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INTEGRATED WATER RESOURCES MANAGEMENT: A TOOL FOR SUSTAINABLE DEVELOPMENT

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Cover Page Footnote

IPCC, 2014 Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32. Loucks, D.P. 2000. Sustainable Water Resources Management. Water International 25(1):3-10. Available online: http://www.informaworld.com/10.1080/02508060008686793 May 01, 2015. Mays, L.W. 2007. Water Resources Sustainability. New York: McGraw-Hill Professional. Mukheibir, P., 2010. Water Access, Water Scarcity and Climate Change. Environmental Management 45: 1027-1039. Rahaman, M.M., Varis, O., 2005. Integrated Water Resources Management: Evolution, Prospects and Future Challenges. Sustainability: Science, Practice, & Policy 1 (1): 15 – 21. Sanctuary, M., Tropp, H., Berntell, A. 2005. WHO: Making water a part of economic development. Sweden: Stockholm International Water Institute (SIWI). Available online: http://www.who.int/water_sanitation_health/waterandmacroeconomics/en/index.html May 01, 2015. Scoullos, M.J. 2003. Impact of anthropogenic activities in the coastal region of the Mediterranean Sea. International Conference on Sustainable Development of the Mediterranean and Black Sea Environment. May, Thessaloniki, Greece. UNCED, 1992. United Nations Conference on Environment and Development. Rio de Janeiro, Brazil. UN, 2009. The 3rd United Nations World Water Development Report: Water in a changing world. Available online: http://www.unesco.org/water/wwap/wwdr/wwdr3/ May 05, 2015. UN-Water/GWP, 2007. Roadmapping for Advancing Integrated Water Resources Management (IWRM) Processes. Available online: http://www.unwater.org/downloads/UNW_ROADMAPPING_IWRM.pdf May 05, 2015. UNEP, 2012. The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management. Wheater, H. S., Mathias, S. A., Li, X., 2010. Groundwater Modelling in Arid and Semi-Arid Areas. Cambridge Books Online: Cambridge University Press. Available online: http://dx.doi.org/10.1017/CBO9780511760280.009 May 01, 2015. World Bank, 2012. Lebanon Country Water Sector Assistance Strategy 2012-2016. Report No. 68313-LB, April 19, 2012. Sustainable Development Department Middle East and North Africa Region.

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Integrated Water Resources Management: A Tool for Sustainable Development

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ABSTRACT

The recent trends show a decrease in water supply coupled with water losses due to inefficient management and pollution. The phenomenon is called water scarcity and he's affecting people's livelihoods around the world. Many approaches have been investigated through international water conferences and forums to develop tools for sustainable water management. IWRM (Integrated Water Resources Management) is one of the most widely adopted tools focusing on a holistic and participatory approach, involving users, planners and policy makers at all levels. In this study, the key concepts of IWRM and its potential in improving the water sector and inducing sustainable development are examined. The water sector situation in Lebanon is considered as an example to show the role and challenges for the implementation of IWRM in developing countries. Recommendations included the clarification of the responsibilities of public authorities, the identification of financial needs for the appropriate selection of investments, the incorporation of capacity building activities and the focus on increasing awareness to achieve water stewardship around stakeholders.

1. Introduction

Here introduce Water quantity and quality concerns are basic to society's well-being, so much so that one of the main United Nations Millennium Development Goals (MDGs) was aimed at reducing the proportion of people without adequate access to affordable water by half by 2015. The target was achieved in 2010, five years ahead of schedule. In 2012, 89 % of the world's population had access to an improved source, up from 76 % in 1990. Over 2.3 billion people gained access to an improved source of drinking water between 1990 and 2012. (UN, 2014).

However, water accessibility is not the only problem affecting livelihoods. Nowadays, there is a growing consensus that the world is rapidly heading towards a physical shortage of freshwater or a decrease in water availability, referred to as water scarcity

1 (Mukheibir, 2010). Water scarcity is both a natural and a human-made phenomenon. While a renewable resource, water supply is threatened by global warming combined to overexploitation of resources. Surface and groundwater supplies are stressed by an increasing demand leading to the consumption of water resources at a much faster rate than can be naturally replenished.

During the past decades, many approaches were developed to ensure the sustainable use of water. Although there is enough freshwater on the planet for seven billion people, it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed. Provision of tools for the sustainable management of water is thus of crucial importance, especially in semi-arid areas where there are few alternatives for water supply.

[1] Mukheibir, P., 2010. Water Access, Water Scarcity and Climate Change. *Environmental Management* 45: 1027-1039.

2. What is sustainable water resources management?

The concept of sustainable resources management has been around for a long time, as water resources managers had been taught the principles of sustained yield management long before publications such as "Limits to Growth"[2] by Dennis Meadows, (1974) and "Our Common Future"[3] by the Brundtland Commission (1987) (Mays, 2007). According to Loucks (2000), sustainable water resources systems are defined as "*water resource systems designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity*"[4]. Another definition is of Dan Rothman (Mays, 2007): "*water resources sustainability is the ability to use water in sufficient quantities and quality from the local to the global scale to meet the needs of humans and ecosystems for the present and the future to sustain life, and to protect humans from the damages brought about by natural and human-caused disasters that affect sustaining life*" [5]. In a recent definition (Wheater et al., 2010), sustainable water management describes a practice which prevents irreversible damage to the resource water and resources related to it such as soils and ecosystems, and which preserves in the long-term the ability of the resource to extend its services for future users[6].

However, sustainable water management involves much more than its name implies and there are many aspects that must be considered. Water must be dealt with in a holistic manner, taking into account the various sectors affecting water use, including political, economic, social, technological and environmental considerations.

The latter holistic water resource approach referred to as the Dublin-Rio principle (UNCED, 1992) highlights that fresh water is finite, vulnerable and essential to sustain life, economic development and the environment[7] (Table 1).

Table 1 - Dublin Principles for sustainable water management (UNCED, 1992)

Dublin Principles for sustainable water management	
Principle 1	Freshwater is a finite and vulnerable resource, essential to sustain life, development, and environment
Principle 2	Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels
Principle 3	Women play a central part in the provision, management and safeguarding of water management and safeguarding of water
Principle 4	Water has an economic value in all its competing uses and should be recognized as an economic good

In addition, the Dublin conference[8] focused on the necessity of Integrated Water Resources Management (IWRM) which is based on a participatory approach, involving users, planners and policy makers at all levels.

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[2] Meadows, Donella H; Meadows, Dennis L; Randers, Jørgen; Behrens III, William W (1972). *The Limits to Growth; A Report for the Club of Rome's Project on the Predicament of Mankind*. New York: Universe Books. ISBN 0876631650. Retrieved 26 November 2017.
1972 first edition (digital version)
1974 second edition (cloth)
1974 second edition (paperback)

[3] Brundtland, G. (editor). (1987). Our common future: the world commission on environment and development. Oxford Press, Oxford.

[4] Loucks, D.P. 2000. Sustainable Water Resources Management. Water International 25(1):3-10. Available online: http://www.informaworld.com/10.1080/02508060008686793 May 01, 2015.

[5] Mays, L.W. (editor). (2007). Water resources sustainability. Mc Graw-Hill, New York, NY.

[6] Wheater, H. S., Mathias, S. A., Li, X., 2010. Groundwater Modelling in Arid and Semi-Arid Areas. Cambridge Books Online: Cambridge University Press. Available online: http://dx.doi.org/10.1017/CBO9780511760280.009 May 01, 2015.

[7] UNCED, 1992. United Nations Conference on Environment and Development. Rio de Janeiro, Brazil.

[8] The Dublin Statement on Water and Sustainable Development was agreed at the International Conference on Water and the Environment (ICWE), on 26-31 January 1992, a preparatory meeting of the United Nations Conference on Environment and Development (UNCED) to be held later that year.

3. Integrated water resources management

Although the concept of IWRM can be dated back to centuries if not millennia, the challenges and implementation of this approach were globally addressed during the last three decades. The evolution of the IWRM concept started during the United Nations Conference on Water (1977) in Mar Del Plata, Argentina, and was thereafter the recommended approach by the International Conference on Water and Environment (1992), Second World Water Forum (2000), International Conference on Freshwater (2001), World Summit on Sustainable Development (2002) and Third World Water Forum (2003). IWRM has dominated the water management dialogue as the major frame of reference for water governance, shaping water policies and the national and international levels[9] (Gerlak and Mukhtarov, 2015). Presently IWRM is a part of international political agendas and is considered one of the key components for achieving sustainable development.

In 2002, at the Johannesburg World Summit on Sustainable Development (WSSD), The Technical Advisory Committee of the Global Water Partnership (GWP) defined IWRM "*as a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*,"[10] and emphasized that water should be managed in a basin-wide context, under the principles of good governance and public participation (Rahaman and Varis, 2005).

However, the concept of IWRM is widely debated and an unambiguous definition of IWRM does not currently exist. Hence, the regional and national institutions must develop their own IWRM practices using the collaborative framework emerging globally and regionally (GWP-TAC, 2000).[11]

4. IWRM key concepts

IWRM explicitly challenges conventional, fragmented water development and management systems and places emphasis on integrated approach with more coordinated decision making across sectors and scales (Figure 1). According to GWP, the five key concepts of IWRM are as follows:

- Multiple uses: Water is a resource for drinking and washing but is also necessary for livelihoods.
- Holistic management: Both the supply of and the demand for water should be considered when creating management strategies.
- Multiple perspectives: Water is an economic, social and environmental good.
- Participatory approach: Local communities must help make decisions about their resources.
- Women involvement: The role of women in collecting, distributing and managing water must be recognized.

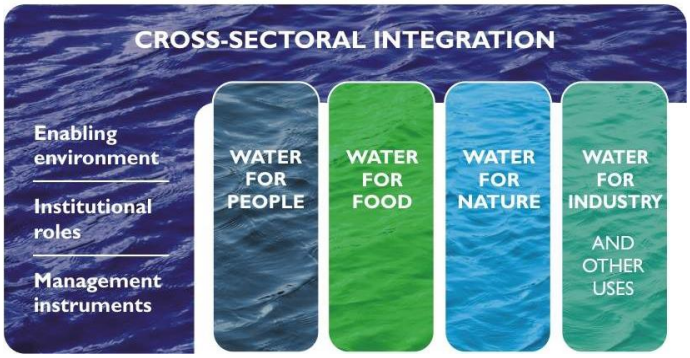

Fig. 1 - IWRM and its relation to subsectors (GWP-TAC,2000)

[9] Gerlak, A.K. and Mukhtarov, F. 2015. 'Ways of knowing' water: integrated water resources management and water security as complementary discourses. *Int Environ Agreements* DOI 10.1007/s10784-015-9278-5

[10] Rahaman, M.M., Varis, O., 2005. Integrated Water Resources Management: Evolution, Prospects and Future Challenges. Sustainability: Science, Practice, & Policy 1 (1): 15 – 21.

[11] GWP: Global Water Partnership. TAC: Technical Advisory Committee. GWP, 2000, Integrated Water Resources Management, Technical Paper No.4, March

The tools for implementation of IWRM are concepts that help the user select a suitable mix and sequence of processes or steps that work in a given situation, context and country. They comprise the following (Figure 2):

- Creating an enabling environment of suitable policies, strategies and legislation for sustainable water resources development and management,
- Putting in place the institutional framework through which to put into practice the policies, strategies and legislation, and
- Setting up the management instruments required by these institutions to do their job.

Fig. 2 – General IWRM Framework (GWP-TAC,2000)

The primary challenge to the implementation of IWRM strategies is the rigid functional divisions within governments as well as international development agencies which work against the types of cross-cutting, holistic approaches to development planning and resource management that IWRM requires. Building capacity for integrated programming continues to be difficult when ministries are organized along sectoral lines and poverty reduction and environmental protection/management plans are drawn up separately.

However,, the holistic approach concept doesn't only involve the integration of the human system such as the administrative divisions, stakeholders, water managers and policy/decision makers but also takes into consideration the integrated management of the natural system components including the integration of freshwater and coastal zone, water and land resources, terrestrial water (rain and soil) and rivers/aquifers, surface water and groundwater, water quantity and quality, and upstream and downstream water issues.

In this context, IWRM should be viewed as a long process rather a one-shot approach. As a process of change which seeks to shift water development and management systems from their currently unsustainable forms, IWRM is a cycle with no fixed beginnings or endings (Figure 3).
The process of IWRM could be nevertheless divided into three major iterative stages for application:

- Planning
- Implementation
- Monitoring and evaluation

The planning stage includes the assessment of water resources issues and priorities, the setting of national goals for water management, and the development of appropriate water resources policies, strategies and legislation, and the preparation of the implementation plan.

The planning phase will allow the identification of the relevant stakeholders, their roles and responsibilities in the implementation of the strategies, the alternative management options and the activities to be undertaken along with the timeframe for their implementation.

The implementation stage consists in the execution of the proposed management actions accompanied with capacity building activities to ensure the availability of expertise for the use of the necessary tools, methodologies and management instruments for implementation.

The evaluation and monitoring stage involve the development of indicators to assess the level of achievement of the management actions and activities being implemented.

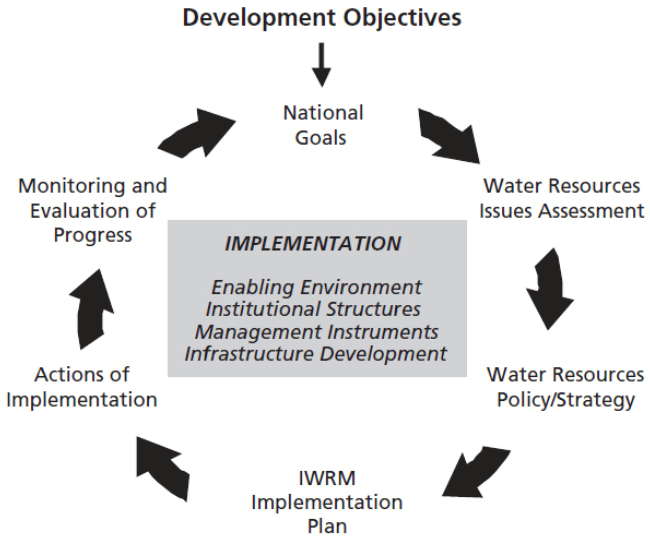

Fig. 3 – Stages in IWRM planning and implementation (UN-Water/GWP, 2007)12

5. Impacts of IWRM on sustainable development

A recent survey (UNEP, 2012)13 about the development impacts of IWRM, showed average positive responses from countries that support a general conclusion that integrated approaches to water resources management have led to positive development impacts including social, economic and environmental aspects.

5.1. Social impacts

The UN World Water Development Report 3 (UN, 2009)14 shows that the benefits for social development that result from sustainable water management and provision of safe water are related to the alleviation of poverty as well as the improvement of human health. Water contributes to poverty alleviation in many ways – through sanitation services, water supply, affordable food and enhanced resilience of poor communities to disease, climate shocks and

[12] UN-Water/GWP, 2007. Roadmapping for Advancing Integrated Water Resources Management (IWRM) Processes. Available online: http://www.unwater.org/downloads/UNW_ROADMAPPING_IWRM.pdf May 05, 2015.

[13]UNEP, 2012. The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management.

[14] UN, 2009. The 3rd United Nations World Water Development Report: Water in a changing world. Available online: http://www.unesco.org/water/wwap/wwdr/wwdr3/ May 05, 2015.

environmental degradation. Water of appropriate quantity and quality can improve health and, when applied at the right time and rate, can enhance the productivity of land, labor and other inputs such as the environment.

Furthermore, access to safe drinking water and adequate sanitation services has other important benefits such as convenience, well-being, dignity, privacy and safety. This is a result of self-sufficiency which in turn helps avoid the risks of outside dependence.

This is particularly important for the islands' local societies which tend to display sharper responses to change and higher vulnerability to disturbances as a result of isolation and size. So, although the above-mentioned benefits are difficult to measure, their effect is quite obvious. For instance, some regions of Asia are facing an increased risk of drought-related water and food shortage causing malnutrition. The implementation of IWRM is proposed as an adaptive action for the alleviation of these impacts and improving the livelihoods in terms of food security and adequate nutrition (IPCC, 2014)15.

5.2. Social impacts

Numerous studies have illustrated that dependable water supplies contribute to GDP growth, and that lack of water contributes to economic stagnation and decline. For instance, (Brown &Lall, 2006)16 have shown that the amount of rainfall and its variability – an expected impact of climate change – have affected the economic development of nations. This variability is demonstrated in the case of Mediterranean countries where rainfall amounts vary greatly between winter and summer periods. The result is a major water crisis in summer, when an increased touristic water demand corresponds to a season of very low water availability. In addition, the difficult summer conditions for agriculture affect the economic development significantly. Therefore, as water becomes more and more scarce for the economic sectors, the government must exploit less accessible sources of freshwater through appropriating and purchasing a greater share of aggregate economic output, in terms of dams, pumping stations, supply infrastructure, among others (Barbier, 2004).17 Consequently, the IWRM approach resulting in an improved management of water resources contribute substantially to economic growth through increasing business productivity and development (Sanctuary et al., 2005)18. For example, evidence in Central and South America show that IWRM is being adopted to manage water availability in semi-arid and glacier-melt-dependent regions and where flooding and landslides in urban and rural areas are caused by extreme precipitation and mostly affecting agricultural development one of the most important economic sectors in the region (IPCC, 2014).

5.3. Social impacts

The water cycle explains interactions between the atmosphere, hydrosphere, and lithosphere, thus constituting a major driving force on our planet. Unsustainable water management practices such as over-consumption and water pollution, combined with climate change and pre-existing water scarcity situations such as low water availability in arid and semi-arid regions could result in severe impacts on nature and society. Ineffective water resources management mechanisms put aquatic ecosystems under higher stress. Conversely, the development of adequate water use planning such as IWRM would avoid heavy overexploitation of reservoirs in case of drought, which jeopardizes the survival of the associated fauna and flora and reduces the availability of resources for agricultural, municipal and industrial uses and further destabilizes the natural renewal of water resources. The appropriate management of water scarcity and drought has the potential to positively impact the status of water bodies, thereby improving the ability to supply the communities with good quality water of sufficient quantity to support lives and livelihoods (EU, 2006)19. For instance, one of the major impacts on freshwater ecosystems is the peaks in wastewater volumes as in the case of the small touristic islands. Scoullos (2003)20 reports that only 80 % of the effluent of residents and tourists in the Mediterranean is collected in sewage systems, with the remainder being discharged directly into the sea or to septic tanks. However, of the 80%

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[15] IPCC, 2014 Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

[16] Brown, C., Lall, U. 2006. Water and Economic Development: The Role of Variability and a Framework for Resilience. Natural Resources Forum 30: 306-317.

[17] Barbier, E.D. 2004. Water and Economic Growth. The Economic Record 80 (248): 1-16.

[18] Sanctuary, M., Tropp, H., Berntell, A. 2005. WHO: Making water a part of economic development. Sweden: Stockholm International Water Institute (SIWI). Available online: http://www.who.int/water_sanitation_health/waterandmacroeconomics/en/index.html May 01, 2015.

19 EU (European Union), 2006. Mediterranean EU Water Initiative / Water Frame Directive Joint Point: Water Scarcity Management in the Context of WFD. Available online: http://www.sogesid.it/allegati/convegni_eventi/water_city_7_2006/WS_Management.pdf May 01, 2015.

20 Scoullos, M.J. 2003. Impact of anthropogenic activities in the coastal region of the Mediterranean Sea. International Conference on Sustainable Development of the Mediterranean and Black Sea Environment. May, Thessaloniki, Greece.

collected in sewage networks, only half are actually connected to wastewater treatment facilities with the rest being discharged into the sea or inside cesspits. The environmental consequences of wastewater discharges are of great concern especially when affecting the only natural source of potable freshwater such as the groundwater in the Aegean Islands which is under high risk of pollution and contamination. Hence, the isolation, small size and lack of resources contribute not only to a greater ecological diversity of insular ecosystems but also to greater vulnerability to disturbances such as the previously mentioned issues related to water quality and availability.

Moreover, IWRM has been reported to be an adopted measure for the adaptation to climate change effects on water resources (IPCC, 2014). With drought stress exacerbated in drought-prone regions of Africa, IWRM is used as a tool to manage compounded stress on water resources facing significant strain from overexploitation and degradation at present and increased demand in the future.

The key water issues, particularly facing Southern Europe, include the increased water restrictions, the significant reduction in water availability from river abstraction and from groundwater resources, combined with increased water demand (e.g., for irrigation, energy and industry, domestic use) and with reduced water drainage and runoff as a result of increased evaporative demand, particularly in southern Europe (e.g. Insular areas of Greece, Italy, Spain, etc…). The suggested adaptation measures by IPCC consist in the implementation of best practices and governance instruments in river basin management plans and integrated water management.

6. Case study: Lebanon

6.1. Status of IWRM in the Lebanese water sector

The GWP21 for the Mediterranean region (GWP-Med), as the Secretariat of the Mediterranean Component of the EU Water Initiative (MED EUWI), has the responsibility of implementing IWRM principles and initiatives in the region including Lebanon. GWP-Med provided assistance to Lebanon within the framework of the MED EUWI, through country dialogues on water, and with support of the MEDA Water Programme of the European Commission and Greece that leads MED EUWI.

During phase I of the MED EUWI (until April 2009), GWP-Med assisted the Lebanese Ministry of Energy and Water (MEW) with the review of the country's ten-year National Strategic Plan for Water (2000–2009) and launched the preparation of the IWRM Plan with focus on multi-stakeholders' consultations. A brief analysis of current needs and trends (up to 2020) of the water supply sector in Lebanon was conducted with focus on demand water supply sector in Lebanon with focus on demand management for domestic, irrigation and industrial uses as well management for domestic, irrigation and industrial uses as well as on non-conventional water resources (particularly wastewater) and techniques (e.g. aquifer recharge). Other activities included the consolidation of the Plan with the provisions of the Law 221, including the evolution of the Water Establishments with regard to Public Private Partnerships. The reviewing of the plan resulted in the development of an awareness component in the Plan focusing on enhancing water demand management and non-conventional water resources, the development of a capacity building component to assist with the implementation of the Plan, and building on a multi-stakeholder approach about 50 targeted stakeholder organizations have been informed and involved in the Dialogue activities under the lead of the MEW22.

During the ongoing Phase II of the MED EUWI23, the GWP- Med24 assisted with the preparation of the National Water Sector Strategy (NWSS) being elaborated by the MEW. The activities included Private Sector Participation in support to Strategic Planning Efforts of the Government, progress towards the preparation of the National IWRM Plan through the set-up and functioning of a Water Evaluation and Planning System for Lebanon (WEAP) to serve as a Decision Support tool for policy/decision makers.

WEAP allows building scenarios on current water accounts and exploring the impact of alternative assumptions or policies on future water availability and use. The scenarios are evaluated with regard to water sufficiency, costs and benefits, compatibility with environmental targets and sensitivity to uncertainty in key variables.

[21] GWP Global Water Partnership

[22] MEW: Ministry of Energy and Water

[23] MED EUWI: the Mediterranean Component of the EU Water Initiative

[24] GWP-Med: Global Water Partnership for the Mediterranean region

One of the challenges is the availability of sufficient data which is one of the preconditions for IWRM planning and the basis for the functioning of the WEAP system. To this purpose, MEW will collect available data from the relevant Lebanese institutions, and these will be then incorporated in and processed through WEAP.

6.2. Problems of the water sector in Lebanon

Although Lebanon is one of the Middle Eastern countries with the highest availability of water per capita (1000 m3/capita) (Figure 4), two thirds of this water is being already used with a significant exploitation of the groundwater resources (World Bank, 2012)25.

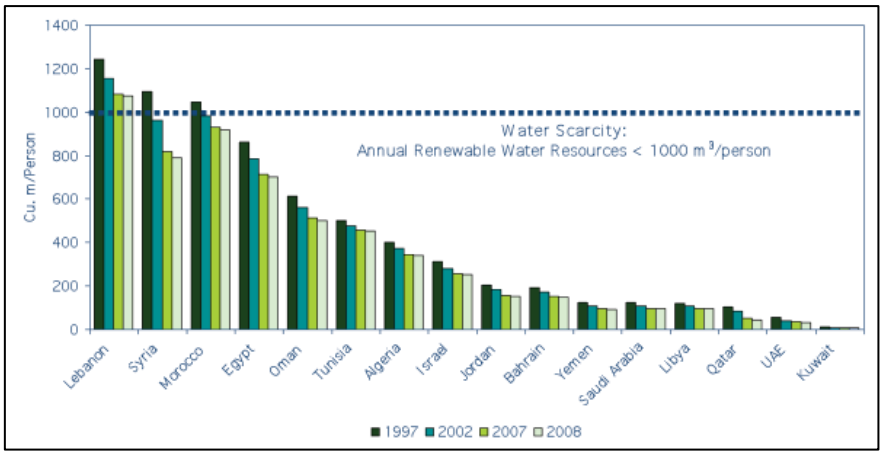

Fig. 4 – Actual annual per capita renewable water resources (worldwater.com)

As in most coastal Mediterranean countries, there is a seasonal incompatibility between water demand (peak in hot dry summers) and water supply (peak in humid and rainy winters). Moreover, only 6% of the total water supply is stored and available for use during periods of high demand due to 1) the topography inducing quick run-off of precipitation to the sea, 2) the lack of appropriate storage infrastructures such as dams, 3) the low efficiency of water supply network and high leakage percentage, and 4) due to the increasing demand from the municipal and industrial sectors. Those facts show that the future would face an overexploitation of natural aquifers leading to saline water intrusion in coastal areas and a need for non-conventional and expensive water supply alternatives such as seawater/brackish water desalination (e.g. Greece, Gulf countries). Water allocation is another problem in Lebanon. Water supply services have large disparities between regions and low continuity over time. Although some reforms were initiated under Law 221/2000 to create autonomous, efficient and integrated water services providers (Water Establishments - WEs), the services are still deficient. The main challenges of the implementation of the IWRM plan is the weak law enforcement due to institutional constraints and low technical capacities of WEs in addition to the lack of incentives to consumers to save water (water tariffs do not depend on usage). Also, coordination within government remains poor, in particular between MEW and the Council for Development and Reconstruction (CDR), with continued fragmentation of responsibilities for investment planning and execution, and consequent low efficiency of public expenditures. Overall, the water sector is delivering poor services at a high fiscal and household cost. The WEs has to overcome tough economic and socio-political challenges if they are to become efficient and accountable service providers. In the meantime, water sector inefficiencies (particularly low collection of tariffs and high-water losses) and environmental damage are costing the economy the equivalent of almost 3% of GDP annually (World Bank, 2012).

[25] **World Bank,** 2012. Lebanon Country Water Sector Assistance Strategy 2012-2016. Report No. 68313-LB, April 19, 2012. Sustainable Development Department Middle East and North Africa Region.

6.3. Problems of the water sector in Lebanon

As previously mentioned, the MEW with the support of GWP-Med has recently developed the NWSS which was adopted by the Council of Ministers in March 2012. The main NWSS objective is 'to ensure water supply, irrigation and sanitation services throughout Lebanon on a continuous basis and at optimal service levels, with a commitment to environmental, economic and social sustainability'. This goal falls within the concept of IWRM and its implementation would greatly contribute to the sustainable development in the country.

The proposed measures by the NWSS for a better IWRM will result in six key outcomes as shown in Table 2.

Table 2 – NWSS outcomes and measures for their implementations (World Bank, 2012)

Outcomes	Measures for implementation
O1. Improved, sustainable and affordable water supply	M1.1 Developing infrastructure to ensure continuous access to high-quality service through increased coverage, reduced unaccounted-for water and optimized network management M1.2 Transformation of the WEs progressively into autonomous and accountable utilities by moving them to a service orientation, strengthening their administrative and financial autonomy, and involving them in project planning and implementation M1.3 Moving the WEs towards financial sustainability by applying over time tariff structures that cover costs and contribute to demand management M1.4 Increasing the role of private capital and management by developing an enabling environment for PPP
O2. Sustainable water resources management and allocation to priority uses	M2.1 Creation of an enabling environment for integrated water resources management and sector regulation M2.2 Development of water resources infrastructure
O3. Putting wastewater on a sustainable footing and protecting the environment	M3.1Developing wastewater infrastructure to increase coverage of collection networks and treatment capacities, optimizing treatment processes and sludge disposal, and ensuring reuse where possible M3.2Improving wastewater management by implementing an institutional and business model for wastewater collection, treatment and reuse M3.3Environmental protection by promoting and improving water quality management, and protection of recharge zones
O4. Profitable and sustainable irrigated agriculture	M4.1 Improving irrigation infrastructure to improve water control and to increase efficiency through modern water-saving irrigation technology M4.2 Improvements in the performance and sustainability of the irrigation sector, through decentralization, stakeholder participation, demand management and cost recovery
O5. Strengthened sector capacity for oversight and reform implementation	M5.1 Restructuring and equipping the MEW to take on policymaking, planning and regulatory roles M5.2 Building human capacity in the sector through recruitment and staff development and training.
O6. Improved efficiency of public investment	M6.1 Improve the efficiency of public expenditure, building from the bottom up, and then prioritizing and phasing

For an optimal implementation of the strategy, it is of utmost importance to 1) clarify the respective obligations and rights of public agencies for the delivery of water services and empower the Wes, 2) prioritize investments within realistic financial ceilings, ensuring that the highest impact investments are undertaken and are linked to accompanying reforms, 3) restructuring and building implementation capacity in a practical, prioritized way, 4) follow worldwide best practice in reform implementation by initiating a targeted engagement strategy of broad dialogue and outreach to increase ownership of the reform program by all stakeholders.

7. Conclusion

The increasing problems of water shortages are obvious worldwide and highlighted in the most vulnerable countries to water scarcity such as the Mediterranean region including Lebanon. The need of tools for the sound management of water resources is thus necessary to ensure social, economic and environmental development for improved livelihood of communities. This study shows the developmental impacts of using the IWRM approach which is a holistic approach that implies the participation of all relevant stakeholders in decision making and policies development. The implementation of this concept proved to be a long and iterative process consisting in the setting of national goals and objectives based on an accurate assessment of water resources, developing a national strategy including a plan for its implementation, defining the tools required for its implementation and the tools for monitoring the progress of the proposed action plan. Finally, it is mandatory to assess the main constraints and challenges that might hinder the implementation of IWRM and identify measures to overcome them and achieve the national targets.

Appendix A. Abbreviations

AfDB African Development Bank
AsDB Asian Development Bank
AP Associated Programs (GWP)
ASEAN Association of Southeast Asian Nations
AWP Area Water Partnership (GWP)

BNWPP Bank-Netherlands Water Partnership Program
BAT Best Available Technology
Cap-Net International Network for Capacity Building in IWRM (UNDP)
CGAP Consultative Group to Assist the Poor
CGIAR Consultative Group on International Agricultural Research
CP Consulting Partners
CWP Country Water Partnership (GWP)
CSD Commission of Sustainable Development
DANIDA Danish International Development Agency
DENR Department of Environment and Water Resources
DFID Department for International Development (UK)
DGF Development Grant Facility (World Bank)
DGIS Dutch Ministry of Foreign Affaires
DHI Danish Hydraulic Institute Water and Environment

EIA Environmental Impact Assessment
EC European Commission
EU European Union

FAO Food and Agriculture Organization
FPG Financial Partners Group

GEF Global Environment Facility
GIWA Global International Waters Assessment
GPA Global Programme of Action
GPG Global public good
GRPP Global and/or regional partnership program
GTZ German Agency for Technical Cooperation
GW-MATE Groundwater Management Advisory Team (World Bank)
GWP Global Water Partnership
GWPO Global Water Partnership Organization (the legal representative of GWP)
GWP Global Water Partnership

HRM Human resources management
HRW Hydraulic Research Wallingford

IWRM Integrated Water Resources Management

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IAHR International Association for Hydraulic Research
ICID International Commission for Irrigation and Drainage
IFI International financial institution
IUCN World Conservation Union
IWA International Water Association
IWMI International Water Management Institute

MDG Millennium Development Goal
M&E Monitoring and evaluation
NEPAD New Partnership for Africa's Development
NGO Nongovernmental organization
NORAD Norwegian Agency for Development Cooperation
NGO Non-Governmental Organization
NWSS National Water Sector Strategy**.** The MEW with the support of GWP-Med has recently developed the NWSS which was adopted by the Council of Ministers in March 2012.

O&M Operation and Maintenance

PARC Performance Assessment Resource Centre (UK)
PSP Private Sector Partnership
PAWD Partnership for Africa's Water Development
RTAC Regional Technical Advisory Committee
RWP Regional Water Partnership (GWP)

SADC Southern African Development Community
SC Steering Committee (GWP)
SDC Swiss Agency for Development Cooperation
SIDA Swedish International Development Agency

TAC Technical Advisory Committee
TEC (TAC) Technical (Advisory) Committee (GWP)
TOR Terms of reference

UNCED United Nations Conference on Environment and Development
UNDP United Nations Development Program
UNEP United Nations Environment Program
USAID U.S. Agency for International Development

WB World Bank
WEAP Water Evaluation and Planning System
WMO World Meteorological Organization
WRCC Water Resources Coordination Council
WSP Water and Sanitation Program
WSSCC Water Supply and Sanitation Collaborative Council
WSSD World Summit on Sustainable Development
WWC World Water Council
WWF World Wide Fund for Nature
WWFx World Water Forum; the "x" indicates the sequence (1, 2, 3, 4)

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