

5.1.3. Water application should be properly scheduled

Successful irrigation depends upon understanding and utilizing irrigation scheduling to develop a management plan and then on efficiently implementing the plan. Irrigation scheduling provides information managers can use to develop irrigation strategies for each field on the farm. Therefore, the appropriate irrigation scheduling strategy is to prevent crop water stress throughout the growing season. Irrigation scheduling should be generalized widely on the Palestinian farms to encourage water saving and control soil salinity and nitrate leaching. Irrigation scheduling by watermark tensiometer experiment

carried out on citrus farms in Northern Governorate/Gaza had significant results and presents a good example of contribution of this equipment to water saving on citrus farms. For instance tensiometers help to determine optimum irrigation needs and timing. It can contribute effectively in water saving in the field with a rate exceeding 30 %. The same approach will be conducted in The West Bank to demonstrate the results to farmers to convince them to adopt water conservation techniques.

5.1.4. Appropriate irrigation methods should be used

It is necessary to promote and enhance modern irrigation techniques especially for citrus or crops which are still traditionally irrigated. One third of citrus farms in Gaza are irrigated with modern techniques whilst the rest is traditionally irrigated. The expected water saving in citrus farms may reach 4 Mcm/year by shifting more than 15,000 dunam from surface irrigation to drip and sprinklers irrigation. On the other hand, wastewater reuse through subsurface drip irrigation system (SDI) has been recently used to manage the potential nitrate leaching and the efficient application of brackish water beside its tangible advantages in water saving is more than 30%.

5.1.5. Using the concept of minimized leaching requirement

The leaching requirement (LR) to prevent salt accumulation in the root zone can be calculated by more than one equation. Since Rhoades & Loveday (1990) developed their equation to keep salinity below the crop tolerance threshold value in order to give 100% yield and since that equation considers the type of irrigation system, it may contribute widely to water saving and salt and nitrate-leaching minimizing. The concept of minimized leaching requirements is necessary in Gaza for shortage of fresh water and to minimize the contamination of water resources. A sorghum experiment carried out using treated wastewater showed a significant reduction in soil salinity values and nitrate leaching under subsurface drip irrigation by adapting irrigation scheduling and adopting minimized leaching requirement without any reduction in sorghum yield.

5.1.6. Plant nutrient should be managed in an optimal way

In evaluating the fertilizer potential of an effluent or in the irrigated water, its N, P, K concentrations should be estimated before scheduling irrigation. This could help calculating eventual additional fertilizers needed for a certain crop and for choosing the appropriate cropping patterns in order to improve the efficient use of water and the nutrients presented in.

5.1.7. Rain Water Collection

The number of greenhouses in Gaza Governorates is rapidly increasing. In 1998 the total area of greenhouses exceeded 12,500 dunam covered by plastic sheets and provided with plastic pipes to collect water and convey it to the available bonds. Accordingly, about 4- 5 Mcm/year of the rainwater may be harvested.

6. MODIFICATION AND REDISTRIBUTION OF CROP PATTERNS IN GAZA

The increased demand for food could be partially satisfied by the anticipated encrease in irrigated agricultural crops from the reuse of wastewater and marginal quality water. The following factors should be examined for the purpose of managing the irrigation demand:

Reallocation of irrigation water supply to lower water consuming and high value crops;

The comparative advantage principle may be formed by evaluating the agro-water policy to optimize water return from agricultural products and defining new crop patterns in the Gaza Governorate;

Future utilization of treated wastewater may play a significant role also in determining the crop patterns in the region;

According to salinity levels in the irrigation water, it is advisable to cultivate new tolerant crops complying with the high levels of salinity in the majority of agricultural wells in Gaza Governorates. Low quality water is recommended for irrigating some tolerant crops that seem feasible in terms of economy and to fulfil the food sufficiency.

Recently, Palestinian Water Authority prepared an emergency plan to protect the areas which are characterized by fresh water to meet successive domestic needs and comprises strict restrictions imposed on drilling new agricultural wells, and reviewing water allocations and even closing illegal wells in the protected area.

7. WASTEWATER TREATMENT, MANAGEMENT AND REUSE

Wastewater reuse has been identified as an important issue to solve the water deficit crisis in the Middle East and South Mediterranean countries. Wastewater reuse will provide an alternative to groundwater for irrigation and recharge purposes, where about 55 Mcm/year of wastewater will be used for irrigation by year 2020. Using treated wastewater for irrigation will clearly minimize the demand on the groundwater for irrigation and will reduce the degradation of the environment. Furthermore, itcould have many beneficial results for the Gaza Governorates and should be considered as part of any management policy. Potential available quantities of treated wastewater effluent are estimated in the following table:

Table 4. Potential treated wastewater quantities (MCM) in Gaza Governorates and West Bank for irrigation purposes.

Year	Gaza Strip	West Bank
2000	6	0
2005	19	1.6
20l0	28	8.2
2020	53	39

Source: WSSPs, 2000.

The Ministry of Planning in close cooperation with PWA has identified locations for three new regional plants in the Gaza Strip to increase the capacity of treatment and to build new wastewater schemes simultaneously. In this context, more than 7000 dunams of citrus and olives will be irrigated with class D effluent in the Gaza area, where plans to cover all the potential irrigated areas adjacent to the new treatment plants are in progress.

8. LEGAL REFORMS AND ECONOMIC CONSIDERATIONS

Economic development for Palestine at the current stage is to a large extent dependent on an adequate water supply. Both agriculture and a wide range of industries depend on water. However, the current price paid in most of the utilities and water departments both in the West bank and Gaza Strip does not reflect the real value of water, since it is not based on an economic analysis to estimate this value. In the National Water Policy, water has a high social, environmental and economical value. Accordingly this resource has to be managed in terms of both quality and quantity in an economically, socially and environmentally effective manner. A tariff policy has to be adopted in order to ensure both efficient use and conservation of water in addition to achieving cost recovery at different levels in the water sector. This tariff policy has to also take into consideration the social conditions of the people including affordability.

Water has a high environmental value. It is essential for life and necessary for an acceptable hygienic standard, but can also be the carrier of serious diseases. A secure and adequate water supply is thus a necessary condition both for the personal well being of people and for a correct level of public health.

8.1. Tariff Structure

As a part of the scope of Services Improvement Program, LEKA completed a tariff study specifically oriented toward determining the average level of cost recovery per unit of water delivered to the users in the Gaza Strip. Domestic and irrigation water tariff is an issue of great importance in water management for the following reasons:

Water allocation between competing uses;
Water conservation;
Generation of additional revenue which could be used to manage systems;

Adopting cropping patterns;
Efficiency of water management;
Overall environmental impacts;
Enhancement of the utilization of treated wastewater.

8.2. Well metering

The last formal enumeration carried out by MoA and PWA indicated that there are about 1735 wells drilled illegally in the Gaza Governorates as shown in table 5.

Table 5. The distribution of legal and illegal wells in Gaza Governorates.

Governorate	No. of legal wells	No. of illegal wells
Northern	710	143
Gaza	474	354
Middle	511	427
Khan Yones	425	634
Rafah?	169	177
Total	**2289**	**1735**

Source: Palestinian Water Authority, Data Base Section 2001.

The PWA launched a campaign to install meters on the agricultural wells in the southern area and it has planned to extend the campaign over all the Gaza Strip.

9. INSTITUTIONAL REFORMS

The organization of the water sector has been established in such a way as to provide clear separation between regulatory and delivery functions and to emphasis that the PWA is the sector regulator and guardian of the nation's water resources. The functions of the sector and the interaction of the relevant organizations with PWA is shown in Annex 2.

The regional Water Utilities would be responsible to deliver retail and all water services to customers. They would be responsible for design, construction, operation and maintenance of retail consumer services including:
Water supply;
Wastewater collection, treatment and reuse;
Storm water collection and reuse;
Water and treated wastewater supplies for irrigation.

The mission of service utility (as shown in the diagram) should be consistent with national policy and goals to achieve the overall mission of the water resources management. Thus the utility mission may appear as:
" *To provide water and wastewater services adequately to all users in accordance with the national policy at a price consistent with the cost".*

10. PROMOTE PUBLIC AWARENESS AND PARTICIPATION

It is important to link the policies to people, keeping in mind that policy formulation and the setting of national priorities should occur with the involvement of all major water stakeholders (both users and managers).
Stakeholders can be linked to policy-makers through existing organizations and forums at national, district and community level. The decentralization of responsibility and increasing accounting to primary stakeholders is an important success factor. As popular participation increases with an effective, two-way flow of information, existing policies may need to be revised. Awareness of water resources challenges,

issues, and opportunities are an essential activity for improving water resources management in Palestine and needs to be enhanced:

At the political level, to create understanding and commitment;

At the executive level in PWA, as part of building capacity; and among the public, to create society-wide commitment;

Growing awareness will encourage public support of policy initiatives, such as tariff reforms, good governance, and decentralization of public decision-making;

Promoting and enabling local participation in planning, operation and management of water resources is a fundamental strategy for achieving sustainable development. Local involvement is a key to ensure water demand management to monitor the performance of public and private institutions;

Local participation and unity is a cultural tradition in Palestine, rooted perhaps in coping strategies for collective survival under difficult conditions. It would be possible to benefit from this tradition to promote public involvement and enhance water resources responsibility and management in society at large. The PWA should also consider incorporating community members in the preparation and implementation of projects;

The PWA has launched a public awareness program in cooperation with the different stakeholders to inform the users, particularly farmers, of the importance of water resources in the developing plan of Palestinian lands. Furthermore, it will enhance social acceptance of utilizing treated wastewater for irrigation purposes and pave the way to run the PWA policy regarding agricultural water tariffs.

11. ENFORCE POLLUTION CONTROL AND PROTECTION OF WATER RESOURCES

The objective is to develop the appropriate and efficient legal, regulatory and institutional instruments to enforce pollution control and protection of water resources through co-ordinated efforts between relevant institutions through the following:

Emphasis on environmental objectives through the protection of catchment areas must increase significantly to avoid further water scarcity and quality problems.

Environmental impact assessment (EIA), including public display and hearing, should be carried out for each project with anticipated environmental effects.

Consider the need for preparation of national EIA Guidelines in cooperation with other relevant institutions.

11.1. Pollution Control regulations

Establish water quality and effluent discharge standards according to pollutant type and sector.

Develop and introduce enforceable penalties and regulatory techniques.

Prepare Guidelines and commence the operationalisation of the regulations developed under strategy 2: “Policies and Regulations”.

Clarify responsibilities between authorities involved in monitoring and compliance of pollution control and land use, and implement necessary re-structuring of institutional functions.

Ensure that the water / wastewater laboratory and data processing services are operational.

11.2. Licenses and Pollution Abatement in High Priority Areas

Carry out rapid identification and assessment of high priority pollution problems (hot spots).

Issue discharge licenses and impose pollution control measures on polluters in these areas.

Follow up by implementation of water quality and pollution monitoring programs.

Prepare guidelines for customer's fees and carry out billing and collection of sewerage fees and pollution charges for specific industrial discharges and large municipal plants.

Enforce pollution control measures (construction of treatment plants, internal measures in the quarries, factories, etc.) and impose special charges on violators.

Follow up by implementation of regular water quality and pollution monitoring programs.

Initiate cooperation with relevant authorities and ministries in order to take the necessary and most efficient measures to protect vulnerable water resources.

Evaluate and approve environmental impact assessment (EIA) for projects with potential environmental impacts.

12. CONCLUSIONS AND RECOMMENDATIONS

Demand management has become a must for the PWA, as well as many other countries in order to sustain its development and satisfy population needs.

Participation of all stakeholders at early stages in the planning and management processes has great impact on the success of management.

One of the major problems in agriculture is overexploitation of water resources and the absence of regulations which control abstraction. In addition, there is an imperative need to establish a proper agriculture water tariff to encourage water conservation and provide incentives for water conservation and penalties for abusive abstraction.

The economic value of water should be the major consideration on water investment among sectors such as agriculture, industry, and domestic use.

Public awareness is a corner stone in the process of demand management as it builds the connection between water management authorities and water users.

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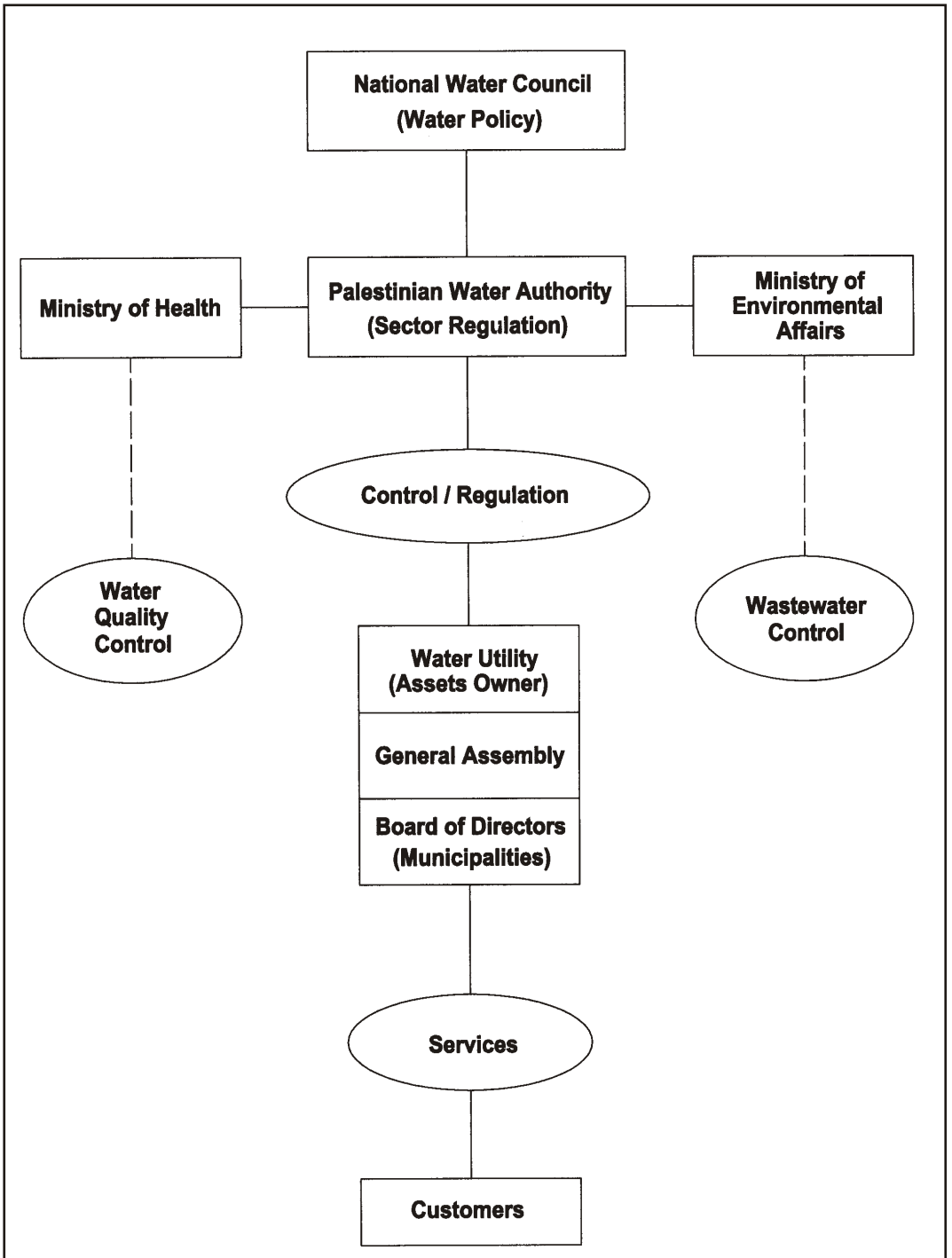
ANNEX 1.

Palestinian Water Authority Policy Principles (Water Sector Strategic Plan)

1. Pursue Palestinian interests in connection with obtaining riparian rights to use water resources shared with other countries.
2. All sources of water are public property.
3. Water has a unique value for human survival and health. All citizens have the personal consumption at costs they can afford.
4. Water has social, environmental and economic values.
5. Water supply must be based on sustainable development of all available and feasible water resources.
6. Industrial and agricultural development and investment must be compatible and optimally integrated with the available resources and based on sustainable development.
7. The development of Palestinian water resources must be co-ordinated at a national level and carried out at the appropriate local level.
8. The national water sector management should be carried out by one responsible body; with the separation of institutional responsibility for policy and regulatory functions from the service delivery functions.
9. Water management at all levels should integrate water quality and quantity.
10. Water supply and wastewater management should be integrated at all administrative levels.
11. A consistent water demand management must complement the optimal development of water supply.
12. Conservation and optimal utilization of water resources should be promoted and enhanced.
13. Protection and pollution control of water resources should be ensured by principle in order to guarantee environmental Protection.
14. The government will co-operate with regional and extra-regional parties in programs and projects utilization of water resources, to identify and develop new and additional supplies and to collect and share relevant information and data.
15. Public participation should be ensured.

ANNEX 2.



Ref: Institutional Reforms Towards Sustainable Water Sector, PWA Editions, March 2000

Figure 7-1
Strategic Institutional Setup For
Water Sector in Palestine

Final Integrated Aquifer Management Plan
Gaza Coastal Aquifer Management Program