Knowledge and innovation for safe and sustainable water resources: opportunities and challenges

Dhaoui, Iyad

Research Unit Money, Development and Infrastructures (MODEVI)/ Faculty of Economics and Management of Sfax

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KNOWLEDGE AND INNOVATION FOR SAFE AND SUSTAINABLE WATER RESOURCES: OPPORTUNITIES AND CHALLENGES

Iyad Dhaoui
Research Unit Money, Development and Infrastructures (MODEVI)/ Faculty of Economics and Management of Sfax, Airport Road km 4.5, Sfax, 3018, Tunisia
iyad.dhaoui@gmail.com

ABSTRACT

As considered a limiting factor for economic development, water management requires special attention. So, undertaking development of sustainable solutions to 21st century water resource problems becomes a strategic imperative. But, this is combined with some problems relating to the management of water. In this perspective, there is a significant need to train a new generation of water management. With the introduction of sustainable integrated water management (SIWM), traditional optimization in water resources which is called sustainability water management (SWM) has lost its leading role. Furthermore, to explain this new purpose, we combine real explanation in the sense that they are based on the investigation of empirical determinations. Indeed, sustainability integrated concept get scientific knowledge out in front of tomorrow concerns. In this sense, we will try to explain how adapting and integrating technological architecture to resource efficiency overcomes challenge statements of the nations existing water problem, especially in agriculture and in industry issues. We will explain also how technological solutions and decision support systems lead to a more knowledge based approach to water resources management.

Keywords: water resources, sustainable integrated water management, innovative technologies, agriculture, industry.

1. INTRODUCTION

Demand for water will increase in all three of these areas as populations grow and as countries become more industrialized. It is estimated that by 2020 around two-thirds of the world's population will be living in water-stressed countries.
Increasing demands are being placed on finite water resources to supply drinking water, water for other societal needs (including energy, agriculture and industry), and the water necessary to support healthy aquatic ecosystems. Having adequate water of sufficient quality underpins the Nation's health, economy, security and ecology.
During the last decades, research and technological development have contributed to our societies' advancement in awareness, knowledge and policy insight of the role water plays in our environmental and socio-economic welfare, and the need to proactively defend the sustainability of our aquatic ecosystems.

2. METHODS

This research aims to provide guidance through demonstrations, best practices, institutional studies, decision-making tools, and other products for a paradigm shift towards sustainable and holistic water management. Firstly, the method is inductive since it must start from the observation of facts to develop proposals that make the approach as clear as possible. The method is finally wants effective insofar as, by its use, it will produce the expected effects especially improved state of knowledge on the subject.

3. COMPONENTS AND VIEWPOINTS

3.1. Water management requires special attention

The challenging but widely accepted concept of sustainable development calls for new approaches on development and, therefore, on water management.
The water resources are becoming more scarce, not only in quantity but because of the degrading quality, while competition for its use is increasing.
After all, it is acknowledged that the growing water crisis is also a crisis of governance.
In the early 1990s, the economic value of water preoccupied many in the water policy field.
The idea was that water, like any scarce resource, should be used efficiently and consumers should pay for it.
Managing and allocating increasingly scarce water re-sources in an integrated way that accommodates different, often competing, uses and users is a challenge of significant proportions.

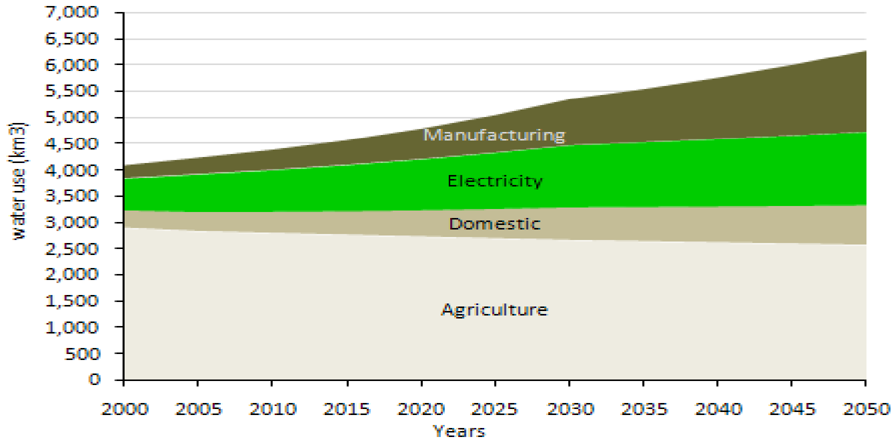
Failure to recognize the economic nature of water, which means regarding water as a completely free, renewable resource, has contributed to inefficient allocation and to wasteful and environmentally damaging uses. Managing water as an economic resource, through the recognition of its full economic value, as well as through the use of economic incentive instruments, is among the key characteristics of a sustainable water policy (Winpenny, 1994; Jonch- Clausen, 1994; Mylopoulos Y. and Kolokytha, 1996; Mylopoulos Y., 1996).
As considered a limiting factor for economic growth development, water management requires special attention. The pressure on using the water resources makes their availability to be reduced and quality to be deteriorated (Engelmann and LeRoy, 1993). Many authors dealt with these problems, some focusing on the Mediterranean region (Grenon and Batisse, 1988; Hamdy and Lacirignola, 1993; 1994). A global perspective of the population growth and water resources availability is presented in Table 1.

Table1. *Perspectives of the population growth and water resources*

	Population (million)		*Water per person (cubic metres)*	*Water per person (cubic metres)*	
	1990	*2025*		*1990*	*2025*
North Africa	140	280	85	610	310
Western Asia	132	286	253	1.920	880
Southern Asia	1.191	2.100	3.980	3.340	1.900
Africa S. Of Sahara	492	1.276	3.575	7.270	2.800
Other Asia	1.794	2.476	8.737	1.870	3.530
Europe	509	542	2.321	4.560	4.280
C.America and caribbean	147	250	1.330	9.050	5.320
Former USSR	276	360	5.379	19.490	14.940
North America	281	344	4.384	15.600	12.740
South America	294	452	10.377	35.300	22.960
Oceania	27	41	2.011	74.980	49.050

Table 1 shows the mounting pressure on water resources in the developing regions due to population growth. It shows the effect of expected population growth between 1991 and 2025 on per capita resources, particularly in all of Africa and in Southwest Asia, the regions in which the fastest population growth in the world is currently being experienced and where it seems likely to continue. In April 2010, the United Nations Population Division updated its global population forecast to nine billion people by 2050, which equates to an additional 2.3 billion mouths to feed. As population rises, so does the demand for food and for the water to produce it.

Figure 1. *World water use by sector*

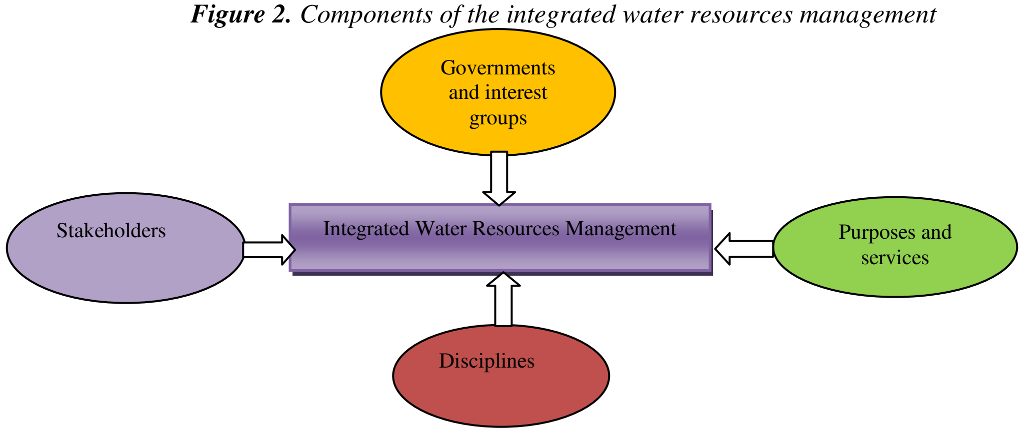


Water is a finite resource. Demand for the world's increasingly scarce water supply is rising rapidly. Already, agriculture uses 70 percent of the world's freshwater and there are no major new sources waiting to be discovered. Using water more efficiently to produce food is an urgent priority. Water is also essential for drinking and household uses and for industrial production: around 20 percent is used for industry and the remaining10 percent for domestic activities.

3.2. The value of an interdisciplinary approach

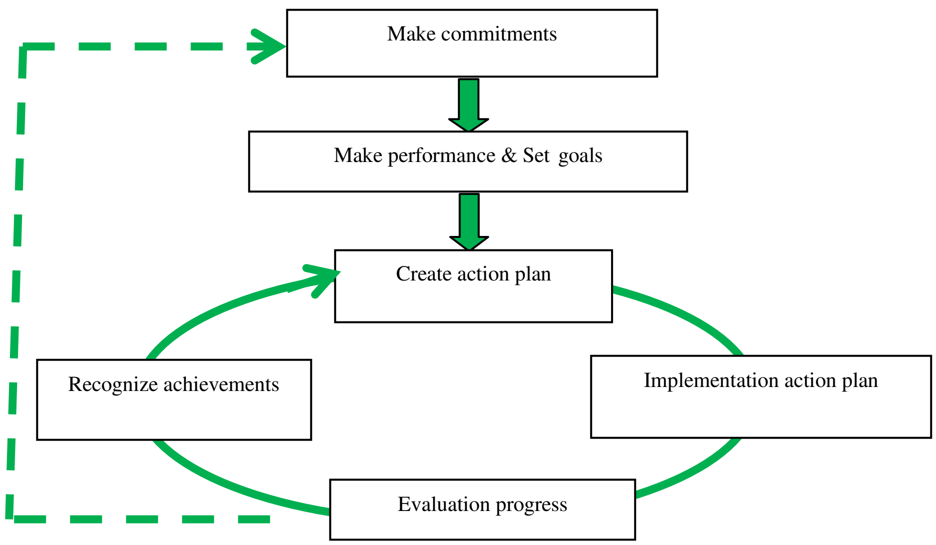
Sustainability is defined as the continuous supply of clean water for human and other uses without compromising the environment, economic and well-being of future generations. Traditional ways of water management have much to teach us about sustainable water harvesting. Where they have been successful, they have been integrated into the society, culture and economy of which they have been part. We should look to traditional knowledge to enhance and incorporate appropriate modern technology. SIWM considers viewpoints of human groups, factors of the human environment, and aspects of natural water systems. SIWM considers the viewpoints of water management agencies with specific purposes, governmental and stakeholder groups, geographic regions, and disciplines of knowledge (see the figure)

Figure 2. *Components of the integrated water resources management*



It is widely accepted today that protection of the water resources and economic development are not separate challenges. Development cannot exist in a deteriorating environmental resource base, and the water resources cannot be protected and enhanced when growth plans consistently fail to consider the full cost of environmental destruction.

Figure 3. *Good water management requirements*



The concept of SIWM has modified the vision of water perspectives and development strategies.

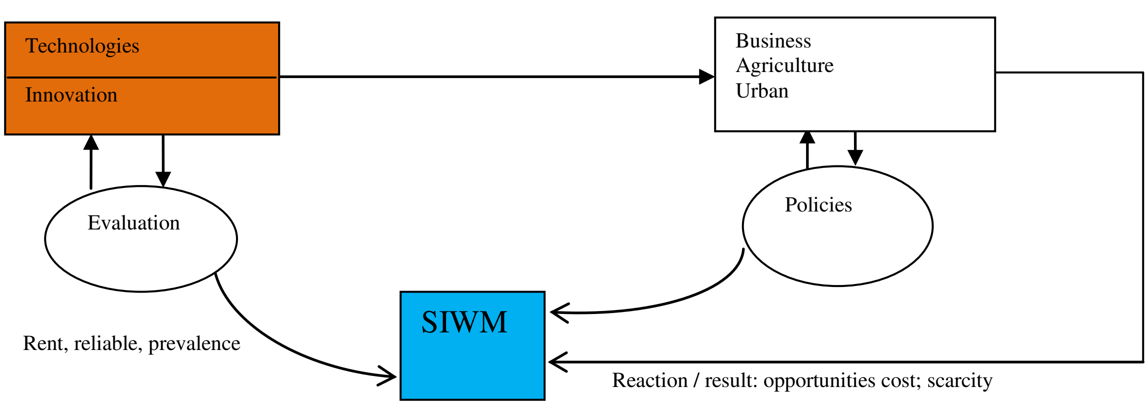
3.3. Interdisciplinary perspectives

The complexity of integrated water resources management requires knowledge and wisdom from different areas of knowledge, or disciplines. Blending knowledge from engineering, law, finance, economics, politics, history, sociology, psychology, life science, mathematics, and other fields can bring valuable knowledge about the possibilities and consequences of decisions and actions.

4. KNOWLEDGE AND INNOVATION FOR SSWM: OPPORTUNITIES

4.1. Need for innovative issues

Figure 4. *SIWM process and the implementation of innovation and technologies*



4.1.1. Agricultural innovative issues

Table 2. *Modern agricultural water management technologies*

Technology	*Sponser*	*Description*	*Results*
Soil Moisture Monitoring technology (SMM)	Nestlé	Affordable and good quality measurements of soil water content and soil temperature in a compact and field-robust probe.	45% reduction in water usage per tonne of produced tomatoes.
Partial Rootzone Drying (PRD)	University of Adelaide	Irrigation technique for sustainable viticulture and premium quality grapes	Grow fruit with up to 50% less water
Traditional and GM plant breeding techniques	ICRISAT	Conserve moisture such as mulching and building ridges to capture rainwater	Particular success in developing and distributing a new variety of pigeon pea, a crop relied on by hundreds of millions of marginal farmers.
Capture water released from the potatoes as they are cooked into crisps before using it in the manufacturing process. Using the system in its factories.	PepsiCo's programme	Extract water from its potato crops	The water will initially be used in the manufacturing process to clean, peel and slice potatoes when they are brought in - also provide tap and drinking water

4.1.2. Industrial innovative issues

- ✓ Businesses should employ the best available, economically viable and most appropriate technologies compatible with expected asset life.
- ✓ Emerging treatment technologies, including application of genomics, ultra-fine nano-technology based selective adsorption, heterogeneous catalysis and hybrid chemical/biological systems.
- ✓ Demonstration of smart, clean, and green technologies and approaches for water management.

4.2. How technological solutions and decision support systems lead to a more knowledge based approach to water resources management?

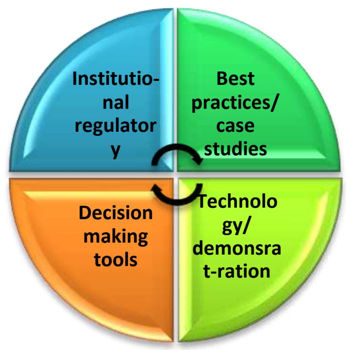
Engrained social preferences may make new scientific knowledge difficult to incorporate into water policy. Their impact is not always easy to measure, particularly as they make themselves known according to very different timescales, and it is difficult to make trade-offs between the short and long term. It is our ambition to make better use of our considerable international co-operation in water research to help address water challenges and promote integrated water resources allocation and management that engages with the people it is designed to help, and meets their needs.

5. CHALLENGES TO WATER MANAGEMENT INTEGRATION

SSWR will target two major challenges:

- Provide the best science in a timely manner to allow faster and/or smarter management decisions for the Nation's existing water resource problems; and
- Get scientific knowledge out in front of tomorrow's problems by developing and applying new approaches that better inform and guide environmentally sustainable water resource management.

Figure 5. *The Four Research Focus Areas for Next Generation Water Management.*



Each of the four research areas has a goal or desired end state that supports the overall objective for challenge

6. CONCLUSION

Sustainable water management requires collaboration between business, civil society and governments. Utilize effective tools for various scales and tiers of application to undertake systems analysis of water resources by addressing health/societal needs, economic and ecosystem concerns. The paper insists also on the fact how important it is to work to bring science and society closer together.

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