Faculty of Graduate Studies

Institute of Environmental and Water Studies

Development of Basic Indicators on Integrated Water Resources Management: West Bank as a Case Study

تطوير المؤشرات الأساسية الخاصة بإدارة الموارد المائية المتكاملة: الضفة الغربية كحالة دراسة

Master Thesis

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This thesis was submitted in partial fulfillment of the requirements for Master Degree in Water and Environmental Engineering from the Faculty of Graduate Studies at Birzeit University, Palestine.

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This thesis was prepared under the supervision of Dr. Ziad Mimi and has been approved by all members of the examination committee

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Abstract

Indicators serve a variety of policy goals. They help in the improvement of water resource management policy through better assessment of the water resource. Indicators on Integrated Water Resources Management (IWRM) are comprised of measurements and derived values that track the changes of water resources conditions and their management efforts and success/failure over time. They help measure the state of water resources in general, the pressures exerted on them, and the resulting impacts on ecological and human health. More importantly, such indicators show progress of measures and policies aims to protect the sustainable development of water resources.

In this research, the IWRM indicators for the West Bank were developed depending on the IWRM indicators in the ESCWA region which were discussed in ESCWA Water Development Report 2 of 2007, in addition to the groundwater indicators which were presented on the Groundwater Resources Sustainability Indicators created by the United Nations Educational ,Scientific and Cultural Organization-UNESCO in 2007. The IWRM indicators were developed to fit with the reliable and available data in the West Bank.

The water status was analyzed depending on the Driving Force-Pressure-State-Impact-Response DPSIR framework, the IWRM indicators for the West Bank were developed and categorized into four group: Enabling Environment and Institutional Roles indicators, Supply availability and management indicators, Demand Management and Protection indicators and Health and Environmental Protection indicators.

The main findings of this research indicate that in the West Bank, groundwater presents almost 100% of the total renewable water resource. Non-conventional water resource, treated wastewater, forms only 0.033% of the total abstraction water resources. The per capita annual water use in the West Bank is 50 m^3/cap/yr. The West Bank achieves a very good percent with 90% for population with access to safe drinking water by networks, furthermore; provision of sanitation services in the West Bank is only 31% which is the lowest percent of the ESCWA countries. Regarding community based organizations; there are only two organizations in the West Bank, whereas many world countries have recently adopted this type of participatory approach in dealing with the issue of water supply. The per capita agricultural water use is only 45 m^3/c/y while it is in other neighboring countries 102 m^3/c/y as Jordan.

ملخص بالعربية

المؤشرات بشكل عام تخدم مجموعة متنوعة من الاهداف، حيث أنها تساعد في تحسين إدارة الموارد المائية من خلال سياسة تقييم أفضل للموارد المائية. تتألف مؤشرات الإدارة المتكاملة للموارد المائية من مجموعة من القياسات والقيم المستمدة، والتي تواكب التغيرات في ظروف موارد المياه وجهود إدارتها ونجاحها او فشلها على مر الوقت. أنها تساعد على قياس حالة الموارد المائية بشكل عام والضغوطات عليها، والآثار الناجمة عن ذلك على صعيد الصحة البيئية والبشرية. والأهم من ذلك، تظهر هذه المؤشرات سبلاً من التدابير والسياسات التي تهدف إلى حماية موارد المياه والمحافظة على استدامتها.

في هذا البحث، تم تطوير مؤشرات ادارة المياه المتكاملة في الضفة الغربية اعتمادا على مؤشرات ادارة المياه المتكاملة في منطقة الإسكوا التي نوقشت في تقرير تنمية الموارد المائية في دول الاسكوا (2007)، بالإضافة إلى مؤشرات المياه الجوفية التي تم عرضها في كتاب مؤشرات استدامة الموارد الجوفية من قبل الأمم المتحدة-اليونسكو (2007). وقد تم تطوير مؤشرات ادارة المياه المتكاملة لتتناسب مع مصداقية وتوفر البيانات المتوفرة للضفة الغربية.

تم تحليل وضع المياه اعتمادا على إطار القوى الدافعة أو الموجهة- الضغوط- الحالة- التأثيرات-الاستجابات (DPSIR). تم تصنيف هذه المؤشرات إلى أربع مجموعات وهي؛ تمكين البيئة والأدوار المؤسسية، مؤشرات الادارة وتوفر التزويد، إدارة الطلب ومؤشرات الحماية، ومؤشرات الصحة وحماية البيئة.

تشير النتائج الرئيسية لهذا البحث إلى أن تغذية المياه الجوفية تقارب 100% من مجموع الموارد المائية المتجددة للضفة الغربية في حين ان الموارد المائية غير التقليدية تنحصر في المياه العادمة المعالجة والتي تشكل فقط 0.033% من مجموع الموارد المائية المستخرجة سنوياً. وعلاوة على ذلك، فان نصيب الفرد السنوي من موارد المياه المستخرجة في الضفة الغربية هو 50 مترمكعب سنويا لكل فرد.

في حين حققت الضفة الغربية نسبة جيدة للسكان الذين تصلهم مياه الشرب عبر شبكات توزيع المياه شكلت 90%، في حين شكلت نسبة السكان المتصلين بخدمات الصرف الصحي فقط 31% وهي من اقل نسب دول الاسكوا. فيما يتعلق المنظمات المجتمعية، هناك فقط اثنتان في الضفة الغربية، في حين أن العديد من دول العالم قد اعتمدت مؤخرا هذا النوع من النهج التشاركي في التعامل مع قضية المياه. وتظهر الاحصاءات ان نصيب الفرد من استخدام المياه في الزراعة ليست سوى 45 متر مكعب لكل فرد سنويا في حين أنه في الدول المجاورة الأخرى تشكل 102 مترمكعب لكل فرد سنوياً مثل الاردن.

Acknowledgment

I would like to express my truthful gratitude to my supervisor, Dr. Ziad Mimi for his unique cooperation, generous intellectual and kind inspirational support, empathy, guidance and advices throughout the progress of my research.

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Last and surely not least, I want to acknowledge my wonderful family, specially my parents, sisters and brother for their continuous support and help. Moreover, special thank is extended to my friends and colleagues, for their encouragement. It is always impossible to personally thank everyone who has facilitated successful completion of this research. To those of you who I did not specifically name, I also give my thanks for moving me towards my goal.

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Abbreviations

CSD	Commission on Sustainable Development
DPSIR	Driving Force-Pressure-State-Impact-Response
DWQ	Drinking Water Quality
ESCWA	Economic and Social Commission for Western Asia
FAO	Food and Agriculture Organization
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
IWRM	Integrated Water Resources Management
MoA	Ministry of Agriculture
OECD	Organization of Economic Cooperation and Development
PALMT	Palestinian Metrology
PARC	Agricultural Relief Committee
PHG	Palestinian Hydrology Group
PSR	Pressure-State-Response
PWA	Palestinian Water Authority
UNDP	United Nations Development Programme
UNDP-POGAR	United Nations Development Programme on Governance in the Arab Region
UNESCO	United Nations Educational Scientific and Cultural Organization
WHO	World health organization
WHPA	Wellhead protection zones
WUA	Water User Associations

Chapter One

Introduction

1.1 General

With the fast growing population, urbanization, food security policies and the expansion of development and economic activities exerting pressure on available water resources integrated management of water resources is becoming an increasingly serious concern. The galloping rise in demand associated with the rapidly changing patterns of water use indicate that the availability of water can no longer be taken for granted, and water use in the immediate future will be governed by increasing scarcity in various parts of the Economic and Social Commission for Western Asia "ESCWA" countries. Pollution further exacerbates water scarcity by reducing water usability downstream (Mimi and Al-Zubari, 2005).

The ESCWA region extent an arid to semi-arid areas where the livelihood of the large population is to a significant degree controlled by the scarcity of water, in addition to being affected by escalating political tensions and subsequent lack of security. It is also a region characterized by a relatively high population growth and, thus, a continuous increase in water demand. That has resulted in a gap between demand and supply which has widened over the years, particularly during the 1990s. In order to reduce that gap and augment the supply, the ESCWA member countries have been seeking additional water sources (ESCWA, 2007).

Hence, the strong pressure exerted on freshwater sources, namely, surface water and groundwater, is not only due to excessive use and overdraft, but also to the remedial measures taken to handle the overexploitation which, in itself, has created new pressures. The situation becomes more serious when such impacts are superimposed on the harsh climatic condition prevailing in the region (ESCWA, 2007).

Prior to 1967, Israel had developed the water resources to which it had access and established a national water carrier; Israeli company (Mekorot) was conveyed water from existing sources of supply to the various centers of demand from agricultural, municipal and industrial customers. Following the 1967 War, Israel took control of water resources, and developed wells, throughout the West Bank, together with a water supply network serving settlements that linked into the Mekorot network. Palestinian water rights in the West Bank were abrogated, including from the Jordan River. In 1995, the Oslo II agreement-Article 40- contained provisions on water and sewage that recognized undefined Palestinian water rights, and returned some West Bank water resources and services responsibility to the Palestinian Authority (World Bank, 2009; Jayyousi and Srouji, 2009).

The unique historical water situation in the West Bank and Gaza Strip governorates has resulted in a low per capita water demand. Water supplies are generally constrained due to technical, institutional and political limitations. Water has been a major issue in the Palestinian-Israeli negotiations since the early 1990's, but up to this day, little progress has been made. Currently, the water problem remains one of the most debatable issues needing to be resolved between Israel and Palestine. The current water crisis is not only a consequence of the water scarcity in the region, but also an inherent part of the general Palestinian-Israeli conflict (Jayyousi and Srouji, 2009).

1.2 Statement of the Problem

Indicators serve a variety of policy goals. They help in the improvement of water resource management policy through better assessment of the water resource situation in a given hydrological and hydrogeological, through identification of critical problems and their causes and by providing a basis for comparison with similar spatial units elsewhere. This in turn leads to improved reporting on monitoring of progress against set targets and improved evaluation of water policy strategy and actions. Indicators provide also a basis for setting more appropriate national targets linked to policy goals and national legislation reforms and may provide for better mobilization of resources (UNESCO, 2007).

Most of the West Bank's natural water resources lie beneath its soil in three shared aquifers basins (eastern aquifer basin, western aquifer basin, and north-eastern aquifer basin). All three of these aquifers derive most of their recharge from rainfall and snowmelt on the Palestinian side of the Green Line (World Bank, 2009).

Until now, there is no clear indicators defined for water management, supply and demand in Palestine, the water abstract amounts are controlled by Israeli side, while the water consumption isn't controlled with any limitations or measures.

The first report for the ESCWA on water development, published in 2003, addressed the vulnerability of the region to socio-economic drought. Whereas the second report published in 2007 focused on state of water resources in ESCWA region, the report gave an overview of the water resources in the ESCWA region based on the most recent data and information obtained from member countries (ESCWA, 2007).

The state of water resources in the region was analyzed and assessed on the basis of data and indicators selected from available information and within the context of the Integrated Water Resources Management (IWRM). The Report gave a comprehensive summary of the current situation of water resources in each member country in terms of availability, accessibility and sustainability (ESCWA, 2007).

Palestine particular data was missed for many indicators besides it didn't reflect the current situation.

1.3 Objectives

The goal of this research is to develop a framework for the indicators of the Integrated Water Resources Management (IWRM). The developed indicators will be applied in the West Bank.

The following are the specific objectives:

1. Propose and develop IWRM indicators for the West Bank
2. Suggest the plan of action: the West Bank situation and working towards better development outcomes

1.4 Thesis Outline

Chapter One introduces a general background about the IWRM; it identifies the water research statement, and describes briefly the main and specific objectives. Chapter Two provides specific definition of the IWRM and the water indicators, types, strength, weakness, beside literature review for previous researches in the same core. Chapter Three shows the methodology followed, Driving Force-Pressure-State-Impact-Response (DPSIR) framework and explain the current IWRM indicators, besides the study area. Chapter Four provides the data analysis and results, the IWRM Indicators and its application on the West Bank. Chapter Five analyzes the West Bank situation and the work towards better development outcomes. Chapter Six presents the final conclusion and recommendations resulted from the research.

Chapter Two

Background

2.1 Study area

The West Bank in Palestine is a hilly area, the hills being used for pasture, with elevations varying from 400 m below sea level in the Jordan Valley to 1000 m above sea level in the hills. These mountains have terraced valley flanks and valley floors and used to support subsistence arable cropping and commercial olive cultivation. The rainfall of the WB is strongly seasonal (October to May) and orographic, 700mm in the mountains and 100mm in the Jordan Valley (Jayyousi and Srouji, 2009).

The existing water resources of the WB are derived from three groundwater aquifer basins (Eastern Aquifer Basin, Western Aquifer Basin, and North-eastern Aquifer Basin) figure 2.1 show the mountain aquifers in historical Palestine, a series of springs that emanate from the groundwater (Jayyousi and Srouji, 2009). All three aquifers share the same predominant geology, largely karstic limestone formations, and are hydrologically characterized by great depth (average 250 metres) and relatively rapid flow (World Bank, 2009).

At the present time, the groundwater and springs provide essentially all of the consumed water in the WB. The yields of the WB Aquifer Basins are not certain because of the lack of understanding of the water balance of these basins (Jayyousi and Srouji, 2009).

The Western Aquifer, with an estimated renewable yield of about 335-450 MCM, flows from the western slopes of the Palestinian hills towards the coast. Water from this aquifer, typically of a very high quality, provides about one fifth of Israel’s fresh water, pumped from numerous wells located just west of the Green Line. In the North-Eastern Aquifer, natural replenishment is estimated at between 130-200 MCM. The Eastern Aquifer, estimated recharge of 155-237 MCM, drains to the Jordan River and the Dead Sea. The aquifer lies almost completely within the West Bank and contains locally more saline waters (World Bank, 2009).

Figure 2.1: Mountain and coastal aquifers in Historical Palestine

Source: West Bank Water Resources, 2010, Mid East Maps

2.2 IWRM Definition

IWRM includes integrating land and water, upstream and downstream, groundwater, surface water and the coastal areas. It involves optimizing the supply, analyzing water balances, adopting wastewater reuse, and assessing the impact. Moreover, IWRM includes demand management through cost recovery policies, increased water efficiency and decentralization (Al-Zubari, 2004).

Good governance is necessary to support the effective function of water user's associations and participation. As such, it is very important to establish an integrated policy that provides a regulatory and institutional framework. IWRM is a participatory planning and implementation process, based on sound science, which brings together stakeholders to determine how to meet society's long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits (Al-Zubari, 2004).

2.3 What are indicators and why do we need them?

The term indicator comes from the Latin word "indicate" which means to point out. An indicator could also be defined as a value derived from parameters, which points to, provides information about. It is widely accepted that indicators have two main advantages or characteristics: they quantify information so that its significance becomes more apparent; and they simplify information about complex phenomena to improve the situation (Al-Zubari, 2004).

Indicators are quantifiable constructs selected to provide information about the functioning of a specific system, for a specific purpose, to support decision-making and management. Essentially they are a means of encapsulating a complex reality in a single construct (Vincent, 2004). Indicators are used to simplify, quantify, communicate and create order within complex data (Marchesi and Candeloro, 2009).

An indicator quantifies and aggregates data that can be measured and monitored to determine whether change is taking place. This is necessary to understand the process of change, and help decision makers understand why change is taking place. The major functions of indicators are (Al-Zubari, 2004):

- Determine the status of a certain system.
- Assess conditions and trends over time.
- Compare places and situations.
- Assess conditions and trends in relation to goals and targets.
- Predict and provide early warning of emerging problems.
- Measure the effectiveness of management policies.

Depending on the United Nations-UN, indicators are for monitoring progress towards sustainable development in addition to assist decision-makers and policy-makers at all levels as well as to increase focus on sustainable development states or to compare an actual with a desired state (UNESCO-WWAP, 2003).

Indicators on (IWRM) are comprised of measurements and derived values that track the changes of water resources conditions and their management efforts and success/failure over time. They help measure the state of water resources in general, the pressures exerted on them, and the resulting impacts on ecological and human health. More importantly, such indicators show progress of measures and policies aiming at the protection and sustainable development of water resources (Al-Zubari, 2004).

Information requirements of various users of indicators vary significantly in terms of the details, aggregation, and quantity. For instance, scientists collect and use the largest amount of data to derive information with the most details, while decision makers and media require aggregated and synopsis information. Figures 2.2 and 2.3 show that primary scientific data comprises the broad base of the "information triangle", while analyzed data comes in the next up layer (moderately technical). Indicators represent the level above to be slightly technical and slightly aggregated. Finally, indices are formed through aggregation of parameters and/or indicators, and they come at the top level as slightly technical and mostly descriptive (Al-Zubari, 2004).

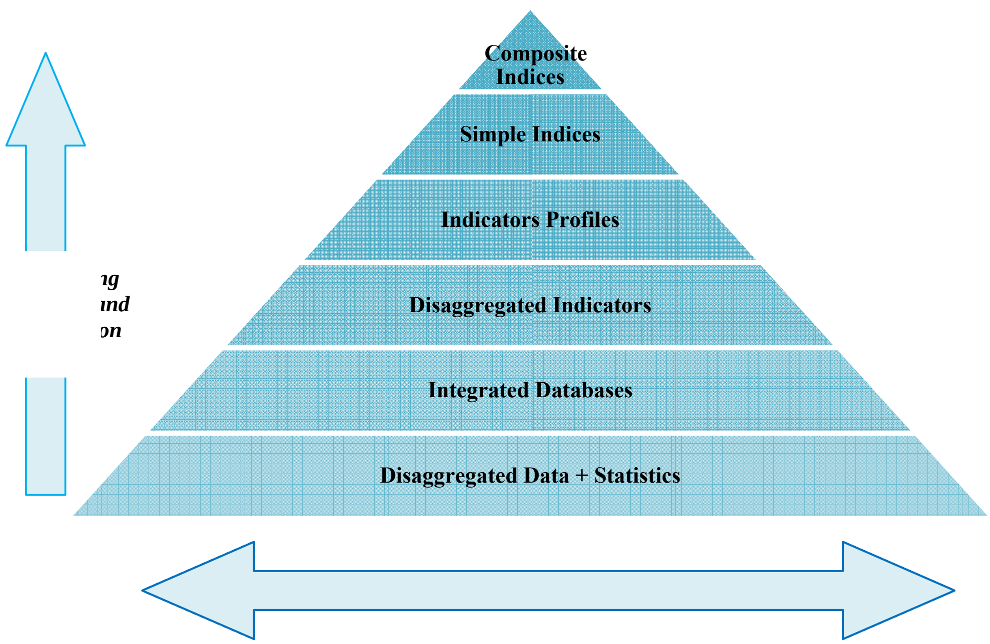


Figure 2.2: The information triangle

Source: Al-Zubari, 2004, Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region

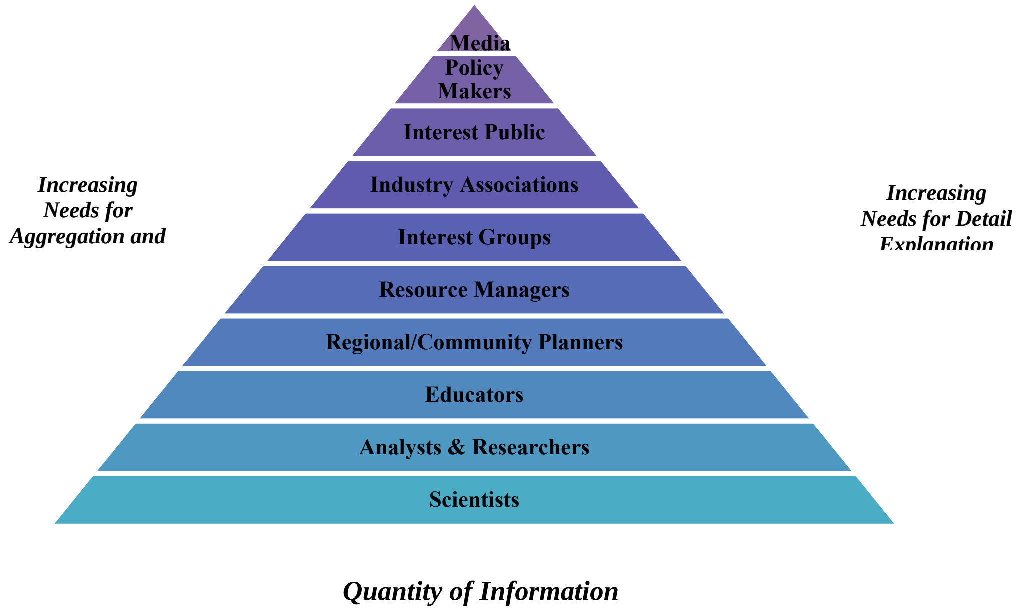


Figure 2.3: Information requirements for various users

Source: Al-Zubari, 2004, Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region

2.4 Types of Indicators

The complex nature of na[illegible]agement in general, and integrated water resources managemen[illegible] development in particular, requires the use of integrated or interlin[illegible] sets of indicators that must be specific, measurable, relevant, simple and [illegible]peatable. On the other hand, emphasis has been shifting from "descriptive" [illegible]dicators to "performance" indicators (Al-Zubari, 2004). The key characteristics for distinguishing these two types of indicators are (Al-Zubari, 2004):

- Descriptive indicators show [illegible] situation.
- Performance indicators show not only trends but distance to some goals or targets associated with a time schedule, set by environmental policy or a reference value.

When combined with targets for future performance, IWRM indicators would show how effectively current policies are helping to improve water resources conditions, and how far a country has yet to go. For effective evaluation of national and local policy performance, indicators should be selected and grouped according to country-specific thematic frameworks reflecting national priorities (Al-Zubari, 2004).

Sustainable development, and the protection and management of water resources act as guiding principles for indicator development and formulation (UNESCO, 2007).

2.5 Strengths and weaknesses of indicators and indices

Indicators and indices are useful for encapsulating a complex reality in simple terms and permitting comparisons across space and/or time. However in providing useful summary information there is a danger that indicators may not accurately represent the intended condition or process – that is they may not be valid. The more complex reality and more intangible is the processes that the indicator is trying to capture, the greater the danger of this occurring (Vincent, 2004).

Aggregating indicators creates even more opportunities for subjectivity and thus must be even more critically appraised. Whilst the purpose of indices is to better encapsulate a complex reality such an undertaking is limited in several ways. By their very nature, the role of indicators is to capture an intangible process so it is not possible to "ground truth" them, and alternative means of validation must be sought. Even with a comprehensive understanding of the conceptual and theoretical underpinnings of the processes and conditions involved, indicators can necessarily only be snapshot in time and thus are limited in their ability to represent dynamic processes. The index is also very much contingent upon the choice of indicators at the lowest level and there is a real possibility that uninformed choices at this level filter through and can lead to an invalid index (Smakhtin, et al, 2004 and Vincent, 2004).

2.6 Theme Indicator Framework

A framework for organizing the selection and development of indicators is essential. Ultimately, the choice of a framework and a core set of indicators must meet the needs and priorities of users, in this case national experts, civil society groups, and decision makers responsible for the development and use of indicators to monitor progress towards sustainable development. It should be stressed that any country wishing to use indicators, in any systematic way, must develop its own program drawing on the resources currently available(Al-Zubari, 2004).

The theme indicator framework was developed to address the following considerations: future risks, correlation between themes, sustainability goals, and basic societal needs. In addressing future risks, the framework becomes a proactive tool to assist decision-making especially where quantitative thresholds are known. Such sustainable development challenges are reflected in many global, regional, and national assessments (Al-Zubari, 2004).

A successful framework should reflect the connections between dimensions, themes, and sub-themes. It should implicitly reflect the goals of sustainable development to advance social and institutional development, to maintain ecological integrity, and to ensure economic prosperity. The framework is guided by limiting the number to a core set of indicators and by striking a balance between country specific conditions and common priority issues of sustainable development (Al-Zubari, 2004).

2.7 Previous Studies

Multi-criteria approach for evaluating long term water strategies study conducted for Egypt, a simple empirical simulation model was used to score different criteria. Four cases have been compared and evaluated by the suggested approach. Each case represents an anticipated national water–related development plan. The application showed that a multi-criteria approach could contribute significantly to decision making process in Egypt. It provides a systemic way of presenting the tradeoffs among policy choices considering many issues (Kheireldin and Fahmy, 2001).

Biltonen and Dalton (2003) offered a framework for such an analysis and analyzed the water poverty link. The water poverty accounting framework presented an analyst to effectively use of water to meet different social goals such as hygiene, sanitation, irrigated production for poor farmers, and environmental demands. In addition to demonstrated the implications for reallocations of water when meeting social goals is deemed describable (Biltonen and Dalton, 2003).
A set of indicators, based on current and target allocations, was developed to show the efficiency of water use to meet different demands. The indicators show where surplus water is available for reallocation, and where additional water is required to meet social and other types of goals, these indicators included; adequacy ratios which indicate how well either current or future needs are being met, and bias indicators which show the bias of allocation of water. The indicator used was current water adequacy, target sufficiency ratio, allocation adequacy ratio, human needs bias indicator and human needs indicator (Biltonen and Dalton, 2003).

Bonn Freshwater Conference that was held on 2001, commend that internationally accepted indicators on different aspects of water management need to be developed. These should include indicators for the relevant targets in the United Nations Millennium Declaration and for other relevant national and international goals. The indicators should be developed through participatory processes, including stakeholders from different levels and around the world (UNESCO-WWAP, 2003).

World Water Development report (2003) developed as comprehensive set of indicators and their 'most friendly' presentation, many definitions was set and cleared as the purposes and use of indicators and their related to the sustainable development, furthermore, the observational challenges for indicator

development, limitations, caveats and discussion points were explained (UNESCO-WWAP, 2003). The report included an extensive compilation of information, drawn from multiple sources, documenting the state of water, the resource and its uses. Many agencies and individuals opened their formal and informal archives to share information from their knowledge bases. These enthusiastic contributions established an important baseline from which to move forward (UNESCO-WWAP, 2003).
In all, more than 160 indicators were reported on, ranging from the global quantum of water available and withdrawals for human use to compliance with water quality standards for key pollutants and governance mechanisms to support water management (UNESCO-WWAP, 2003).

The second edition of The United Nations World Water Development Report (2006) discussed the consequences of poor data availability. The number of indicators presented in the second edition of the report declined to 62 because there was no systematic process for updating the data used for most of the indicators presented in the first report (UNESCO, 2006).

No new global estimates of available water resources or of volume abstracted by major sectoral users are available. So in the third edition of the report (2009) it remains impossible to provide information on the evolution of key indicators, 21 indicators has been updated and included in the report (UNESCO, 2009).

Arabstats is a web site sponsored by the United Nations Development Programme on Governance in the Arab Region (UNDP-POGAR). It is a repository of statistical indicators for human development in the region. In keeping with the UNDP's mission to accelerate progress in human development, *Arabstats* track the processes of human empowerment implied not only by increases in income, trade and investment, but also in education and health care, freedom of expression, the rule of law, transparency and accountability, respect for diversity, protection from violence, and the preservation of the environment, all of which are understood to be "essential dimensions of human development and well being" (Arabstats, 2008).

Indexed by variable, country, and year, the data set facilitates cross-country comparisons of progress not only toward the millennial goals but to structural changes in governance and other indicators that will make human development sustainable in the region. The website contains many sectors indicators including water sector indicators, furthermore, definition for each indicator and the available data set for Arab states (Arabstats, 2008).

Al-Zubari (2004) developed the basic indicators on integrated water resources management in the ESCWA region. He illustrated the current water indicators in the ESCWA region and analyzed them within the IWRM framework in addition to proposed future IWRM indicators for the ESCWA region (Al-Zubari, 2004).

On 2007, the United Nations made a publication presents the third set of Indicators of Sustainable Development and provides suggestions on how to adapt them to national conditions and priorities. The newly revised Commission on Sustainable Development -CSD indicators contains a core set of 50 indicators. These core indicators are part of a larger set of 96 indicators of sustainable development. The introduction of a core set helps to keep the indicator set manageable, whereas the larger set allows the inclusion of additional indicators that enable countries to do a more comprehensive and differentiated assessment of sustainable development. The division of indicators along the lines of four 'pillars' (social, economic, environmental and institutional), the indicators of water was set as five major indicators (United Nations, 2007).
In the same year, The Water Development Report (2) published by the ESCWA in 2007 gives an overview of the water resources in the ESCWA region based on the most recent data and information obtained from member countries. The state of water resources in the region is analyzed and assessed on the basis of data and indicators selected from available information and within the context of IWRM. The Report gives a comprehensive summary of the current situation of water

resources in each member country in terms of availability, accessibility and sustainability (ESCWA, 2007).

In this research, IWRM indicators will be studied and developed for the West Bank as case study. This is done by analyzing the current available indicators from the ESCWA report using the DPSIR framework; in addition, many indicators will be developed to fit with the current situation of the case study.

Chapter Three

Methodology

3.1 PSR and DPSIR Indicator Frameworks/Models

The most widely adopted indicator framework is the Pressure-State-Response (P-S-R) framework founded by the Organization of Economic Cooperation and Development (OECD). The PSR was originally designed to understand the pressures of human activities on the changing state of the environment, and the societal response to this change, which could feed back to mitigate the effects of the pressures or repair the natural resource (Al-Zubari, 2004).

The framework was developed by the European Environment Agency by adding the “driving force” which reflects those human activities that impact on sustainable development, either in a harmful or beneficial way, in a connected chain of causes and effects, so the formwork developed to the Driving Force-Pressure-State-Impact-Response (DPSIR) framework (Marchesi and Candeloro, 2009).

According to the DPSIR framework (Figure 3.1), social and economic changes such as population growth, agricultural policies, food demand, and new technology constitute driving forces that cause different kinds of pressures on the environment (Al-Zubari, 2004).

The aims of the DPSIR model are:

- To provide information on all of the different elements in the DPSIR chain
- To demonstrate their interconnectedness
- To estimate the effectiveness of responses (Al-Zubari, 2004).

Indicators have a key role as they provide the synthetic information required to quantify, analyze, evaluate and monitor each component of the model (Marchesi and Candeloro, 2009). Indicators for DPSIR are explaining as:

- Driving forces or Drivers (D) are underlying factors influencing a variety of relevant variables.
- Pressure indicators (P) describe the variables which directly cause (or may cause) environmental problems.
- State indicators (S) show the current condition of the environment.
- Impact indicators (I) describe the ultimate effects of changes in the state.
- Response indicators (R) demonstrate the efforts of society (i.e. politicians, decision-makers) to solve the problems (Marchesi and Candeloro, 2009).

The DPSIR methodology provides a basis for harmonization in terminology and indicators in addition to ensure the establishment of the relationship between policy and economic issues and the most important issues in groundwater development and management. This methodology is used to further identify and specify water and groundwater indicators and enables identification of indicators that are relevant directly to the water and groundwater situation and indirectly to other challenge areas of the Water World Assessment Programme (UNESCO, 2007).

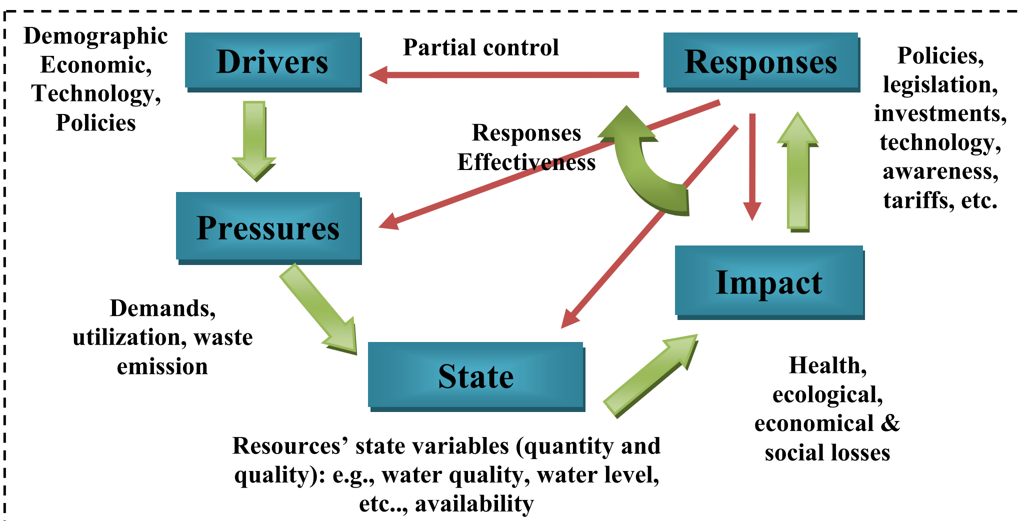


Figure 3.1: DPSIR Framework

Source: Al-Zubari, 2004, Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region

The main characteristics and criteria for the IWRM and sustainable development indicators should be as shown below in figure 3.2:

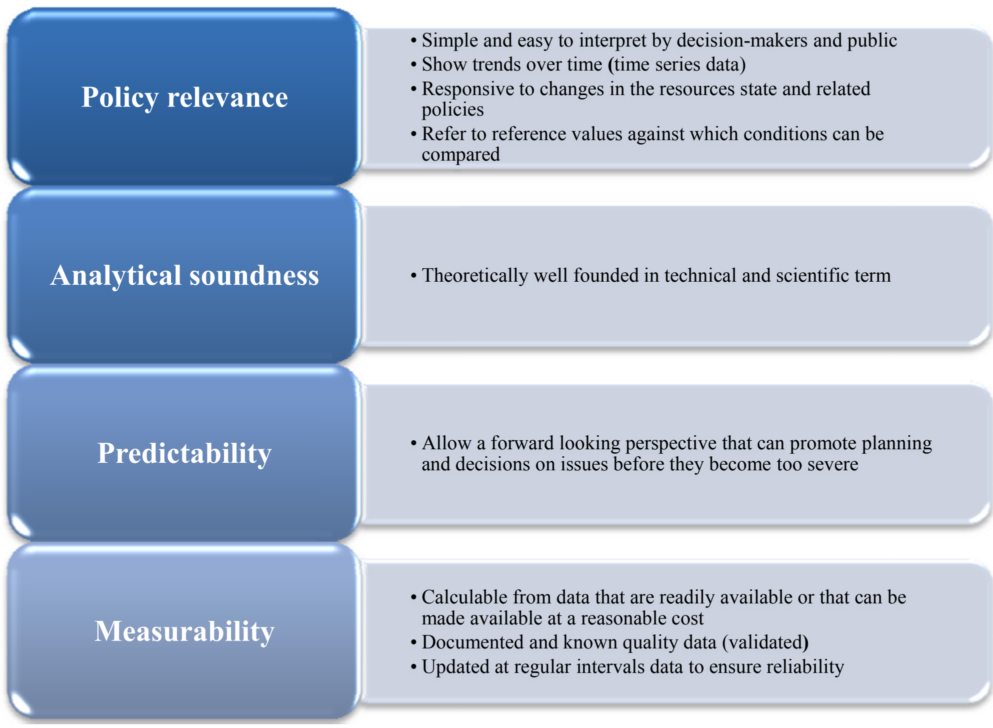


Figure 3.2: The main characteristics and criteria for the IWRM

Source: Al-Zubari, 2004, Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region

3.2 Analysis of Current Indictors within the framework of IWRM

Three principal targets are representing the process of IWRM (Figure 3.3):

- **Social welfare and equity.**
- **Economic efficiency.**
- **Environmental sustainability** (Al-Zubari, 2004).

As well as the means to achieve these targets:

- **Enabling Environment;** policies, legislative framework, financing and incentive structures
- **Institutional Roles;** creating an effective organizational framework, building institutional and individual capacity
- **Management Instruments;** assessment, IWRM Planning, efficiency in water use, social change instruments, conflict resolution, regulatory instruments, economic instruments, knowledge sharing (Al-Zubari, 2004).

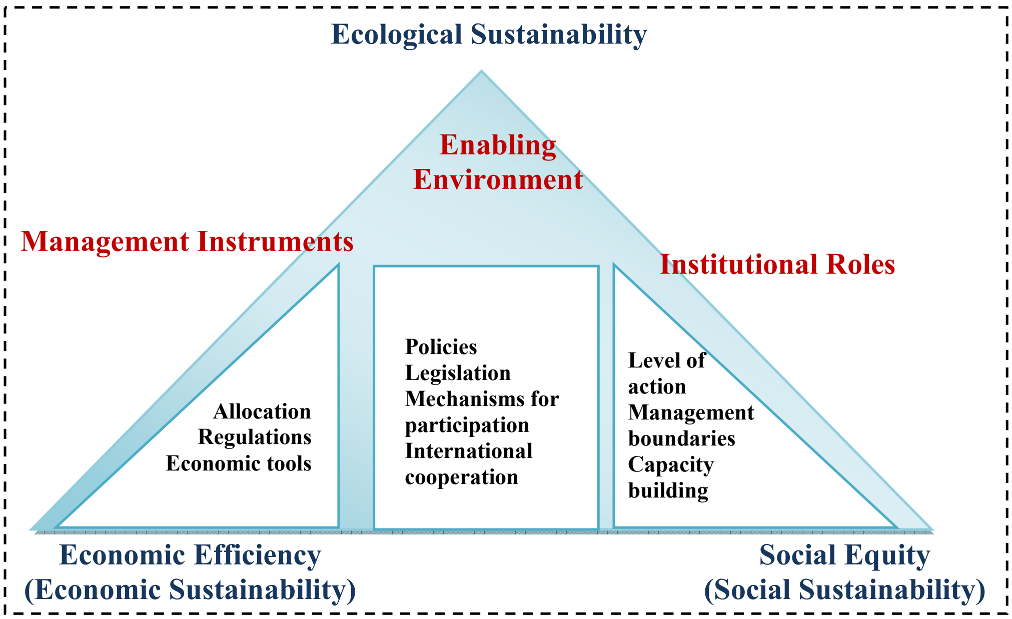


Figure 3.3: IWRM General Framework

Source: Al-Zubari, 2004, Development of Basic indicators on Integrated Water Resources Management in the ESCWA Region

3.3 Developing the IWRM indicators for the West Bank

The IWRM indicators for the West Bank were developed depending on the IWRM indicators in the ESCWA region which were discussed in Al-Zubari (2004) report, ESCWA Water Development Report 2 (2007), in addition to the groundwater indicators which were presented on the Groundwater Resources

Sustainability Indicators (2007) created by the United Nations Educational , Scientific and Cultural Organization- UNESCO.

The IWRM indicators were developed to fit with the reliable and available data in the West Bank, the IWRM indicators for the West Bank are developed, categorized and summarized as follows:

1. **Enabling Environment & Institutional Roles** (policies and planning, water legislation reforms, financing and investment in water sector; water institutions, stakeholders participation, awareness and civil society involvement**)**
2. **Supply availability and management** (monitoring and data collection efforts, aridity, availability of water resources, shared water resources, water use, groundwater indicators)
3. **Demand Management and Protection** (efficiency of water supply systems, efficiency of water use, economic returns and water resources allocation, economic tools, cost recovery, water resources protection)
4. **Health and Environmental Protection** (guidelines and standards, access to safe drinking water, access to sanitation, human health, wastewater management policies, ecosystem protection) (Al-Zubari, 2004).

3.4 Methodology

The study methodology combines standard data gathering and analysis of the water situation of the West Bank, data was collected through desk research of secondary sources. The indicators were developed by the researcher in reference to the Al-Zubari (2004) report, the Water Development Report-2 (ESCWA 2007), and the groundwater indicators which were presented on the Groundwater Resources Sustainability Indicators (2007) created by the UNESCO. Moreover, new indicators were developed to reflect the current water situation in the West Bank.

The indicators development were carried out through personal communications conducted with experts from related sectors, the indicators were prepared into specialized tables; each table contains a list of the related indicators. Decision makers were met by the researcher, the list of indicators were discussed, the indicators that didn't fit with the Palestinian situation and data availability were excluded, while the indicators that can be applied on the West Bank were selected and checked again, sample of the lists shown in Annex (1) while the list of decision makers shown in Annex (2). The related ministries and organizations were: Palestinian Water Authority (PWA), Ministry of Agriculture (MoA), Al-Bireh Municipality, Palestinian Hydrology Group (PHG), Palestinian Metrology (PALMT), the Agricultural Relief Committee (PARC), Food and Agriculture Organization (FAO).

Some of the indicators values were direct numbers or percentages while some of them were calculated values. The developed indicators were categorized depending on the IWRM general framework which was discussed previously. Figure 3.4 shows the research methodology, while table 3.1 shows the developed IWRM indicators with the four main categories and their components depending on the personal communication results.

The values of the indicators were compared with the values of the ESCWA countries in order to determine the status of the West Bank and the plan of action needed.

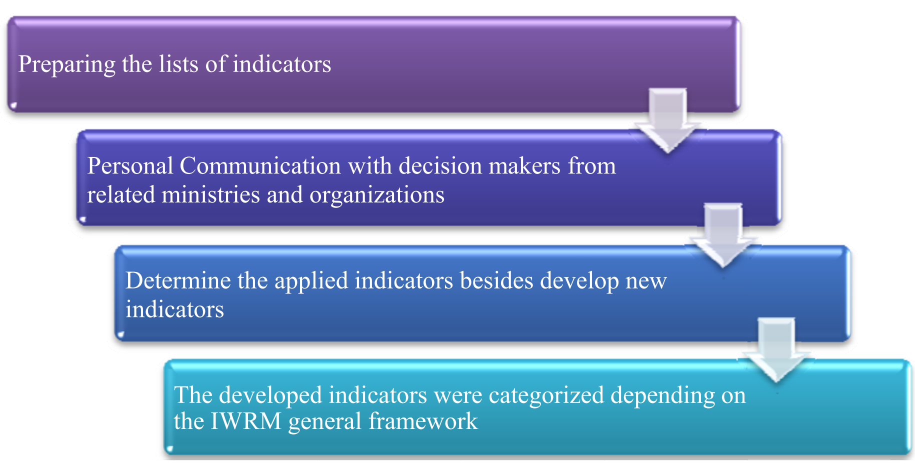


Figure 3.4: The research methodology

Table 3.1: Developed IWRM Indicators

No.	Issue	Sub-issue/ Element required to be measured	Current Indicator covering issue	Unit	Type of Indicator (DPSIR)
I.	**Enabling Environment and Institutional Roles**				
1	Policies	National water resources policies based on IWRM	- Existence of national water resources policies based on IWRM principles	Y/N	R
2	Legislation	Water rights, reform of existing legislation, enforcement	- Existence of legislation	Y/N	R
3.a	Financing of & investment in water sector	Investment in water and sanitation	- Investment in water sector per year	M$/yr	R
3.b		Role of the private sector	- Percent of domestic water supply operated by private sector (tankers)	%	R
4.a	Institutional framework	Fragmentation of water institutions, national apex coordinating body, regulatory and enforcement bodies.	- Number of water-related institutions responsible of water resources	Number	S + R
4.b			- Existence of national apex body	Y/N	R
5.a	Capacity building	Investment in capacity development and training	- Number of water professionals per served population	Number per 1000	S + R
5.b			- Number of universities/institutes providing water training	Number	S + R
6.a	Stakeholders participation	Community based organizations (WUA)	- Number of community based organization	Number	R
7.a	Awareness & civil society involvement	Awareness activities	- Number of water awareness activities per year	Number/ yr	S + R
7.b		Involvement of water/environment NGOs	- Number of Water/Environment NGOs	Number/ million capita	R
II.	**Supply Availability and Management**				
1	Monitoring & data collection	Data collection efforts	- Density of hydrological networks	Area Km^2/ station	R
2.a	Aridity	Long term annual rainfall average	- Long term annual average	mm/yr	S
2.b		Water Scarcity Indicator	- Annual per capita water share of abstraction water	m^3/cap/ yr	S
2.c		Evaporation rate	- Evaporation rate	mm/yr	S
3	Availability of water resources	Available conventional water resources	- Groundwater recharge in the three basins - Groundwater recharge as a % of total renewable water resources	Mm^3 %	S

No.	Issue	Sub-issue/ Element required to be measured	Current Indicator covering issue	Unit	Type of Indicator (DPSIR)
4	Availability of water resources	Available non-conventional water resources	- Treated wastewater reuse - Wastewater and drainage water reuse as % of total abstraction water	Mm^3 %	R R
5		Dependency ratio between conventional and non-conventional water resources	-Total non-conventional water as % of total abstraction water	%	R
6		Water harvesting (storage facilities)	- Capacity of storage/ artificial recharge - Number of homes used water harvesting system	Mm^3 Number	R R
7.a	Shared water resources	Dependency on shared water resources	- Percentage of shared water resources to total available water resources	%	S
8	Water use by sector	Consuming sectors	- Municipal water use -Total water demands -Domestic water use as % of total water demands - Per capita water use of domestic water	Mm^3 Mm^3 % L/cap/yr	P P P P (+R)
9			- Agricultural water use - Agricultural water use as % of total water demands	Mm^3 %	P
10		Use of sectors by source	- Agricultural sector water use by source - groundwater % - treated wastewater %	% %	P + S
11		Consumption trends	- Ratio of water demand growth rate to population growth rate	%	P
12	Ground water indicators	Groundwater Vulnerability	-Sum of areas with GW vulnerability problem/ Total studied area	%	R
III.	**Demand Management and Protection**				
1	Efficiency of water use	Efficiency of water supply systems	- Unaccounted for water (domestic)	%	S + R
2		Adoption of water saving techniques in main consuming sectors	- Percentage of irrigated areas using water saving irrigation system	%	S + R
3	Metering and consumption monitoring	Consumption monitoring in main consuming sectors and water sources	- % of metered households - % of metered groundwater wells	% %	R R
4.a	Economic tools	Water pricing in consuming sectors (Uniform or Block)	- Water pricing in the domestic sector - Tariff structure	Y/N Y/N	R R

No.	Issue	Sub-issue/ Element required to be measured	Current Indicator covering issue	Unit	Type of Indicator (DPSIR)
4.b	Economic tools	Water pricing in consuming sectors	- Ratio (average price of water /person consumption)	$/person	R
5	Water cost recovery	Cost recovery in different consuming sectors	- Cost recovery in the domestic sector	%	R + S
6.a	Economic returns & water resources allocation	Consuming sectors contribution to national economy	- Agriculture GDP as % of total GDP	%	D
6.b			- Agriculture labor force as % of total labor force	%	D
7.a	Value of water in agriculture sector	Water productivity and value in consuming sectors	- Value added of Agriculture sector	M$	S + P
7.b			- Water used for agriculture per capita	m^3/c	S + P
7.c			- Irrigated water per irrigated area	m^3/ Dounm	S + P
8	Reuse in main water consuming sectors	Extent of treated wastewater reuse in agriculture	- Percent area irrigated with treated wastewater to total irrigated area	%	R
9.a	Resources Protection	Groundwater vulnerability planning documents	- Existence of groundwater vulnerability documents for land use	Y/N	R
9.b		Wellhead protection zones (WHPA)	- Existence of WHPA for domestic water supply wells	Y/N	R
IV.	**Health and Environmental Protection**				
1.a	Guidelines& standards	Existence of standards for drinking water, water reuse, disposal, and adherence	- Intensity of domestic water quality monitoring	Days	R
1.b			- % of valid samples passing DWQ standards	%	S
2	Access to safe drinking water	Total population, rural and urban	- % population with access to safe drinking water	%	S + R
3	Access to sanitation	Total population, rural and urban	- % population with access to improved sanitation facilities	%	S + R
4	Human health	Outbreak of water-borne diseases	- Incidence of outbreaks per year	Number/ yr	I
5.a	Wastewater Management Policies	Collection, treatment, reuse, sludge disposal	- % wastewater volumes collected of total produced	%	R
5.b			-% Wastewater treated of the total wastewater Collected	%	R
5.c			- % wastewater reused of total collected	%	R

No.	Issue	Sub-issue/ Element required to be measured	Current Indicator covering issue	Unit	Type of Indicator (DPSIR)
5.d	Wastewater Management Policies	Collection, treatment, reuse, sludge disposal	- Total Number of wastewater treatment plant	Number	R+P
5.e			- % people served by the treatment plant/total people	%	R
6.a	Water pollution	Water quality indicators	- Zero concentration of faecal coliform in piped water	%	S
6.b		Water and health	The health costs of poor water and sanitation services of GDP	%	P
7	Ecosystem protection	Basic water requirements for ecosystem	- Existence of minimum basic water requirement for ecosystem	Y/N	R

Abbreviations: m^3/p/y, cubic metres per person per year; GDP, gross domestic product; Y/N, Yes or No, mm/yr, millimeter per year.

Chapter Four

Data Analysis and Results

4.1 The Enabling Environment and Institutional Roles Indicators

The indicators under this category include IWRM policies and planning, water legislation, financing and investment in water sector, reforms of water institutions, capacity building, stakeholders' participation; awareness and civil society involvement**.**

The purpose of the "existence of national water resources policies based on IWRM principles" and "the water rights, reform of existing legislation" indicators are to assess the situation of the legislative and regulatory framework within the IWRM methods and principles that can be implemented in the West Bank. For the proper application of IWRM, policies and proper institutions are necessary to create the solid base of the enabling environment.

"Investment in water and sanitation sector" indicator represents the cost of the water sector. It shows the level and extent of investment made in the West Bank in water and sanitation services. The level of investment in the water sector reflects the financial aspect of IWRM in its relevant context.

A high percent of households in West Bank are provided with water by the private sector (tankers), the "percent of households operated by private sector" indicator reflects the role and the extent of the private sector, which is the tankers since the water sector supervised by the PWA and its departments besides the municipalities and local councils, the tankers only transfer water to people whom didn't have water networks as well people who didn't have their enough water portions.

Under the institutional framework, the "number of water-related institutions responsible of water resources", "existence of a national apex body" indicators show the state of the institutional environment for water resource management in the West Bank, and reflect the number of independent institutions present in the West Bank.

The capacity building indicators; "number of water professionals per served population" and "number of universities/institutes providing training" reflect the extent of available human resource capacity, and hence the possible need of training to improve the institutional capacity for water resource development. Besides the level of training, capacity available and the number of institutions those are able to provide the adequate knowledge transfer necessary for creating an enabling environment for the implementation of IWRM.
Decentralization and participation in proper implementation of IWRM expressed by the number of community based organizations (Water User Associations - WUA) in the West Bank. There are only two associations at the West Bank located in Jericho and belong to farmers.

Awareness and civil society involvement play a major role in IWRM implementation, the "awareness activities" and the "number of water or environment NGOs" indicators reflect efforts made in public awareness as part of the IWRM process. Table 4.1 presents the enabling environment and institutional roles indicators and their values for the West Bank.

Table 4.1: Enabling environment and institutional roles indicators and their values for the West Bank

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
1	Policies and Planning	National water resources policies based on IWRM	- Existence of national water resources policies based on IWRM principles	Y/N	Y	PWA (2010) [a]
2	Legislation	Water rights, Reform of existing legislation, enforcement	- Existence of legislation	Y/N	Y	PWA (2010) [a]
3.a	Financing of & investment in Water Sector	Investment in water and sanitation	- Investment in water sector per year	Million $/yr	39.1	World Bank (2009)
3.b		Role of the private sector	- Percent of households operated by tankers	%	16	World Bank (2009)
4.a	Institutional Framework	Fragmentation of water institutions, national apex coordinating body, regulatory and enforcement bodies.	- Number of water-related institutions responsible of water resources	Number	4	PWA (2010) [a]
4.b			- Existence of national apex body	Y/N	Y	PWA (2010) [a]
5.a	Capacity Building	Investment in capacity development and training	- Number of water professionals per served population	Number per 1000	0.022[1]	PWA (2010) [a]
5.b			- Number of universities/institutes providing water training	Number	5	PWA (2010) [a] PHG (2010)
6.	Stakeholders participation	Community based organizations	- Number of community based organization (Water Users Association-WUA)	Number	2	Personal communications
7.a	Awareness & Civil Society Involvement	Awareness activities	- Number of water awareness activities per year	Number / yr	450	PWA (2010) [a]
7.b		involvement of water/environment NGOs	- Number of Water/Environment NGOs	Number / million pop.	11.91[2]	PENGON (2010)

[1] Number of water professionals (have high level education with experience more than 10 years) per served population is (52 person/ 2350583 population)*1000=0.022, population reference is PCBS, 2008

[2] Number of Water/Environment NGOs is (28organizations*1Million)/2350583 population=11.91, population reference is PCBS, 2008

4.2 Supply Availability and Management Indicators

This category includes monitoring and data collection efforts, aridity, availability of water resources, shared water resources, water use by sector, and groundwater indicators.

Density of hydrological network is defined as the average area served by one hydrological station. The purpose of this indicator is to assess the adequacy of existing hydrological networks to provide the necessary information on freshwater in the context of freshwater assessment.

Aridity indicators as; “long-term annual average of rainfall”, and “evaporation rate” indicate the existence and severity of water scarcity in the West Bank.

Water scarcity indicator is defined as total annual available water resources (renewable) divided by the total population of the country; it is used to monitor the average individual share of water resources in the country. This indicates the existence and severity of water scarcity in the country, in this research the total annual available water resources is adoption as annual abstraction by Palestinians’ from the three basins in the West Bank which is 121 Mm^3 yearly (Mimi and Aliewi, 2005).

An Important IWRM indicator is availability of water resources which includes available conventional and non-conventional water resources, “dependency ratio” and “water harvesting”; each indicator measures the significance of non-conventional water vs. conventional water resources as components of total abstraction water resources in the West Bank.

West Bank depends on the groundwater resource for water supply. Treated wastewater reuse is so small amount due to lack of efficient treatment plants and lack in wastewater reuse concepts, importance and required technologies. The treated wastewater reuse is estimated 0.04 Mm^3 only, (data collected through personal communication with PARC, Al-Bireh Municipality and MoA, 2010).

The water harvesting indicator reflects the extent of use of water harvesting both for artificial groundwater recharge and as a part of non-conventional water resources at a national level, the amount of water harvested (6.45 Mm^3 yearly) play essential and integrate role for 230,000 homes in the West Bank, (ADA and ADC, 2007).

The political situation and Israeli occupation put the West Bank under fully dependency on shared water resources; the indicator "percentage of shared water resources to total available water resources" indicates the West Bank dependency on shared water resources.

Table 4.2 presents the supply availability and management indicators and their values for the West Bank.

Table 4.2: Supply Availability and Management Indicators and their values for the West Bank

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
1	Monitoring & Data Collection	Data collection efforts	- Density of hydrological networks	Area Km^2/ station	18.77[3]	PWA (2010) [a] ADA and ADC (2007)
2.a	Aridity	Long term annual rainfall average	- Long term annual average	mm/yr	518	PALMET (2010)
2.b		Water Scarcity Indicator	- Annual per capita water share of abstraction water	m^3/cap/ yr	51.47[4]	Mimi and Aliewi (2005)
2.c		Evaporation rate	- Evaporation rate	mm/yr	152	PALMET (2010)
3	Availability of Water Resources	Available conventional water resources	- Groundwater recharge in the three basins - Groundwater recharge as a % of total renewable water resources	Mm^3 %	679 100	Nazer (2009)

[3] Density of hydrological networks (WMO's)=5500 km^2 area of the West Bank /293 stations = 18.77

[4] Water Scarcity Indicator =(121*10^6 annual available water resources)/ 2350583 population = 51.47 m^3/cap/yr

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
4		Available non-conventional water resources	- Treated wastewater reuse - Wastewater reuse as % of total abstraction water	Mm^3 %	0.04 0.033[5]	PARC, AlBireh Municipality, MoA (2010)
5		Dependency ratio	-Total non-conventional water as % of total abstraction water	%	0.033	PARC, AlBireh Municipality, MoA (2010)
6		Water harvesting (storage facilities)	- Capacity of storage/ artificial recharge - Number of homes used water harvesting system	Mm^3 Number	6.45[6] 230,000	ADA and ADC (2007)
7	Shared Water Resources	Dependency on shared water resources	- Percentage of shared water resources to total available water resources	%	100	PWA (2010)[(a)]
8	Water Use by Sector	Consuming sectors	- Municipal water use - Total water demands - Domestic water use as % of total water demands - Per capita water use	Mm^3 Mm^3 % L/cap/yr	101 190 53.2 70	Jayyousi and Srouji (2009)
9			- Agricultural water use - Agricultural water use as % of total water demands	Mm^3 %	89 46.8	Jayyousi and Srouji (2009)
10		Use of Sectors by Source	- Agricultural sector water use by source - groundwater % - treated wastewater %	 % %	 99.95[7] 0.045[8]	PARC, AlBireh Municipality, MoA (2010)
11		Consumption trends	- Ratio of water demand growth rate to population growth rate	%	4.29	Jayyousi and Srouji (2009)
12	Ground water indicators	Groundwater Vulnerability	Sum of areas with GW vulnerability problem/ studied area	%	9.09[9]	Qamhieh (2006)

[5] Treated wastewater reuse is estimated to be 0.04 Mm^3, and the percentage of treated wastewater used as % of total abstraction water is 0.04/ 121= 0.033 %.

[6] Capacity of storage/ artificial recharge is 50750 m^3 (Jansen,2007) for capacity of storage and 6.4 Mm^3 water collected in cistern using rooftop catchment systems = 6.45 Mm^3

[7] Percentage of treated wastewater use is 0.045% (note 8) so remain of the ground water use percentage is 99.95%

[8] Treated wastewater reuse is estimated to be 0.04 Mm^3, so the percentage of treated wastewater used is 0.04/89= 0.045% and the percentage of groundwater used is 99.95%

[9] The Sum of areas with GW vulnerability problem is 500 Km^2 / 5500 Km^2 the West Bank area = 9.09%

Also, Israel and the West Bank share the Mountain Aquifer's in three basins: the Western mountain, the Eastern Mountain and the North-eastern basins. Around 80% of aquifer recharge occurs inside the West Bank. Israel abstracts much higher quantities of groundwater than Palestinians. Through its military occupation Israel reserves itself 88% of the well pumpage from these 3 basins (EWASH, 2009).

This will cause irreversible long term damage to the sustainability of this shared water resource, "the per capita annual share from abstraction water" indicator reflect the huge difference the Palestinians in the West Bank only have 49.77 m^3/cap/yr while the Israelis have 68.43[10] m^3/cap/yr (Israel Central Bureau of Statistics, 2007 and Mimi and Aliewi, 2005).

The "ratio of water demand growth rate to population growth rate" indicator help in continuous monitoring for sectoral water demands (domestic, agricultural, and industrial) in order to update the total national water demand on annual basis. The value of the future demand was calculated by Jayyousi and Srouji (2009) based on the current consumption levels and the expected growth in population the value estimated to be 859 Mm^3 in year 2020, the expected growth in population is estimated by the PCBS in 2020 to be 2.0, so the ratio is 4.29 %.

The "groundwater vulnerability" indicator is major indicator reflect the percentage of areas have problems and affect the groundwater contamination, it is measured by divided the areas have groundwater vulnerability by the total studied areas in the West Bank; the areas have groundwater vulnerability estimated as 500 Km^2.

[10] Israel population is 7,116,700 capita (Israel Central Bureau of Statistics, 2007) while the water abstraction is 487 Mm^3 (Mimi and Aliewi, 2005) so the per capita annual share from abstraction water is 487 *10^6/ 7116700 = 68.43 m^3/cap/yr

4.3 Demand Management and Protection Indicators

This category includes efficiency of water use, adoption of water saving techniques, economic returns and water resources allocation, economic tools, cost recovery, groundwater and surface water resources protection.

Efficiency of water use indicators incorporate "unaccounted for water (domestic)" and "percentage of irrigated areas using water saving irrigation systems" indicate the amount of water lost from the system and therefore gives an indication of the level of management in urban centers, and the state of repair of the distribution system. It also indicates increase or decrease of using water saving irrigation methods in irrigated agricultural areas in the West Bank.

Household metering is necessary for the purpose of monitoring water use domestic and irrigation from the various sources of water available. Therefore, metering is important for obtaining the necessary data that is crucial for proper planning within IWRM. Moreover, variations in consumption among different sectors, as well as differences in water use according to socio-economic and demographic characteristics of the metered households, or the type and size of irrigated crops, provides important data regarding the social and economic aspects of water use and demand for the West Bank.

Water pricing is necessary for cost recovery that reflects the true price of water and environmental protection. For the purpose of water pricing, tariffs should be affordable (to recognize the social needs of the vulnerable and marginalized groups, the importance of water for sanitation and public health), acceptable to the public. Price of water vary from one district to other in the West Bank due to different operation cost, the ratio explain the relationship between the water price and consumption of water.

The water cost recovery is an indicator to measure the extent to which water service providers is covering its cost and its consumers are paying the full cost of water, and hence the extent of implicit subsidization. It also gives an indication to non-payment in the West Bank.

“Agricultural sector contribution to the total GDP” indicator reflects the economic significance and potential of the agricultural sector in the West Bank and compares it to the amount of water allocated for the sector. However, the “agricultural labor force as a % of total labor force” indicator reflects the significance of the agricultural sector regarding job opportunities in the West Bank. The agriculture sector is the main consumer of water; the “value added of agriculture sector” indicator used to give an estimate of the value of water in different economic sectors, indicates the ability to pay for water in these sectors, and gives an idea as to how economic development should be focused given scarce water resources.

A field study conducted by MoA for Ramallah district estimated the potential areas that could be irrigated with treated wastewater, the wastewater treatment plans suggested to be near the targeted areas, the study show that total of 12.2 Km^2 distributed in four areas (the Ein Sinya Area, wadi Jariot area, the Beit Ur Al-Tahata, Saffa and Bi’lin, and Ein Qinya) could be irrigated by treated wastewater and recommended to be cultivated with new fruit trees as olives, alfalfa, stone fruits, apples, grapes and citrus (MoA, 2010)[(b)].

Water use efficiency in the water sector is fundamental to integrated water resources management. The largest sector in terms of water use is the agricultural sector. While the economic and social benefits from agriculture decrease, the social cost of this sector is increasing due to the increasing price of water (Molden, 2007). Therefore, “percent area irrigated with treated wastewater to total irrigated area” indicator helps to assess the size and extent of agricultural practices that use treated wastewater for irrigation within the agricultural sector of the West Bank.

Table 4.3 presents the demand management and protection indicators with their values for the West Bank.

Table 4.3: Demand Management and Protection Indicators and their values for the West Bank

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
1	Efficiency of Water use	Efficiency of water supply systems	- Unaccounted for water (Domestic) of water supplied	%	37	Jayyousi and Srouji (2009)
2		Adoption of water saving techniques in main consuming sectors	- Percentage of irrigated areas using water saving irrigation system of total irrigated area	%	35	MoA (2010)[(a)]
3	Metering and consumption monitoring	Consumption monitoring in main consuming sectors and water sources	- % of metered households - % of metered groundwater wells	% %	100 100	PWA (2010) [a] PWA (2010) [a]
4.a	Economic Tools	Water Pricing in consuming sectors	- Water pricing in the Domestic sector - Tariff structure (Uniform or Block)	Y/N Y/N	Y Y	PWA (2010) [a] PWA (2010) [a]
4.b			Ratio (average price of water /person consumption)	$/ person	23.4[11]	PWA (2010) [a]
5	Water Cost Recovery	Cost recovery in different consuming sectors	- Cost recovery in the Domestic sector	%	50	World Bank (2009)
6.a	Economic Returns & Water Resources Allocation	consuming sectors contribution to national economy	- Agriculture GDP as % of total GDP	%	8.2	MoA (2010)[(a)]
6.b			- Agriculture labor force as % of total labor force	%	13.4	MoA (2010)[(a)]
7.a	Value of water in agriculture sector	Water productivity and value in consuming sectors (value added)	- Value added of Agriculture sector	M$	635	MoA (2010)[(a)]
7.b			- Water used for agriculture per capita	m^3/ capita	45[12]	Jayyousi and Srouji (2009)
7.c			- Irrigated water per irrigated area	m^3/ Dounm	414	MoA (2010)[(a)]

[11] Ratio (average price of water /person consumption = the average water price is 1.17 $/m^3$, so the ratio is 1.17/50 = 23.4 $/person

[12] Water used for agriculture per capita = Agriculture water use is 89 Mm^3 / 2350583 capita = 37.8 m^3/capita

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
8	Reuse in main water consuming sectors	Extent of treated wastewater reuse in agriculture	- Percent area irrigated with treated wastewater to total irrigated area	%	0.18[13]	PARC, AlBireh Municipality, MoA (2010)
9.a	Resources Protection	Groundwater vulnerability planning documents	- Existence of groundwater vulnerability documents for land use	Y/N	Y	PWA (2010) [a]
9.b		Wellhead protection zones (WHPA)	- Existence of WHPA for domestic water supply wells	Y/N	Y	PWA (2010) [a]

Due to increasing urban sprawl and population growth, more pressure is being made on natural land and nature. Urban growth leads to an inevitable increase in wastewater production that affects the quality of water for domestic supply and indirectly leads to the pollution of groundwater. So, resource protection is very important indicators for the IWRM implementation, "existence of groundwater vulnerability documents for land use" and "existence of wellhead protection zones- WHPA for domestic water supply wells" assess in determine whether water ecosystems are properly protected through land use planning, zoning for surface water protection, identifying lands for groundwater vulnerability to avoid contamination and loss of groundwater sources, and establishing Wellhead protection zones for domestic water supply wells to ensure public health measures and consequently prevent outbreaks.

4.4 Health and Environmental Protection Indicators

Health and Environmental Protection Indicators includes; quality and quantity standards for water use and their enforcement, access to safe drinking water, access to sanitation, human health, wastewater management policies, and ecosystem protection.

[13] Percent area irrigated with treated wastewater is 0.16 Km^2 / total irrigated area 87 Km^2= 0.18%

Guidelines and standards of water indicators as “intensity of domestic water quality monitoring” and “percent of valid samples passing Drinking Water Quality-DWQ standards” indicate the frequency of quality monitoring for the domestic water supply, to ensure that the quality of water being used for domestic purposes is acceptable according to World health organization-WHO guidelines. The drinking water quality-DWQ available needs improvements in order to meet the quality standard required to achieve the intended health benefits.

WHO placed strategic importance on the drinking water quality-DWQ aspect of water supply due to its importance in protecting health and reducing morbidity. WHO is in the process of providing support for implementing the drinking water quality standards and strengthening their drinking water quality surveillance and control activities.

Accessibility to improved water sources is of fundamental significance to lowering the faecal risk and frequency of associated diseases. Its association with other socioeconomic characteristics, including education and income, also makes it a good universal indicator of human development.

As well “percentage of population with access to improved sanitation facilities” indicator, this represents a basic indicator useful for assessing sustainable development, especially human health. Accessibility to adequate excreta disposal facilities is fundamental to decrease the faecal risk and the frequency of associated diseases. Its association with other socioeconomic characteristics (education, income) and its contribution to general hygiene and quality of life also make it a good universal indicator of human development.

A low incidence of disease and outbreaks is associated with other socio-economic aspects, such as quality of life, health and safety in addition to economic and financial losses incurred by the person infected and losses as a result of an outbreak.

Wastewater management policies are an important link in the implementation of IWRM principles. As such, wastewater collection serves two purposes:
(1) The improvement of the environmental health conditions related to water, and hence the improvement of the environmental and socio-economic conditions of the community.
(2) The prevention of water contamination by wastewater, and hence the protection of the ecological stability and integrity of the ecosystem, which is a fundamental principle in IWRM.

Wastewater treatment is a necessary aspect in the protection of water resources and the environment in general. As such, the proper implementation of IWRM principles requires adequate attention to water treatment. As such, wastewater collection and treatment would ultimately improve the quality of the environmental health aspects for communities. The protection of the ecological integrity of water system is a crucial aspect of IWRM.

Reusing treated wastewater is considered as one of the basic pillars for water demand management that would lead to social, economic and environmental benefits, the three fundamental principles of integrated water management. Reusing wastewater has economic benefits (as a result of the pricing of water), social benefits as a result of more available water for use in irrigation and environmental benefits by preventing the waste of water and the release of contaminants into clean water courses.

"Concentration of faecal coliforms in piped water" indicator assesses the quality of water available to communities for basic needs. It identifies communities where contamination of water with human and animal excreta at source or in the supply is posing a threat to health. In addition, "the health costs of poor water and sanitation services of GDP" indicator specifies the cost of poor water access and sanitation. It show the percentage occupied from the total GDP.
Table 4.4 presents the health and environmental protection indicators and their values for the West Bank.

Table 4.4: Health and Environmental Protection Indicators and their values for the West Bank

No.	Issue	Sub-issue/ Element	Applied Indicator covering issue	Unit	Value	Ref.
1.a	Guidelines& Standards	Existence of standards for drinking water, water reuse, disposal, and adherence	- Intensity of domestic water quality monitoring	Days	240	PWA (2010) [a]
1.b			- % of valid samples passing DWQ standards	%	84	PWA (2010) [a]
2	Access to safe drinking water	Total population, Rural and Urban	- % population with access to safe drinking water	%	90	World Bank (2009)
3	Access to sanitation	Total population, Rural and Urban	- % population with access to improved sanitation facilities	%	31	World Bank (2009)
4	Human Health	Outbreak of water-borne diseases	- Incidence of outbreaks per year	Number / yr	25	PWA (2010) [a]
5.a	Wastewater Management Policies	Collection, treatment, reuse, sludge disposal	- % wastewater volumes collected of total produced	%	35	PWA (2010) [a]
5.b			-% Wastewater treated of the total wastewater Collected	%	12.8[14]	ADA and ADC (2007)
5.c			- % wastewater reused of total collected	%	0.14[15]	PARC, AlBireh Municipality, PWA (2010)
5.d			- Total Number of wastewater treatment plant	Number	4[16]	ADA and ADC (2007)
5.e			- % people served by the treatment plant /total people	%	9.86[17]	HWE (2007)
6.a	Water Pollution	Water quality indicators	- Zero concentration of faecal coliform in piped water	%	80	World Bank (2009)

[14] The collected wastewater is 28 Mm^3, and the treated water is 3.585 Mm^3, so the percentage is 12.8%.

[15] Total wastewater produced is 80 Mm^3, the collected wastewater collected is 28 Mm^3, and the reused of treated water is 40000 m^3, so the percentage is 0.14%.

[16] Four plants are located in West Bank cities, namely Jenin, Tulkarem, Ramallah and one in Al-Bireh.

[17] Total people served by the 4 treatment plants is 231900, the percentage (231900/2350583) = 9.86%

6.b		Water and health	The health costs of poor water and sanitation services of GDP	%	0.04	World Bank (2009)
7	Ecosystem protection	Basic water requirements for ecosystem	- Existence of minimum basic water requirement for ecosystem	Y/N	N	PWA (2010) [a]

IWRM, as a set of management principles, is crucial for areas that are characterized by aridity and semi-aridity. As such, it is fundamental to understand the situation of water availability, especially in recent years, where an increase in populations is occurring in water poor areas. Water scarcity can have severe social and environmental impacts on communities, such as decrease in the quality of life, loss of biodiversity and the instigation of water conflicts.

Therefore, IWRM can provide the necessary tools that help in assessing the resources available and the water needs, establishing the necessary legal and institutional frameworks for action, in addition to managing conflict over water resources by creating sharing regimes, “existence of minimum basic water requirement for the ecosystem” indicator assess whether the ecosystem (including the human population and the general environment in which they live) has the basic minimum water needs available.

Chapter Five

Way Forward: Plan of Actions

5.1 Analysis of the West Bank Situation

An indicator is an instrument for problem identification and not for problem solution. For instance, the groundwater recharge indicator may help to detect the amount of groundwater renew every year, but such an indicator does not serve directly as an indicator to water supply and availability. This requires identification of other indicators as domestic water use and agriculture water use.

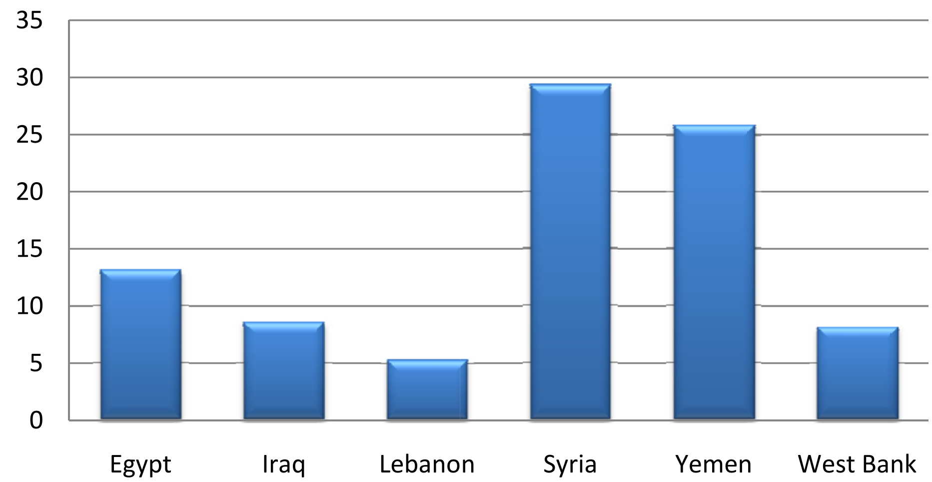
Combinations of several indicators are frequently used also, because implementation of one single indicator can only rarely satisfy the required objectives. For instance, health and environmental protection indicators (quality, water pollution) can be seen as early warning indicators, which support identification of stresses and impacts measures to protect groundwater can be adopted in a timely way. Mutual integration of environmental indicators also supports better understanding of groundwater contamination problems and, with respect to DPSIR framework, helps to formulate a relevant response indicator. Indicators also serve to forecast trends in groundwater quality, but only if they are repeatedly generated during a longer period of time and statistically significant datasets are collected. The reliability of the collected data should be supported by the use of standardized monitoring and sampling methods. Indicators based on short term monitoring data can-not identify slow changes in groundwater systems and are not suitable for planning or managerial purposes (UNESCO, 2007; Al-Zubari, 2004; Jonch-Clausen, 2004 and Vincent, 2004).

Comparison with the ESCWA countries indicators values can represent a view of the West Bank situation and the needed plan ions to implement the IWRM basis and reach to stable and acceptable state of water resources and consumption.

The groundwater recharge as a percentage of total renewable water resources indicator is a significant factor which affects national IWRM frameworks and policies with respect to necessary investments, energy costs, water sectoral and geographical allocation, etc. In the West Bank the groundwater recharge consist 100% of the total renewable water resource which is similar to the Bahrain and Kuwait countries, while the average groundwater recharge in the ESCWA countries is 10.2% of total renewable water resources (ESCWA, 2007).

The percentage of non-conventional water resources of total renewable water resources in a country shows how much a country depends on such water resources. In the West Bank the only non-conventional water resources is the treated wastewater and it is only consist 0.033% , whereas the treated wastewater produced as percentage of total non- conventional water resources in the ESCWA countries consist 93.7, 92.4 in Jordan and Yemen respectively (ESCWA, 2007), these two countries have the similarity weather with the West Bank and these percentage shows the need to develop and increase the amount of treated wastewater to use as non-conventional water resources and decrease the pressure on the fresh water resources.

The agriculture sector is the main water consumer in many of the ESCWA countries, while the agriculture GDP as a percentage of the total GDP doesn't represent huge percent, in the West Bank it form 8.2%, the same manner in Egypt, Iraq, Lebanon, with 13.2, 8.6 and 5.3 correspondingly, this percentage increased in Syria, and Yemen to 29.4 and 25.9 in respective (Figure 5.1), the average ESCWA countries percent is 8.0% (ESCWA, 2007), so the West Bank is in the common average, while there is possibility to increase the percentage by networking and planning with related sectors.



The entire populations in the Gulf Cooperation Council- GCC countries, except Oman, have access to safe drinking water. In the remaining ESCWA member countries, accessibility of populations to safe drinking water ranges from 21% for Oman to 97, 90 % for Jordan and Syria respectively (ESCWA, 2007). The West Bank achieves a very good percent with 90% for population with access to safe drinking water.

With respect to sanitation services, there is practically full coverage in 100% accessibility for populations in Kuwait, Qatar and the United Arab Emirates. The level of services in the remaining countries ranges from 89% for Oman and Syria to 38% for Yemen (ESCWA, 2007). Provision of sanitation services in the West Bank is only 31% which become the lowest percent of the ESCWA countries.

The existence of a wastewater collection system might be a good indicator of the health status of communities in terms of its impact on human lives; this indicator does not specify the fate of the collected wastewater in the water cycle. Thus, the final impact on the ecosystem and the water cycle is unknown if there is no information regarding the disposal of the collected wastewater.

5.2 Working towards Better Development Outcomes

One of the important indicators regarding the enabling environment and institutional roles is the existence of national water resources policies and existence of legislation indicators; the Palestinian Water Policy have been established in the Water Law Number (3) of 2002 (ADA and ADC, 2007), and are the basis for decisions on the structure and tasks of water sector institutions and water sector legislation. The Law includes securing Palestinian water rights and regulating and coordinating integrated water and wastewater investments and operations. The Water Law is still young and it may take some time before the regulatory functions become embedded in the "culture" of the water sector. The water law now needs to be modified and then review for the modification copy depending on the current situation, the responsibilities of the PWA and its references must be clear since it must be the administer and organizer for the water sector and not the implemented part, there must be law and authority with a clear strategies and work plan to implement the plans. (ADA and ADC, 2007; World Bank; 2009 and PWA, 2010[b])

Financing and investment in water sector is a major indicators represent the actual investment in the West Bank in this major sector, current investment in the West Bank water sector is two tenth of planned levels with an average 39.1 million $ per year (Table 4.1), the target sector investments due to water strategy 2000 is about 180 million $ per year (World Bank, 2009), moreover, few major investments are going ahead and more is being invested in small emergency projects than in large infrastructure. The development partnerships with donors that move awkwardly between the political context and the development challenge and are often stuck in emergency rather than strategic mode.

Another set of indicators is fragmentation of water institutions, national apex coordinating body, regulatory and enforcement bodies, the PWA is the national apex body in the West Bank but there is an immediate need to create a more favorable environment for PWA as a regulator to gain the trust and confidence of the water users of the West Bank.

Unaffordability for pay and in some cases the wellness for pay create problems in cost recovery, the cost recovery must recoupment the cost of water service as the capital and operation cost through the operational period but in the West bank the cost recovery rate for network supply averages is only 50% nationwide (World Bank, 2009), which may lead to increased dependence on Israel. The government ends up footing the bill and even then the cost is deducted at source by the Israelis.

Efficiency of Water use as the unaccounted for water in the West Bank averages 37% (Table 4.3), and this is the highest in the region compared with Jordan and Egypt 14 and 27% respectively (ESCWA, 2009). This indicates in general poor management, inadequate operations and underinvestment in maintenance.

Water resources are not currently efficiently used in the West Bank and scarce resources are being wasted and wastewater reuse in agriculture is currently limited to a small pilot scale as 0.04 Mm^3, practically, many countries in the region have just started to invest in wastewater treatment plants, such as Lebanon (ESCWA, 2009). In some countries, especially in the GCC, a substantial share of the wastewater supplied for municipal use is reused in agriculture, horticulture, public parks and golf courses after adequate treatment. In Iraq, treated wastewater is only partially reused because of the low cost of alternative sources of water supply for irrigation. Wastewater reuse has major benefits since it can be a valuable alternative to freshwater resources. It allows costs to be saved for wastewater treatment and for fertilizers and can increase agriculture production. For instance the tariff for surface water provided by the public irrigation system in the Jordan valley is only US$ 0.02/m^3 for the fresh water (ESCWA, 2009), which means that the use of treated wastewater for irrigation is more expensive than the natural water resource.

Water Pricing in consuming sector indicator leads to one of the strategies plans for the water sector which is the tariff system (Uniform or Block), so as to cover the economic, social and operation and maintenance to have full cost recovery for the water, the tariff system applied in the West Bank districts with difference in water cubic meter price, the visualization in the PWA is to has a bulk utility which will be responsible on other sub utilities in the north, middle and south then those utilities will be responsible on other sub utilities which consists from special committee, those committees will be responsible only for water and wastewater services and independent from other services, this will enhance the decentralization and give the PWA the role of regulator.

ESCWA (2009) demonstrated that all countries in the ESCWA region rely extensively on their Governments for water allocation, treatment, transportation, distribution and disposal. As a result, central water agencies have become overburdened by the size of their administrative and financial responsibilities. Consequently, the quality of water services has been deteriorating steadily in many countries in the region including the West Bank, as decision-making and implementation is concentrated at the higher echelons.

One aspect of water management being experimented in rural areas is that stakeholders' participation by community based organizations (Water Users Association- WUA). The establishment of water user associations may contribute to enhancing the welfare of farmers and improving the development of irrigation and drainage services. Many ESCWA member countries have recently adopted this type of participatory approach in dealing with the issue of water supply (ESCWA, 2009).

In the West Bank there are only two associations located in Jericho and belong to farmers. While in the Syria and Jordan the faggar system was developed, which consists of small wells and canals, and the system of falaj in Oman and the United Arab Emirates, the canal system in Egypt and the irrigation and agricultural drainage water authorities in the Saudi Arabia. In recent years, an increasing number of water societies have been created in Egypt in order to share common benefits. Water user societies and administrative boards have also been formed in Yemen, Jordan and Egypt (ESCWA, 2009).

Agriculture sector is a key sector for the revival of the Palestinian economy; there are many steps that could be taken in the nearer term, including the technology transfer agenda and the development of plans for wastewater reuse in tandem with investment in treatment (Jacques and Christian, 2009). The per capita agricultural water use is only 45 m3/capita/year (Table 4.3) while it is in other neighboring countries (Figure 5.2) 101.6, 914.3, 227.7, 845.3 m^3/c/y for Jordan, Egypt, Lebanon, and Syria respectively (ESCWA, 2007).

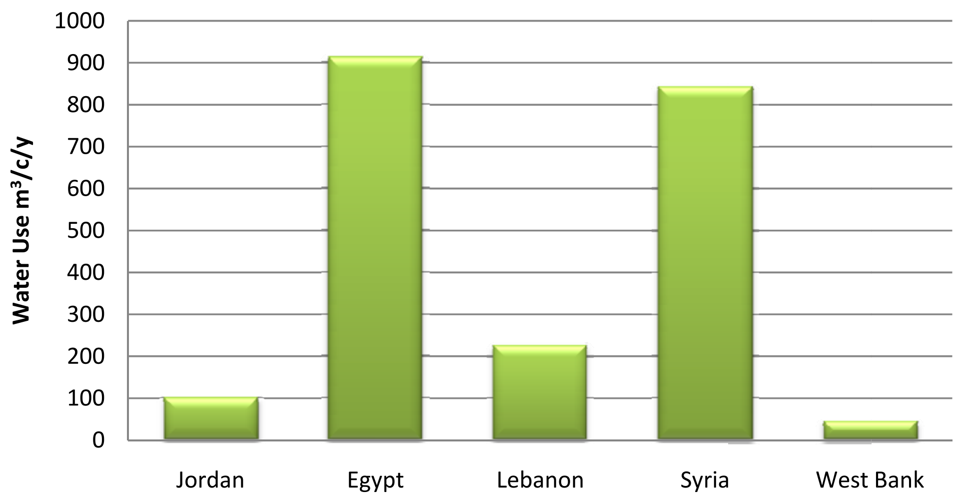


Figure 5.2: The per capita agricultural water use in some of ESCWA countries and West Bank

This situation lead to the agriculture sector strategy 2010-2013 which includes the policies targeting the effective and sustainable management of agricultural resources throughout the Palestinian territory, these policies are;

1. Increase water availability and improve supply management through rehabilitate water infrastructure and raise water sources designated for agriculture

2. Improve demand management of the agricultural water by enhance the efficiency of water transportation and distribution systems and upgrade irrigation systems and use complementary irrigation
3. Sustainable use, increasing the area, reclaiming the land and sustainable use of agricultural biodiversity through identify, classify and reclaim lands and enhance the productivity, afforest government and privately-owned land, develop and rehabilitate rangeland, and conserve and sustainably use agricultural biodiversity (FAO, 2010).

By implementing these policies, water quantities designated for the agricultural activity will be increased, either by securing Palestinian water rights or by upgrading the management and competent use of existent irrigation water sources, besides encroachments on agricultural water sources will be curbed and water use will be regulated (FAO, 2010).

The legislation situation for the West Bank is similar to the other ESCWA countries, the Law on Agriculture No. (2) of 2003 constitutes the basic legal framework that regulates the agricultural activity and covers all aspects of agricultural development. Still, there is a dire need to enact many other regulations and basic directives in order to complement the legal framework.

The political situation play a key role in the West Bank water resources control, a Joint Water Committee (JWC), composed of Israelis and Palestinians, is established under the Oslo Accords to oversee the management of shared water resources and deal with all water and sewage-related issues, but only inside the West Bank. This committee effectively gives Israel a veto on all decisions on water resource and infrastructure development, including in Areas A and B. Only a small percentage of projects submitted to the JWC (to drill wells, construct filling points, networks etc.) have been approved, and many of those that received approval by the JWC have not been implemented due to delays or refusal by the Israeli Civil Administration to issue permits Area C (EWASH, 2009 and PWA, 2010[b]). The PWA reported that 328 Palestinian wells were operational in the West Bank, compared to 774 wells in 1967 (World Bank, 2009).

Additionally, the per capita annual share from abstraction water in the West Bank is approximately 50 m^3/cap/yr, on the contrary of the situation in Israel which share the water resources with the West Bank, the per capita annual share from abstraction water 68.43 m^3/cap/yr (Table 4.2).

Moreover, the Palestinians have been denied access to the Jordan River, the main surface water resource, since 1967. Since Israel diverted all of the flow of the Upper Jordan River at Lake Tiberias/the Sea of Galilee, the Jordan River has been reduced to a foul trickle (15%) causing a serious decline of 1m/yr in the Dead Sea level (EWASH, 2009).

Quick comparison between the population in the West Bank and the others in Israel show the difference in the rights, proportion, and inequity; the Palestinian domestic consumption is on average 70 l/c/d (Jayyousi and Srouji, 2009), with Israeli domestic consumption being on average 280 l/c/d (EWASH, 2009). The small Israeli settlements are supplied by generously large, high pressure pipelines, whereas adjacent Palestinian towns with a much larger population are left with much smaller diameter pipes. Moreover, Mekerot (the Israeli company responsible on water) regularly and drastically reduces the meager flows to Palestinian communities during hot summer months, in which the settler consumption doubles. Restrictions on Palestinian movement and access due to the Wall, checkpoints, barriers and roadblocks as well as bypass roads, closed military areas, nature reserves and Area C zoning, have cut many Palestinian communities off from their water resources.

The water resources are used and managed most effectively when they are linked to broader development objectives. This needs integrated steps and collaboration between all the sectors, ministries, public and private organizations, essentially, the development effort required strategic plans to cope the current obstacles, unsustainable water practices, particularly aquifer over pumping and lack of pollution control that could compromise the economic welfare of future generations.

Figure 5.3: Sectors Collaboration to develop Strategic Plans

Important spot must be taken into consideration is the institutional reform, to redefine sector architecture in the light of today's reality and to equip and build capacity in the agencies that have to carry the agenda forward. The challenge is not just at the top; the institutional building must be applied for the small and large service providers and includes all the pyramid members.

Besides all, the water resources, access, control, and management will be linked to the Palestinian water situation in the negotiations on the permanent settlement.

Chapter Six

Conclusions and Recommendations

6.1 Conclusions

The holistic nature of the IWRM in the West Bank requires constant knowledge exchange between the West Bank and other ESCWA member states since there is similarity in the water status with some of them. It also requires a continuous upgrading and updating of the available information of the basis of which effective policy measures may be taken. Such objectives can only be achieved through a set of suitable indicators that reflect the situation of water resources in a dynamic and realistic manner.

The challenges are great, but the unsustainable management and inequitable access to water resources can't continue because the risks of inaction are even greater. Decision makers and leaders in the water domain can inform the processes outside this domain and manage water resources to achieve agreed socioeconomic and environmental objectives. But decision makers and leaders in government, the private sector and civil society determine the direction that actions will take.

Considering the above, the main findings of this research can be summarized as follows:

- In the West Bank the groundwater recharge consist 100% of the total renewable water resource which is similar to the Bahrain and Kuwait countries, the average groundwater recharge in the ESCWA countries is 10.2% of total renewable water resources.
- The groundwater recharge as a percentage of total renewable water resources indicator is 100% in the West Bank, while the non-conventional water resource is only the treated wastewater and it is only forms 0.033% of total renewable water resources.

- The per capita annual share from abstraction water resources in the West Bank is 49.77 m^3/cap/yr.
- Civil society involvement is still weak in the West Bank; raising awareness tends to be overlooked by officials when it comes to planning for IWRM. Moreover, the execution of such activities needs to be coordinated with other official bodies or non-governmental bodies that normally would not be involved in water resources.
- Efficiency of Water use as the unaccounted for water in the West Bank averages 37%, and this is the highest in the region compared with Jordan and Egypt 14 and 27% respectively. This indicates in general poor management, inadequate operations and underinvestment in maintenance.
- Water reuse is widely applicable in the ESCWA region; however, specific techniques or levels of treatment depend on local priorities and local economic feasibility. The amount of treated wastewater reused is so small percent of area irrigated with treated wastewater to total irrigated area is 0.18%.
- The average ESCWA countries percent for the agriculture GDP as a percentage of the total GDP is 8.0%, while it is in the West Bank in the common average 8.2%, and there is possibility to increase the percentage by networking and planning with related sectors.
- The West Bank achieves a very good percent with 90% for population with access to safe drinking water.
- Provision of sanitation services in the West Bank is only 31% which become the lowest percent of the ESCWA countries.
- The existence of a wastewater collection system might be a good indicator of the health status of communities in terms of its impact on human lives.
- Regarding community based organizations; only two organizations in the West Bank, whereas many ESCWA member countries have recently adopted this type of participatory approach in dealing with the issue of water supply.

- The per capita agricultural water use is only 45 m3/c/y while it is in other neighboring countries 101.6 m3/c/y as Jordan.

6.2 Recommendations

- The apex body must prevent the duplication of work by coordinating among the different bodies, and thus making the water sector more efficient.
- It is important to provide a supportive environment for community based organizations, support can be achieved through creation of knowledge exchange networks, supporting and promoting local movements, and access to finance.
- Different types of activities or campaigns should be done to reach the widest possible sections of the population, and they must be target all districts in the West Bank with focusing on quality of activities and expand the target groups.
- In this research, data collected from many resources since there is no complete reference include most of the data required to develop indicators, so it is recommended to have a one reference in one publication and a main responsible on the updating of it. This publication will be the reference of other researchers and decision makers for planning and management to reduce risks and costs and will be early identification of risk or emergency (early warning systems) to allow for prompt action besides it will be indicator to measure the level of performance in the achievement of specific objectives, policy success, process efficiency or the quality of a system.
- The IWRM indicators have been applied on the West Bank level and so it is recommended to have a one to apply more specific indicators in basic sectors as environment, health, nature and land use, climate change, air, waste and material flow and agriculture.

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Annexes

Annex 1: Primary questionnaire developed and distributed among the related sectors

المؤشرات الأساسية للإدارة المتكاملة للمياه في الضفة الغربية

السنة التي تمثلها القيمة	احدث قيمة للمؤشر	Indicator name	وحدة القياس	اسم المؤشر	الرقم
		- Per capita investment in water sector	دولار/فرد بالسنة	نصيب الفرد من الاستثمار في قطاع المياه	1
		total amount of money (in $) that is invested in the water sector of each country	دولار في السنة	مجموع الاموال التي يتم استثمارها في قطاع المياه خلال السنة	1a
		- Percent of domestic water supply operated by private sector The volume of domestic water that is provided by the private sector	مليون متر مكعب	مجموع المياه التي تستخدم للاغراض المنزلية ويتم تزويدها من قبل القطاع الخاص	2a
		the total volume of domestic water supply available	مليون متر مكعب	مجموع المياه التي يتم تزويدها	2b
		- Number of water-related institutions responsible of water resources (surface water, groundwater, desalination, wastewater)	عدد	عدد المؤسسات المسؤولة عن ادارة المياه	3
		- Number of water professionals - Number of universities/institutes providing water training in the country - The number of the water professionals that have received training	عدد عدد عدد	- عدد الاشخاص المتخصصين بمجال المياه -عدد الجامعات والمعاهد التي تقوم بالتدريب في مجال المياه -عدد الاشخاص الذين تلقو تدريب من فترة قريبة في مجال المياه	4
		-Number of organizations registered at the authority (Ministry of the Interior) and worked in water or environment sector development (local organizations)	عدد	عدد المؤسسات المسجلة وتعمل في قطاع تطوير المياه والبيئة	5
		- Number of water awareness activities per year	عددبالسنة	عدد نشاطات التوعية التي تنفذ سنويا	6
		- Density of hydrological networks (WMO's) The average area served by one hydrological station	كم^2/محطة	متوسط المساحة التي تخدمها المحطة الهيدرولوجية واحدة والتي يتم حسابها من : مساحة المنطقة المخدومة عدد المحطات الهيدرولوجية الموجودة فيها	7
		- Long Term annual average (minimum 20 years)	ملم بالسنة	معدل سقوط الامطار سنويا (20 سنة على الاقل)	8

		- Drought Frequency - Flood Frequency	احتمالية	معدل الجفاف معدل حدوث الفياضانات	9
		- Evaporation rate	ملم بالسنة	معدل التبخر سنويا	10
		- Treated wastewater reuse	مليون متر مكعب	كمية المياه والمستخدمة بعد المعالجة	11a
		- Agricultural drainage reuse	مليون متر مكعب	مياه الصرف الزراعي التي يعاد استخدامها	11b
		- Dams capacity (storage/ artificial recharge)	مليون متر مكعب	القدرة التخزينية للخزانات المستخدمة	12
		- Agricultural sector water use by source - surface water % - groundwater % - treated wastewater %	مليون متر مكعب او %	استخدام المياه في الزراعة تبعا للمصدر المياه السطحية% المياه الجوفية% المياه المعالجة%	13
		- Domestic sector water use by source - surface water % - groundwater % - desalinated water %	مليون متر مكعب او %	استخدام المياه للاغراض المنزلية تبعا للمصدر المياه السطحية% المياه الجوفية% المياه المحلاة%	14
		- Industrial sector water use by source - surface water - groundwater - treated wastewater	مليون متر مكعب او %	استخدام المياه في الصناعة تبعا للمصدر المياه السطحية% المياه الجوفية% المياه المعالجة%	15
		- Irrigation system efficiency (Agriculture)	مليون متر مكعب او %	كمية المياه المفقودة في نظام الري كمية المياه المستخدمة في الري في المزارع مقسومة على كمية المياه التي يتم توزيعها عن طريق شبكات الري	16
		- Percentage of irrigated areas using water saving irrigation system the area of irrigated farms using water saving irrigation systems (sprinkler and trickle)	كم^2	مساحة الاراضي التي يتم ريها باستخدام نظم توفير في الري	17
		- % of metered households	عدد عدد	عدد البيوت التي تستخدم عداد لاستهلاك المياه عدد البيوت الكلي التي يتم تزويدها بالماء	18
		- % of metered groundwater wells	عدد عدد	عدد الابار الزراعية التي تستخدم عداد لاستهلاك المياه عدد الابار الزراعية الكلي	19
		- Cost recovery in the Domestic sector	%	استرداد التكاليف في القطاع المنزلي	20

		- Cost recovery in the Agricultural sector	%	استرداد التكاليف في قطاع الزراعة	21
		- Value added per cubic meter of water in Agriculture	دولار/متر مكعب	القيمة المضافة لكل متر مكعب من المياه في الزراعة او كمية المياه التي يتم استخدامها في قطاع الزراعة	22
		- Value added per cubic meter of water in Services	دولار/متر مكعب	القيمة المضافة لكل متر مكعب من المياه الخاصة بالخدمات او كمية المياه التي يتم استخدامها في قطاع الخدمات	23
		- Value added per cubic meter of water in water-dependent industries	دولار/متر مكعب	القيمة المضافة لكل متر مكعب من المياه في الصناعات او كمية المياه التي يتم استخدامها في قطاع الصناعة	24
		- area irrigated with treated wastewater	كم^2	مساحة الاراضي التي تستخدم المياه المعالجة للري	25
		- Existence of surface water protection zones	نعم / لا	وجود مناطق حماية المياه السطحية	26
		- Existence of groundwater vulnerability documents for land use	نعم / لا	وجود وثائق تبين تعرض المياه الجوفية لاستخدامات الأراضي	27
		- Existence of WHPA(Wellhead Protection Areas) for domestic water supply wells	نعم / لا	وجود مجال حماية البئر للابار التي تستخدم للاغراض المنزلية	28
		- intensity of Domestic water quality monitoring	عدد الايام	كثافة رصد جودة المياه التي تستخدم للاغراض المنزلية	29
		- % of valid samples passing DWQ standards	%	نسبة العينات التي تطابق في معايير جودة مياه الشرب بناء على WHO	30
		- % population with access to safe drinking water	%(شخص)	نسبة (عدد) السكان التي تصلهم مياه صالحة للشرب	31
		- % population with access to improved sanitation facilities	%(شخص)	نسبة (عدد) السكان الذين لديهم شبكات صرف صحي	32
		- Incidence of outbreaks per year	عدد الحوادث في السنة	حوادث تلوث المياه وانتشار الامراض عن طريق المياه في السنة	33
		- Morbidity (diarrhea)		حالات الاصابة بالاسهال بسبب المياه الملوثة في السنة	34
		- % wastewater volumes collected of total produced	مليون متر مكعب مليون متر مكعب	كمية المياه العادمة التي يتم انتاجها كمية المياه العادمة التي يتم جمعها	35a 35b
		- % wastewater treated of total collected	مليون متر مكعب	كمية المياه التي يتم معالجتها	36
		- % wastewater reused of total collected	مليون متر مكعب	كمية المياه التي يتم اعادة استخدامها بعد معالجتها	37

		- % of water bodies conforming with national standards amount or volume of water whose quality conforms to set national standards	مليون متر مكعب	كمية المياه التي تطابق جودتها المعايير الوطنية كمية المياه المتوفرة للاستخدام	38a 38b
		- Biochemical Oxygen Demand (BOD) in water bodies (UNEP's)	mg/L	كمية وجود BOD في مياه الشرب	39
		- Concentration of Faecal coliform in Freshwater (WHO's)	%	تركيز القولونيات البرازية في المياه الصالحة للشرب	40

Annex 2: List of the researcher and decision makers met to discuss the indicators

No.	Organization	Name	Title
1.	Agricultural Development Association (PARC)	Eng. Thaer Jalloud	Project Coordinator/ Projects Department
2.	Al-Bireh Municipality	Eng. Lamia Hamael	Sanitation Unit Engineer
3.	Food and Agriculture Organization of the United Nations	Dr. Azzam Saleh	Senior Agricultural Advisor
4.	Palestinian Metrology	Mr. Isam Esaife	Director of Applied Metrological Studies
5.	Palestinian Water Authority	Eng. Adel Yasin	Director of Sanitation Unit
6.	Palestinian Water Authority	Eng. Ashraf Dweikat	Head Of Data Bank Section
7.	Palestinian Water Authority	Eng. Nael Ahmad	Advisor for Projects Management Unit
8.	Palestinian Water Authority	Dr. Rashed Alsaed	Advisor for Sanitation Unit
9.	Palestinian Water Authority	Eng. Subhi Samhan	Dirctor of Water Quality Service
10.	Palestinian Water Authority	Dr. Yousef Awayes	Director General of International Coordination Unit (ICU)
11.	Palestinian Water Training Institute (PWTI)	Eng. Saleh Errabie	Director of Palestinian Water Training Institute (PWTI)
12.	Palestinian Water Training Institute (PWTI)	Eng. Shereen Zeidan	Training Coordinator
13.	Ministry of Agriculture	Mr.Kasim Abdo	Director General of Soil & Irrigation
14.	Ministry of Agriculture	Dr. Thameen Hijawi	Senior Technical Advisor