Changing behavior as a policy tool for enhancing food security

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Abstract

Recent developments in international markets point to a dramatic food crisis all over the world. The media today is repeatedly dominated by staggering reports on the global food crisis, soaring crop prices and demands for bio-fuels, raising fears of political instability. Since 2002, media reports have mostly highlighted the dramatic situation of food insecurity. The Arab region is most seriously affected by the global food crisis. It is clear that the root causes of 'the Arab springs' and revolutions underway in various Arab countries are not only a desire for trans-formation to a more democratic political system but also desire for the realization of social justice among citizens, the eradication of poverty and hunger, and a narrowing of the gap between rich and poor.

This paper addresses the need for a change in individual and societal behavioral patterns. It addresses the need for communities to assist governments in preventing and managing water-related food crises. It brings together world waters in its complexities, with new dimensions of institutional context and cultural norms. The effectiveness of ongoing traditional approaches may be limited without additional measures and tools to help governments understand how to engage in cooperative behavioral change.

Keywords: Changing behaviour; Culture and ethics; Food security; Integrated water resources management (IWRM); Water–food crisis

1. Introduction

Recent reports suggest that 'over one billion people experience the hardship that hunger imposes' (FAO, 2009), a figure which continues to rise even amidst the advancements made in agricultural sciences in the 21st century. Engulfed within current population growth, economic instability and climate change, food security has become an urgent challenge for national and global governance. The feeble outcome of the 2009 World Summit on Food Security suggests that affluent countries are not yet ready to make food security a top priority. As for the Arab region, the situation is becoming no longer sustainable, due to the high costs and negative environmental consequences associated with the deteriorating status of water resources and the resulting deteriorating livelihoods in the region.

The main objective of this paper is to contribute to the ongoing debate and to inquire further into the basic question of the use of behavioral change as a policy tool to enhance food security and mitigate the water–food crisis. In this way, changing behavior is introduced as a soft path approach and as a tool for realizing sustainability in water and food management.

The paper consists of six sections which are interrelated and integrated in a manner to show inter-linkages among them, and to bring about leverage to mitigate water-related food crises and ultimately to resolve these issues. The sections are divided as follows: (1) an introduction to clarify water-related food crises worldwide; (2) world water–food security divides; (3) a discussion of the root causes or challenges being faced, and examples of water–food crises; (4) key questions for changing behavior and a model of thinking as a tool for enhancing water/food crises; (5) the way forward: addressing the complex question of water–food crises and the international responses to them (from the Group of Eight, the UNs Implementation of the Millennium Development Goals (MDGs), and via virtual trade); and (6) concluding remarks (Figure 1).

2. World water divide over food security

Over 1,000 million people experience the hardship that hunger imposes, a figure which continues to rise even amidst the apparent riches of the 21st century. Engulfed within a current population growth, economic instability and climate change, food security has become an urgent challenge for national and global governance.

Despite US Secretary of State Henry Kissinger's declaration at the 1st World Water Summit in 1974 that global hunger would be eradicated by 1984, and despite the many political commitments made since then, the number of people lacking access to a minimum diet has risen from 824 million in the MDG baseline year of 1990 to 1,020 million in 2009.
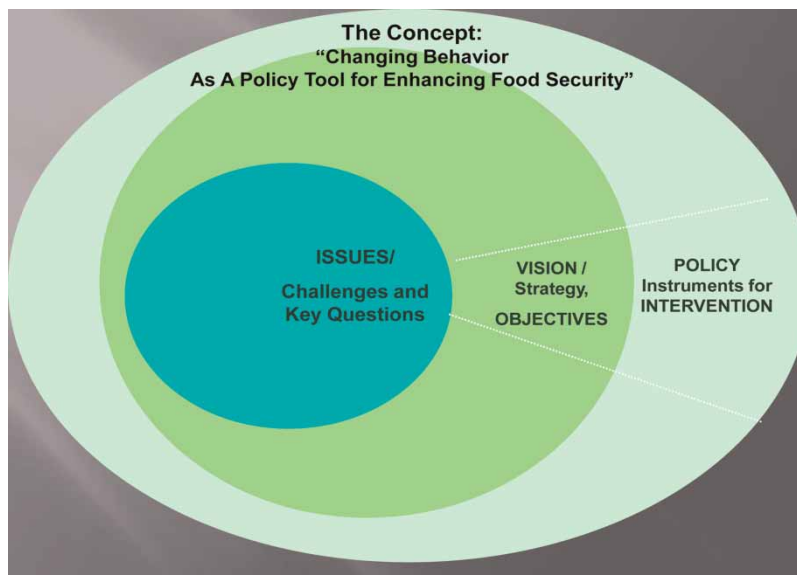

Fig. 1. Illustration of the integrated concept used in this paper to address water–food related crises.

Moreover, India, Yemen, Mexico, Burkina Faso, Egypt and several other countries have had, or have been close to, food riots recently, something not seen in decades of low global food commodity prices. Meanwhile, there are shortages of beef, chicken and milk in Venezuela and other countries, as governments try to keep a lid on food price inflation. Jacques Diouf, head of the FAO, stated in London recently that 'If you combine the increase of the oil prices and the increase of food prices, then you have the elements of a very serious social crisis in the future' (FAO, 2008).

As for the Arab region, there is a conviction that: 'if the Arab world doesn't start growing more food now, it will face a major and more acute food crisis in the future'. It was noted at a United Nations Experts Seminar in 2008 that 'Arab agricultural lands are declining, due to drought, desertification, and water shortage' (FAO, 2008). Speaking at the same seminar, Abdu Diof, FAO President, said that over 40% of those suffering from hunger throughout the world live in Arab countries: 31 million out of 75 million people. He added that 'Arab countries were importing 50% of all of their food, with food production in Arab countries hovering at a meager 3%. Arab countries have been advised to increase their agricultural production from 2 to 5% in order to meet growing food demands' (FAO, 2008).

A recent study (Seckler *et al.*, 2009) highlighted, *inter alia*[1], the following conclusions on the dimensions of the water induced food crisis:

- 'In the semi-arid regions of Asia and the Middle East, which include some of the major breadbaskets of the world, the ground water table is falling at an alarming rate, there is an urgent need to focus the attention of both professionals and policy makers on the problems of ground water depletion, which must be seen as the major threat to food security in this century.
- 15–35 million people were at risk of famine, 786 million were vulnerable to chronic under nutrition, and hundreds of millions suffered from micronutrient deficiencies, diarrhea, measles, malaria, parasites, and other nutritional impairments.
- In addition, the study suggested *a normative scenario* to achieve food security in the warmer, more crowded, more connected, but more diverse world of 2060, which requires: (a) widespread acknowledgement of food as a human right; (b) large increases in food production and income; (c) a pervasive global safety net, and the capacity to cope with surprises. Some elements of these requirements are already in place.'

The foregoing reports and conference proceedings highlight that the divide is clear between north and south, whilst the problem is also a global phenomenon in certain countries of the north, and it is possible to find such conflicts in rich or poor countries alike. Ban Ki-moon, the UN Secretary-General, emphasized the same conclusion at the World Economic Forum in Davos (24 January 2008), when he stated that: 'This is not an issue of rich or poor, north or south,' pointing to examples of water problems strongly linked to water and food induced conflicts in China, the United States, Spain, India, Pakistan, Bangladesh and the Republic of Korea, 'all regions are experiencing the problem' (United Nations Experts Seminar, 2008).

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[1] The paper concerns a project on water supply and demand for 118 countries over the 1990–2025 period, in which the nature and geographic focus of growing water scarcity are identified.

3. What are the root causes of water–food induced conflict?

This section gives a description of the variables responsible for causing water–food related crises and answers the question of why such crises are triggered. The identification of these variables and their characterization will form the basis for designing a better strategy to mitigate such crises. The variables are, *inter alia*: (1) population growth; (2) climate change impact; (3) world trade rules; (4) land tenure and gender; (5) biofuels; (6) food aid; (7) biotechnology and genetically-modified (GM) crops; and (8) mismanagement of water/food conflicts.

3.1. Population growth

Whilst future population growth will aggravate food insecurity, its significance is often exaggerated. Current global food production is more than sufficient to meet the FAO's minimum dietary requirement for all – it is the eating habits of the existing population and the resolve to distribute resources fairly that will dictate future food security. For example, 33% of the world's grain production is fed to animals.

Despite projections that global food production must rise by 70% by 2050 to meet the needs of the projected 40% growth in world population, the FAO has repeatedly expressed 'cautious optimism' that this demand can be met (FAO, 2009).

3.2. Climate changes impact

The urgency of tackling the causes of food insecurity is redoubled by our knowledge of the impact of climate change. Much of the tension in international climate change negotiations stems from the misfortune that agriculture will be most affected in those countries least responsible for greenhouse gas emissions. Indeed, a warming climate may improve food production in temperate zones, home to most of the richer countries.

A 2009 report by the International Food Policy Research Institute (see Godoy, 2009) estimates that, in the absence of resolute government action, 'food availability in the sub-Saharan African region will average 500 calories less per person in 2050, a 21% decline'.

In South and East Asia, the retreat of Himalayan glaciers threatens food security through disruption of the critical water cycle. One-fifth of the world's population lives in the five major river basins of the Himalayan water towers (Padma, 2010).

Despite these warnings, climate negotiators are presenting a two degree temperature rise as an acceptable threshold, leaving poorer countries to adapt as best they can. National Adaptation Programmes of Actions prepared by the Least Developed Countries focus on modest community-level initiatives, including the use of alternative seed varieties (Padma, 2008), improved soil management, maintenance of water management systems and reforestation.

Rogers (2009) referred to the statement made by Ban Ki-moon, the UN Secretary-General, at the World Economic Forum, in Davos (24 January 2008), where emphasis was put on the strong link between water and food induced conflicts. In the case of conflict in Darfur (The Sudan), which is implicated by drought, 'Mr Ban Ki-Moon cautioned that a shortage of water resources could spell increased conflicts in the future. He pledged UN action on water resources. He also noted, 'Our experiences tell us that environmental stress, due to lack of water, may lead to conflict, and would be greater in poor

nations. Population growth will make the problem worse. So will climate change? As the global economy grows, so will its thirst. Many more conflicts lie just over the horizon' (Rogers, 2009).

The author has previously elaborated (Hefny, 2009) on the strong link between water and food induced conflicts and noted that 'climate changes are of concern not only from an environmental viewpoint, or in regard to regional water supply', but rather, the impact is felt through 'the social ramifications of climate change, in countries of the Nile Basin may most likely politically destabilize the region, by causing waves of environmental refugees from countries, as happened in the tragic case of Darfur, Sudan … the expected damage to the economic base, could lead to grave political implications' (Hefny, 2009).

3.3. World trade rules

The shortcomings of trade in agriculture have their roots in the desire to support the pattern of small family farms which were dominant in Europe and the US in the aftermath of the Second World War. Determined to achieve food security, the European Common Agricultural Policy and the US Farm Bill combined subsidies and tariffs to support the sector. These policies proved successful, generating colossal internal food surpluses.

Not surprisingly, the poorer countries of the modern world are keen to copy this approach. Such ambitions remain unfulfilled largely because, in 1995, the richer countries were successful in their efforts to include agriculture in the system of open market rules governed by the World Trade Organization. At the same time, they refused to unravel their own protectionist model. Africa's share of global trade in agriculture has fallen from 15% in the 1960s to 3.2% in 2006.

This hypocrisy remains a fundamental barrier to development and food security. Developing countries find their domestic markets undercut by cheap food imports dumped by rich countries. Exporters encounter trade barriers erected in Europe and USA. In 2009, the FAO quoted a figure of $365,000 million per annum as the total subsidies for agriculture paid by the rich OECD countries in 2007, nearly ten times the annual cost of eradicating hunger by 2025.

3.4. Land tenure and gender

Insecure tenure is a fact of life for the majority of poor farmers found in many parts of the developing world. Lack of incentive for investment is compounded by poor security for lenders. This has become more acute with the feminization of agriculture, as men migrate for urban work.

Women now produce 60–80% of food in developing countries yet their land rights and access to local economic decision-making is often minimal (Actionaid, 2010). African women own just 1% of the land.

3.5. Biofuels

An IMF analysis attributed one third of the 2008 rise in food prices to the influence of biofuels. These petrol additives such as ethanol and biodiesel are manufactured from plant crops as a means of reducing dependence on fossil fuels and potentially cutting carbon dioxide emissions. In 2009, one quarter of US grain was converted into transport fuel, enough to feed 330 million people for a year. This production was backed by subsidies of around $6,000 million combined with tariffs blocking imports of the more efficient Brazilian ethanol manufactured from sugarcane. Subsidies also support European targets for

biofuels which are pursued largely by acquiring rights to agricultural land in developing countries (One-world, 2010).

Anti-poverty campaigners object to the conversion of land and food for rich motorists at a time of global food insecurity. The net saving in carbon dioxide emissions from maize-based ethanol has been exposed as less than 20%. 'Second generation' biofuel crops such as jatropha, which can be grown on land unsuitable for food crops, are unlikely to achieve commercial production until 2020.

3.6. Food aid

Monitoring the balance of food supply and demand throughout the world is the core mandate of the FAO, delivered by its Global Information and Early Warning System[2]. Based on this information, the World Food Programme prioritizes regions where the depth of hunger is most serious, typically delivering food aid for school children, expectant mothers, work-for-food programs and refugee camps.

The agency aimed to support 100 million people in 74 countries in 2010, requiring a budget of $6,400 million. About the same number is assisted by international aid agencies, leaving over 800 million beneath the hunger threshold, dependent on highly variable or non-existent domestic safety net arrangements.

The US is the largest food donor but remains controlled by domestic political interests (Irin, 2010), which insist that aid should be disbursed as surplus grain from national stocks, and that the chain of delivery must be handled largely by US contractors. Other donors have moved on from this inefficient approach; food is purchased from surplus areas within the beneficiary country or by transferring cash or vouchers directly to those in need.

3.7. Biotechnology and GM

GM crops (New York Times, 2009), in which a gene of desired characteristic is transposed from one plant to another, is the most extreme and controversial output of biotechnology companies. Claiming higher yields, and lower chemical inputs, GM crops sound like the answer to global food security. Although the technology has so far concentrated on overcoming weeds and pests, it has potential to respond to nutritional needs or drought and salinity brought on by climate change.

However, GM food technology clashes with the values of food sovereignty as it depends on capital-intensive farming and the intellectual property rights are predominantly owned by a single company, Monsanto. There are reservations over the capacity of developing countries to establish regulatory frameworks needed to manage inevitable conflicts of interests. Very few countries in Africa have adopted GM crops and 2010 saw the landmark rejection of a modified aubergine plant by the Indian government (India Together, 2010).

3.8. Mismanagement of water/food conflicts

Approaching the issue from a different perspective, Rogers (2009) states that, in recent years, the key issues that cause water–food induced conflicts are, *inter alia*:

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[2] See: http://www.fao.org/giews/english/about.htm

Table 1. Key factors causing water–food induced conflicts.

Key factors
1. Water scarcity and population growth
2. Mismanagement of water, especially in the agricultural sector
3. Problems of trans-boundary rivers
4. Limited information on water resources
5. Water policy overlaps
6. Water quality degradation and water pollution
7. The growing gap between water supply and demand: the structural imbalance
8. Lack of broad spectrum vision in water management authorities
9. Limited awareness of water issues
10. Slow transfer of technology from applied research to practice
11. Shortage of capacity building and institutional development
12. Inadequate stakeholder participation and gender issues in water management
13. Shortage of available funds for water development and conservation projects
14. Rejection of changing the unfavorable social habits and attitudes towards water uses due to poor public awareness programs

- flooding: due to increased or changed rainfall patterns, coastal flooding due to sea level rise, storm damages due to intensification of cyclones and hurricanes;
- droughts, due to reduced precipitation;
- melting of glaciers, reduced snow pack and diversion of streams;
- a reduction in water quality due to pollution from households, cities, industries and agriculture;
- severe damage to the aquatic ecosystem due to these quantity and quality changes; and finally
- economic conflict among countries, cities, industries and agriculture over shrinking water supplies.

While the aforementioned variables are often presented as problems for the future, they do also need to be assessed under the current global situation of widespread asymmetries in the amount of available water resources across countries, and in regions within them, but also the widespread disparities in the ability of groups to deal with them.

Table 1 presents some of the key factors that cause water–food induced conflicts.

4. Changing behavior as a tool for enhancing food security

People tend to assess the choices before them in terms of costs and benefits, and then select the choice that maximizes their net benefits. Traditional policy tools use sanctions (fines and other penalties), price signals (taxes, financial incentives), regulations and the provision of information to very effectively achieve behavioral change.

While the model of rational choice will and should continue to be the fundamental building block model for policy making, Collin *et al*. (2003) cautioned that 'it has limitations from a behavioral change perspective'. Considerable attention has been given in the literature of cognitive science to models of individual behavior change *per se*, but much less attention has been given to models or theories that attempt to understand behavior change within groups, organizations and whole communities.

The design of programs to reach populations requires an understanding of how those communities work, their barriers and enablers to change, and what influences their behaviors in general.

For this purpose, there is a need for a change in the mental model, i.e. a model of thinking through dialogue that creates new convictions. But what is meant by a mental model? According to Senge (1990), 'a mental model is a discipline that depicts on the mind set behind all decisions or actions. It can represent the real obstacles, in problem solving, especially if these obstacles are structural, ingrained in the mind over a long time. This creates tension, which could be creative in many instances'. Senge explained further that 'the problems with mental models arise when the models are tacit – when they exist below the level of awareness. It is built on-the-fly, from knowledge of prior experience, schema segments, perception, and problem-solving strategies'.

4.1. Reasons for changing behavior

What are the basic reasons for governments wanting to influence or change behavior? The most fundamental reason is that it can confer economic, social and community benefits. Regulations to prevent collusive behavior among businesses, for example, can result in lower prices and greater consumer choice. Some behavior is simply undesirable and needs to be prevented. In some cases, individuals do not always behave in their own or the community's best interests.

There are many examples that encourage governments to use changing behavior as a management tool in the areas of food consumption and public health (e.g. obesity and tobacco use) and in the environmental area (e.g. recycling and water use). In this context, there are three key factors:

(a) Governments cannot solve complex problems alone. It is clear that achieving significant progress requires the active involvement and cooperation of citizens (Australian Public Service Commission, 2009);
(b) Behavior-based interventions can be much more cost-effective (Australian Public Service Commission, 2007) by using limited resources to develop more sophisticated and comprehensive approaches to changing the behavior of users and other parties, than by concentrating on traditional policy tools and service delivery; and
(c) Other benefits can be drawn from enhancing personal responsibility. When citizens display greater restraint and understand the impact their behaviors have on themselves, their family and the environment, it can actively improve the social capital of communities.

4.2. International experiences with changing behavior

In order to achieve behavioral change, particularly as part of tackling complex policy problems, a basic understanding is required of key determinants of behavior. How people behave is determined by many factors and is deeply embedded in social situations, institutional contexts and cultural norms. Here, the following good examples can be highlighted:

- The Australian Public Service Commission (2009) faced the following 'wicked' problems in a public policy context:
  ○ Water resources; as the sustainability of Australia's water resources for agricultural, industrial and domestic use is under serious pressure, the question of how to balance competing interests and ensure the water-using behavior of citizens and organizations is of key importance.

○ Obesity; this is a complex and serious social health problem with multiple factors contributing to its rapid rate of growth over recent decades. How to successfully address obesity is subject to debate but depends significantly on the motivation and behavior of individuals and only modestly on the quality of secondary health care. Even where the issue is not necessarily complex, it is often crucial that people get involved to achieve desired outcomes. This is clear, for example, in areas such as health and employment services.

• The UK Government recently convened a Behavior Change Forum[3] to:
  ○ Exchange experience of behavioral change policies and their implementation;
  ○ Pool research and policy evaluation on behavioral change;
  ○ Disseminate research findings and good practice across government;
  ○ Advise on and promote common policy tools and support for those engaged in behavior-focused policies.
• The Canadian Government has also been actively interested in the area of behavioral change and has produced a set of guidelines known as the 'Tools of Change' to alter public behavior around complex problems in the environmental and health areas[4].
• One of the purposes of such websites is to provide case studies of behavioral change interventions so that the public sector can learn from experiences and assess the efficacy of different measures for different situations.

4.3. How can routines, behavior and habits be changed?

Backhaus & Heiskanen (2009) rated expert advice on how to change energy behavior. They confirmed that changing behavior and habits is 'an action that needs action research methodology', in which researchers and practitioners work together to develop, test and refine tools for improved interaction which is sensitive to context, timing and the needs of different users and stakeholders.

The methods listed below are used for changing behavior in a similar resource-based sector, that of energy. It is our view that these tools can also be used to change behavior on a sustainable basis in water-related food conflicts. The list was drawn up after an EU project in 2009[5], as a result of practical experience and expert advice on how to change energy behavior. The actions advised are, *inter alia*:

1. Assess susceptibility to change: use planning guides;
2. Create awareness of habit when dealing with habitual behavior;
3. Use emotional appeals in order to gain the target group's attention;
4. Use rational arguments to accompany emotional appeal;
5. Build on ongoing change processes;
6. Change the users' environment to be conducive to change;
7. Give feedback through monitoring achievements;
8. Use commitment and goal-setting.

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[3] The UK Behavior Change Forum presents a wide range of information on its website (www.gov.uk/government/task-forces/behaviour-change.htm#Research), with its major focus being on sustainable development.
[4] See www.toolsofchange.com/en/home/ and www.learningforsustainability.net/tools/guides.php.
[5] See http://www.energychange.info

This analysis therefore suggests that there is a need to formulate a comprehensive approach to behavioral change for water–food related conflicts. The need to understand how components interact and work cooperatively across jurisdictions and organizations, and how to engage stakeholders, highlights the need for a range of core skills in addition to the more traditional analytical, conceptual and enhanced management skills (which include communication, the ability to work cooperatively and big-picture thinking skills). There is also a need for policymakers to be aware of and apply behavioral change theory, and to understand the importance of investing in evaluation and research.

5. The way forward: addressing the complex issue of food security

As was highlighted in the previous sections, it is clear that water–food induced conflict is a complex and vulnerable issue, with no certain outcomes or resolution. Although, special emphasis has been given to changing behavior as a tool for mitigating and managing water–food induced conflicts, this complex issue still needs to be assessed within an integrated water resources management (IWRM) approach. However, there is also a need for contingency plans parallel to initial plans, to be able to face the threats of rising poverty and hunger in most of the developing countries.

The complexity of water–food induced conflict has physical (hard) factors and human (soft) factors that are interactive, within a systemic structure. It is therefore advocated that this solution be followed, which corresponds to IWRM. It is our view that if we follow this solution, we would be able to overcome the existing water–food crisis and its increasing state of insecurity, and move forward towards food security in most developing countries.

As a methodology, this holistic view is needed to see the big picture of challenges, vision and the tools needed for intervention. Figure 2 highlights this methodology.
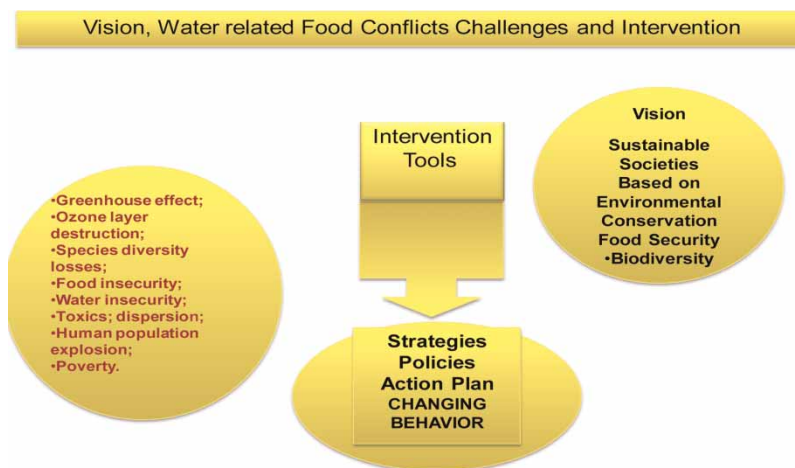

Fig. 2. Vision, water-related food challenges and possible interventions.

5.1. MDGs fell short in their implementation

Reviewing the implementation of the United Nations' MDGs in September 2000, we find that there are 15 countries in Africa where the incidence of hunger exceeds 35% of the population (UN, 2000). Today, in South Asia, 46% of young children are underweight and, in India, less food is available to rural households than in the 1950s. These issues affect Sub-Saharan Africa and South Asia more than any other regions.

One third of all child mortality is attributed to malnutrition. The second MDG indicator is therefore the proportion of children under five years who are under weight in relation to their age. In developing countries, this figure has only reduced from 31 to 26% in the period 1990–2008, far short of the 2015 target of just over a 10% reduction. Development agencies point out that the MDG benchmarks for hunger place too much emphasis on the quantity rather than the quality of food. The absence of vital protein and micro-nutrients such as iron and iodine impairs the ability to learn and reduces resistance to disease, especially in young children. The actual funding required to achieve the hunger-related MDG by 2015 has been estimated by development agencies at up to $40,000 million per annum. By comparison, western governments raised $2,000,500 million to rescue their ruined banks, according to the IMF.

5.2. The 2009 G8 summit

The 2009 G8 summit in L'Aquila, Italy, unveiled the Agriculture and Food Security Initiative. The promise of $20,000 million spread over three years aims to support national action plans on hunger within a coherent global strategy for food security. For their part, African governments have committed to the Comprehensive Africa Agriculture Development Programme which aims to achieve growth of 6% per annum in the sector, through increasing investment.

Driven by the challenges and consistent with the worldwide movement towards IWRM, several countries have embarked on reforming their water sector (e.g., Tunisia, Jordan, Yemen and Egypt) and some others have made a good start. Many countries, in partnership with donors and financial institutions, are taking steps in water sector reforms. A shift in thinking and action in water management is slowly taking place in the Arab region.

5.3. The right to food is recognized as a human right

The right to food as a human right increasingly figures on the agenda of the international community. There is a Special Rapporteur for the Right to Food at the United Nations Commission for Human Rights, and his first report on the global food crisis was submitted in September 2008 (OHCHR, 2008). The report was submitted in accordance with the Human Rights Council Resolution 9/6 on the follow-up to the Seventh Special Session of the Council on 'the negative impact of the worsening of the world food crisis on the realization of the right to food for all' adopted by the Council at its ninth session. In the report, the Special Rapporteur summarizes the efforts that have been made by governments and international agencies to build resilience against the risk of future food crises.

5.4. IWRM is central to water–food conflict resolution

IWRM is an excellent approach to resolve such conflicts and end polarization, and find better solutions to complex situations. This is because IWRM is based on balancing all interests and securing equitable distribution of benefits from the improved management of water. To put conflict management tools and techniques into practice, the IWRM concept could guide the way we think. It can reflect the complexity of water–food induced conflict, triggered through hydrological cycle limitations, the competing demands of the water sectors in relation to supply, as well as illustrating the mismanagement of the resource. And certain instruments and approaches inherent to IWRM, such as stakeholder participation and conflict management tools, will allow competing claims to be moderated through well-informed processes.

5.4.1. The need for stakeholder participation.   This requires that stakeholders at all levels of the social structure have an impact on decisions of water–food management. Participation is about taking responsibility, recognizing the effect of sectoral actions on other water users and aquatic ecosystems and accepting the need for change to improve the efficiency of water use and recognize other water users' rights. Therefore, participation is an instrument that can be used to pursue an appropriate balance and achieve long-lasting consensus and common agreement between different users of water.

5.4.2. Applying the principles of water ethics.   Established ethical frameworks are also necessary to address issues such as food insecurity due to the allocation of limited water resources, and its relationship to efficiency, productivity, valuation, as well as to equity and social justice. Access to freshwater and food have increasingly been identified as a major potential threat to world peace in this century. The ethical issues related to water mirror broader debates on social ethics and relate to a number of ethical principles.

A COMEST[6] Sub-commission on water resolved that rather than once more analyze the ethical issues of water management, it should promote best ethical practices. Some fundamental principles were identified as essential components: human dignity, participation, solidarity, human equality, common good, stewardship, transparency and universal access to information, inclusiveness for water management policies, empowerment which is required to facilitate participation in planning and management, best ethical practices, and partnerships focus at the local level. Brelet (2004) highlighted examples of best ethical practice in water use from Africa, Asia and Latin America.

5.5. Virtual water and the water footprint

Producing goods and services generally requires water (Allan, 1999). The water used in the production process of an agricultural or industrial product is called the 'virtual water' used in the product. For example, in order to produce 1 kg of grain, we need 1–2 m^3 of water. Producing 1 kg

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[6] The World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) was established by UNESCO in 1998 with a duty to adopt ethical principles for all practices related to scientific research, and as such it seeks to motivate and advise scientists to include ethics within their intellectual endeavors.

of cheese requires 5 m^3 of water, and for 1 kg of beef we need an average of 16 m^3 of water. The virtual water concept is claimed to have basically two major areas of practical use:

- Virtual water trade can be used as an instrument to achieve water and food security, as well as efficient water use;
- It can used to make the link between consumption patterns and impacts on water (the 'water footprint' concept).

If one country exports a water-intensive product, it exports water in virtual form. Trade of real water between water-rich and water-poor regions is generally impossible, but trade in water-intensive products (virtual water trade) is realistic. If the importing country is already facing water scarcity, this represents real water savings and less pressure on its water resources. If the water-exporting country has abundant resources, the entire flow becomes an efficient instrument in improving global water use efficiency.

The second practical use of the virtual water concept lies in the fact that the virtual water content of a product tells something about the environmental impact of consuming that product. Knowing the virtual water content of products creates awareness of the water volumes needed to produce various goods, thus providing an idea of which goods impact most on the water system and where water savings could be achieved. Hoekstra & Hung (2002) introduced the concept of the water footprint, being the cumulative virtual water content of all goods and services consumed by one individual or by the individuals of one country. The water footprint can be a strong tool to show people their impact on natural resources and is, quite simply, the volume of water used. The water footprint of a nation is equal to the domestic water resources used, minus virtual water export flows, plus any virtual water import flow.

6. Concluding remarks

The above analysis suggests that changing behavior has proven to be a complex issue, and that influencing human behavior is very difficult. The effectiveness of ongoing traditional approaches may be limited without the addition of measures to understand how to engage citizens in cooperative behavioral change. This is where the tools for changing behavior are needed and are important, as highlighted in this paper.

The measures of intervention taken so far by the international community have not been effective in addressing the question of enhancing food security. The implementation of the United Nations MDGs fell short of fulfilling their goals. The fulfillment of the Group of Eight commitments made in 2009 under their 'Food Security Initiative' need to be reviewed in the forthcoming Ninth Summit (in 2012).

However, there is a need to apply the concept of IWRM in water resources management, as it could guide the way we think. This would enhance the process of stakeholder participation and implement conflict management tools, as well as allowing competing claims to be moderated through well-informed processes. In addition, applying the principles of water ethics, within this context, would make it possible to create innovative strategies that create good leverage for averting a wider global water–food crisis.

There is already experience at the government level, and at the level of communities and organizations. The best of this experience could be taken as best practice or used as success stories, which need to be benchmarked and learned from, and then become the center of attention for change and development of the water–food sector in all countries and regions.

As the foregoing analysis suggests, it is becoming an absolute necessity to apply behavioral change as part and parcel of the soft path approach and as a tool for realizing sustainability in water and food management. Using an action research methodology is pertinent in changing behavior as a tool for water–food management. This is dependent on a process of rethinking and examining, critically, the questions that matter: What do we do to identify water–food conflicts? Why do we do what we do? How do we do it properly?

And the next step? On this basis, it will be possible to reassess the water–food crisis and conflict, and creatively change behavior as an effective policy tool for enhancement of food security.

The advent of the forthcoming 2012 World Water Forum in Marseille will create a momentum to propagate the need for a water–food strategy, in which an 'ethical framework' could be suggested. As a follow up to such an important issue, and in view of the exchange of ideas and discussions, it is proposed here that a working group be established within the 'Botín Water Observatory' which could design such a strategy and its directions. In the meantime, the Arab Water Council and the Arab Network for Water Ethics (ANWE) could be part of this process on behalf of the Arab region.

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