

Committee on World Food Security

High Level Panel of Experts on Food Security and Nutrition

Water and food security V0 DRAFT

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Submitted by the HLPE
to open electronic consultation

This V0 draft has been produced by the HLPE Project Team under guidance and oversight of the HLPE Steering Committee.

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This V0 draft is submitted for open e-consultation on our dedicated platform <http://www.fao.org/fsnforum/cfs-hlpe/water-food-security-V0> as part of the HLPE report elaboration process, for public feedback and comments.

Please read the cover letter to this electronic consultation, page 2.

Comments can be sent by e-mail to: cfs-hlpe@fao.org or to fsn-moderator@fao.org.

This consultation will be used by the HLPE to further elaborate the report, which will then be submitted to peer review, before its finalization and approval by the HLPE Steering Committee.

The final report is expected to be ready for publication in end April / early May 2015.

This V0 draft may be thoroughly corrected, modified, expanded and revised after the present consultation.

For this reason we invite you not cite or quote elements from this V0.

Please only refer to the final publication for quotations.

COVER Letter from the HLPE to this V0 Consultation

HLPE consultation on the V0 draft of the Report:

Water and Food Security

In October 2013, the Committee on World Food Security requested the High Level Panel of Experts on Food Security and Nutrition (HLPE) to prepare a report on Water and Food Security. Final findings of the study will feed into CFS 42nd session in October 2015.

As part of the process of elaboration of its reports, the HLPE now seeks inputs, suggestions, comments on the present V0 draft. This e-consultation will be used by the HLPE to further elaborate the report, which will then be submitted to external expert review, before finalization and approval by the HLPE Steering Committee.

HLPE V0 drafts are deliberately presented at a work-in-progress stage – with their range of imperfections – early enough in the process, when sufficient time remains to give proper consideration to the feedback received so that it can be really useful and play a real role in the elaboration of the report. It is a key part of the scientific dialogue between the HLPE Project Team and Steering Committee and the rest of the knowledge community. In that respect, the present draft identifies areas for recommendations at a very initial stage, and the HLPE would welcome any related evidence-based suggestions or proposals. We would also appreciate if this draft is not cited or quoted until it is finalized.

In order to strengthen the related parts of the report, the HLPE would welcome comments and inputs on the following important aspects:

1. The scope of the topic of water and food security is very broad. Do you think that the V0 draft has adequately charted the diversity of the linkages between water and food security and nutrition? Is there important evidence or aspects that the present draft has failed to cover?
2. Has the report adequately covered the diversity of approaches and methodological issues, in particular concerning metrics and data for water and food security? Which metrics do you find particularly useful and which not?
3. Food security involves trade of agricultural produce, and a virtual trade of water. Agricultural trade interacts with water and food security in various ways, and differently for food importing countries, food exporting countries, water scarce versus water rich countries. Do you think the V0 draft has appropriately covered the matter?
4. In this report, we considered the potential for an expansion of the right to water to also encompass productive uses. What kind of practical and policy challenges would this bring?
5. Which systemic actions/solutions/approaches would be the most effective to enhance water governance, management and use for food security?

DRAFT V0 – DO NOT CITE OR QUOTE

We are aware that we have not yet adequately covered, in the V0 draft, some issues of importance.

We invite respondents to suggest relevant examples, including successful ones and what made them possible, good practices and lessons learned, case studies, data and material in the areas of:

- a. Comparative water performance (productivity and resilience) for food security and nutrition of different farming systems, and food systems, in different contexts
- b. Water use in food processing
- c. Water for food and nutrition security in urban and peri-urban contexts
- d. Water governance, policies and management systems capable of better integrating food security concerns while tackling trade-offs between water uses/users in an equitable, gender just and deliberative manner. We are particularly interested in examples that have enhanced social justice and also benefitted marginalised groups.
- e. We welcome also examples on how the role of water for food security and nutrition is accounted for in land governance and management and land-use, including links between land tenure and water rights.

We thank all the contributors in advance for their time to read, comment and suggest inputs on this early version of the report.

We look forward to a rich and fruitful consultation.

The HLPE Project Team and Steering Committee

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1 INTRODUCTION

2 Water is essential for all forms of life. Water is what brings life to many ecosystems, such as forests,
3 lakes or wetlands, and is fundamental for many economic sectors, including energy, manufacturing as
4 well as cultural and aesthetic uses.

5 Meanwhile, water is a fundamental to human food security and nutrition (FSN).¹ Water of sufficient
6 quantity and quality is an essential input to all types of agricultural production, as well as the
7 preparation and processing of food (CA, 2007; FAO, 2012; Rosegrant and Cline, 2002). Safe drinking
8 water and sanitation are likewise fundamental to the nutrition, health and dignity of all (UNDP, 2006).

9 Yet water is a resource under increasing stresses, which undermine its contributions to FSN:
10 population growth, changing lifestyles - including changing food consumption patterns towards more
11 livestock products- and increasing demands from a range of economic sectors including agriculture,
12 energy generation, mining, and manufacturing are increasing competition for limited freshwater
13 resources; increasing pollution in many parts of the world from both agriculture and industry are
14 rendering water unfit for use and impacting on human and ecosystem health; unsustainable resource
15 management is reducing terrestrial and aquatic ecosystem functions and services of land, fisheries,
forests and wetlands,
16 including their ability to provide food and nutrition to rural and urban poor communities in particular.

17 Inadequate or lack of access to safe drinking water and adequate sanitation facilities and hygiene
18 practices is reducing the nutritional status of people through water-borne diseases and chronic
19 intestinal infections.

20 In general, these core problems, which can be exacerbated by climate change, tend to
21 disproportionately affect poor and marginalised women, men, and children across the globe due to
22 existing power imbalances and unequal gender relations. Failure to effectively and efficiently allocate
23 and utilize available water resources, especially in regions marked by water scarcity, can further
24 undermine the ability of communities to meet their basic nutritional food needs. How access and use
25 of water takes shape in specific national and local settings depends on the particular social, political
26 and cultural context of water management, as well as the particular governance dimensions of water
27 availability and access. While some groups face structural discrimination and exclusion, climate
28 change is making the task of solving these problems even more urgent.

29 How to solve these problems is not obvious, partly due to the nature of water itself. Water availability is
30 highly variable across time and space (Mehta, 2014). Its availability is characterised by the complex
31 interactions of a number of elements which include rainfall, temperature, wind, runoff,
32 evapotranspiration, storage, distribution systems and water quality. Freshwater is a limited resource,
33 and creating additional water supplies through, for example, increased storage or desalination, has
34 limited opportunities. It is thus necessary to manage within the natural limitations of available
35 freshwater. The earth's land surface receives about 110,000 km³ of rainfall annually. More than half of
36 this water is evapotranspired (transmitted from soils and through plants to the air); about 20,000 km³
37 falls on land that is cultivated in some form; and about 40,000 km³ becomes available in dams, lakes,
38 rivers, streams and aquifers for human and environmental uses (UN WWAP, 2012; CA, 2007;
39 Rosegrant, 1997).

40 While accessible water resources are adequate at global levels to meet the water needs of the world,
41 (about 40,000 km³), these resources are unevenly distributed across the globe with per capita
42 resources particularly low in the Middle Eastern, North African and Southern Asian regions. Within
43 regions and countries there are significant variations in water availability. Availability also varies
44 considerably over time, with significant intra- and inter-annual water variations, concentrated in poorer
45 regions (Grey and Sadoff, 2007). Inequality within and between countries, communities and
46 households means that many people continue to have inadequate access to water embedded in food,
47 as reflected in unacceptably high under-nutrition rates (see, for example, FAO 2013a), as well as

¹ The World Food Summit in 1996 adopted the following as a definition of food security: "Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (FAO, 1996). This definition is based on four dimensions of food security: Food availability: the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports. Food access: access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Utilization: utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. Stability: to be food secure, a population, household or individual must have access to adequate food at all times.

1 limited or no access to clean drinking water and sanitation with significant adverse food and nutrition
2 outcomes. In parts of the globe, historical rainfall patterns are changing, adding significant uncertainty
3 to the availability of water in many regions in the future.

4 Meanwhile, the human population is expected to grow to 9.6 billion people by 2050, with the result that
5 per capita water availability will continue to decline into the future (Table 1), particularly in developing
6 countries where population growth will be concentrated. Per capita water availability is also declining
7 due to growing water pollution, which makes water unusable for many human purposes (Palaniappan
8 et al., 2010), and variability of supply is growing to different degrees as a result of climate change
9 (Bates et al., 2008). While future water demand estimates vary, there is agreement that domestic,
10 municipal and industrial demands are growing faster than irrigation demands; that municipal and
11 domestic demand increases are closely aligned with urbanization trends; that there is particularly high
12 uncertainty regarding industrial water demand trends; and that irrigation demands will continue to
13 account for the largest share of total water demands. Taken together, these various trends point to a
14 serious dilemma of dramatically increasing, competing demands on what is after all a limited natural
15 resource, and one which is crucial to all life and particularly the food security and nutrition of all
16 humanity.

17 Growing water scarcity and variability will increase the competition for water resources across sectors,
18 with water often being taken away from the agricultural sector to drive greater economic value per unit
19 of water in other sectors. Increasing competition also often results in smaller, and poorer, water users
20 losing their access to water. Conflicts are likely to grow between urban and rural users, upstream and
21 downstream users, between in-stream (aquatic resources) and off-stream (mostly human) users (CA,
22 2007) and between countries dependent on shared or transboundary water resources. All this makes
23 arriving at good decisions – and therefore good decision *making* – with regard to water an urgent
24 imperative.

25 The underlying issue is: who should get what access to which water when, for how long and for what
26 purposes? Answering this question is complicated and often controversial enough within a single
27 country. Yet this is clearly not enough. While it is often observed that “water flows to power”, it is also
28 clear that, because of the existence of transboundary basins, water is a resource that “ignores”
29 administrative boundaries (be in infra or supra national), thus complicating the challenge of sharing
30 water and of water governance.

31 Many processes, from local to global scales, are relevant to water issues such as for example trade in
32 food and other commodities; global climate policy; global energy policies; financial policies,
33 development policies and related international processes, such as on investment, (World Commission
34 on Dams) or on sustainable development (Rio+20 and the Sustainable Development Goals), and
35 importantly, on environment (Convention on Wetlands of International Importance (Ramsar), the
36 United Nations Convention to Combat Desertification, and the Convention on Biological Diversity..

37 The Committee on World Food Security in its 40th session requested the High Level Panel of Experts
38 on Food Security and Nutrition (HLPE) to prepare a report on Water and Food Security for its 42nd
39 session in 2015, noting that “*Water has an important role in food security through its multiple impacts
40 on: health and nutrition (drinking water, cooking water, sanitary aspect/diseases), on agricultural
41 production (access to water, water management, improvement of irrigation and dryland agriculture)
42 and on food processing (water management, quality of water...).* This topic should be seen in the
43 wider context of the nexus between water, soil, energy and food security which is recognized as a
44 pillar of inclusive growth and sustainable development.”

45 In a business as usual scenario, population growth and shifts towards increased use of animal based
46 protein in affluent communities across the world will require world food and feed production to increase
47 by 60% between 2005 and 2050 (FAO, 2012). Without improvements in agricultural water productivity
48 the world will need to increase significantly water withdrawals affecting other development sectors. In
49 his seminal study of starvation and famines, Amartya Sen argued that the fixation with the per capita
50 food availability decline (FAD) is a misleading way to look at hunger and famine, since hunger is more
51 about people not having access to food due to wider social and political arrangements as opposed to
52 there not being enough food to eat (Sen, 1981 and 1983). Looking at per capita availability of a
53 resource lacks relevant discrimination and is even more gross when applied to the population of the
54 world as a whole (Sen, 1981). Water scarcity is also often misleadingly perceived as per capita water
55 availability rather than inequality in access to water supply. But usually, water access is determined by
56 social and political institutions, cultural and gender norms and property rights. Some groups may suffer
57 from lack of water even when there is more than sufficient water available in a region. Thus, water

1 shortages (and famines) are best understood as entitlement failures requiring effective and democratic
2 governance solutions that can be accepted as legitimate by all (Anand, 2007; Mehta, 2014).

3 In light of the aforementioned problem statement, this report aims to (i) better understand the multiple
4 linkages and interdependencies related to water (and therefore underpinning water governance), how
5 they are governed and the resulting implications for FSN; and (ii) to propose ways which, by acting on
6 them at different levels, can lead to improved FSN, now and in the future. In the light of growing water
7 shortages and variability as well as competing claims over the resource, the governance of water
8 management for FSN is critical. We will examine the framing of water-FSN discourse, the interactions
9 (from local, to national and global) among different institutions, actors and structures that determine
10 how and by whom power is exercised, and where decisions are taken on water for FSN. Rights,
11 relationships, responsibility, and accountability are key issues along with the set of rules, as well as
12 cultural or social norms that regulate access, use and control over water. This also means critically
13 engaging with the right to water and the right to food and examining their relationship and asking
14 whether some expansion in definitions is required. Finally, the entire report takes into account
15 inherent uncertainties around accessing water for FSN – namely climate change, rapid economic
16 changes and consumption patterns, land deals and their water-related consequences as well as
17 competing demands on water.

18 The water domain has been traditionally divided into two sectors: water supply / services and water
19 resources management, or as the 2006 Human Development Report puts it, 'water for life' and 'water
20 for production' (UNDP 2006). Water for life refers to water for drinking and domestic purposes and is
21 considered key for human survival. Water for production refers to water in irrigation, industry and
22 small-scale entrepreneurial activities as well as using water to produce food for subsistence. This
23 distinction, however, is highly problematic from the perspective of local users whose daily activities
24 encompass both the domestic and productive elements of water and for whom there is little sense in
25 separating water for drinking and washing and water for small-scale productive activities so crucial for
26 survival. This distinction is particularly limiting when advancing water for FSN and also gives rise to
27 some limitations in the conceptualization of the right to water in relation to the right to food. Added to
28 this complication is sanitation which was only added to the MDG discussion in 2002. Even though
29 sanitation and water issues are highly interlinked, they have different logics, politics and disciplinary
30 underpinnings and usually when water and sanitation are mentioned in the same breath, sanitation
31 issues are often ignored. Traditionally, wastewater and issues concerning water quality were also
32 treated separately and not in an integrated manner. Similarly, land and water governance tend to be
33 treated separately in policy discourses both at the national and global levels.

34 In water, data is very often a challenge for action. Data definition, quality and transparency, precision
35 at lower geographical scales, disaggregation by users, and gaps are the biggest issues. First, water
36 management focuses on hydrologic entities such as a basin or watershed², which are therefore often
37 used to report on water data, but these are different from administrative units or country boundaries.
38 Second, lack of transparency, especially concerning transboundary water resources can impede co-
39 operation. Third, there are currently few, reliable statistics at lower geographical scales. Much of the
40 available data are either modelled or estimated for hydrological units or national levels, and then
41 disaggregated using algorithms or statistical tools. Global figures are not sufficient to have an
42 adequate picture of issues at lower scales. Fourth, there is also a lack of disaggregation by categories
43 of users, or gender, and their entitlements. There has been little comparable international data on
44 gender indicators and most of the agencies lack proper sex-disaggregated data, making it impossible
45 to monitor progress or devise gender sensitive policies.³ Fifth, there are major data gaps, especially to
46 cover other aspects than volumetric ones, for example social aspects, which are especially needed at
47 lower scales; in the coverage of small-scale irrigation; understanding of groundwater use; coverage of
48 some key demand sectors or domains such as peri-urban or slums areas.

49 All of this is all the more a challenge for action as water management, and the related tools, often
50 require an extensive knowledge base, which can be quite challenging in data-poor environments. Use
51 of inappropriate data (such as data at inappropriate scale) can lead to policy debates at the
52 international and national levels to be at odds with the perceptions, knowledge and experiences of

² This refers to the area of land where surface water from rain and melting snow or ice converges to a single point at a lower elevation, usually the exit of the basin, where the waters join another water body or flow into the ocean.

³ There have recently been some improvements, however. The WHO/UNICEF Joint Monitoring Programme post-2015 consultation has emphasized issues of Equity, Equality and Non-Discrimination (END) which can overcome some of the issues outlined above. For instance, it has been proposed that intra-household inequality should be addressed through disaggregating data by age, gender, health, disability, etc.

- 1 local water and food users (Mehta and Movik, 2014). This report utilizes data and analysis from the big
- 2 existing databases, and when data is not available, we use qualitative analysis.
- 3 A short report of this nature cannot be exhaustive on this matter. It does, however, serve to synthesize
- 4 existing research findings and highlight key concerns and opportunities to assist national and
- 5 international policy makers to adopt effective policies and strategies to address the challenges of
- 6 water in relation to food security and nutrition in a less fragmented way than is the case now.

In this report, two fundamental lenses are used to examine the issue of water and FSN. The first is the human rights framework, particularly the rights to food and water, and how these two rights intersect and support each other.

In particular, we are interested in exploring whether the right to water can be expanded to encompass uses of water that are directed towards the realization of the right to food.

The second is a lens that looks at the possibility of reframing the challenge in order to reframe the solution – looking at issues of redistribution and equity, reduction of waste, and changes in agricultural and dietary practices in order to ensure water for FSN.

The report is organised as follows: Chapter 1 highlights the multiple linkages between water and FSN and provides an overview of global and regional trends around the different aspects of water and looks at emerging challenges such as water quality, land acquisitions and grabs, and climate change, that are critically affecting water for FSN now and in the future. It also examines a range of competing narratives, discourses and metrics to understand water for FSN. Chapter 2 spells out how agricultural production and water use in food processing and production are affected by a range of uncertainties and how different alternative pathways need to be explored to reduce risk and improve food security. Chapter 3 turns to look at the different regimes and processes affecting water allocation, access and use from local to global. Water is a contested resource and these politics are unpacked before looking in detail at the relationship between the right to water and the right to food and an exploration of a possible expansion of the right to water. Chapter 4 spells out specific recommendations for policy and practice.

1 WATER FOR FOOD SECURITY AND NUTRITION: 2 CHALLENGES FROM GLOBAL TO LOCAL

3 Water and food security and nutrition are linked in numerous ways, from food production and
4 transformation to consumption and absorption. In fact, FSN is very dependent on water resources, on
5 their availability, accessibility, quality and stability. These resources are submitted to increasing and
6 competing demands, from agriculture and other economic sectors. Availability and demand determine
7 water scarcities, which are very different around the globe and with different impacts according to
8 economic and social situations.

9 1.1 Water, key to Food Security and Nutrition

10 1.1.1 Charting the multiple linkages

11 Water is central to food security and nutrition: it is a key factor for the production of food, including
12 processed foods; it is key for food preparation; and it contributes to nutrition directly through potable
13 water, and indirectly through water for hygiene and sanitation (WASH), which is a factor of health and
14 as such has a direct impact on nutrition.

15 **Figure 1 The multiple interfaces between water and food security and nutrition (FSN)**

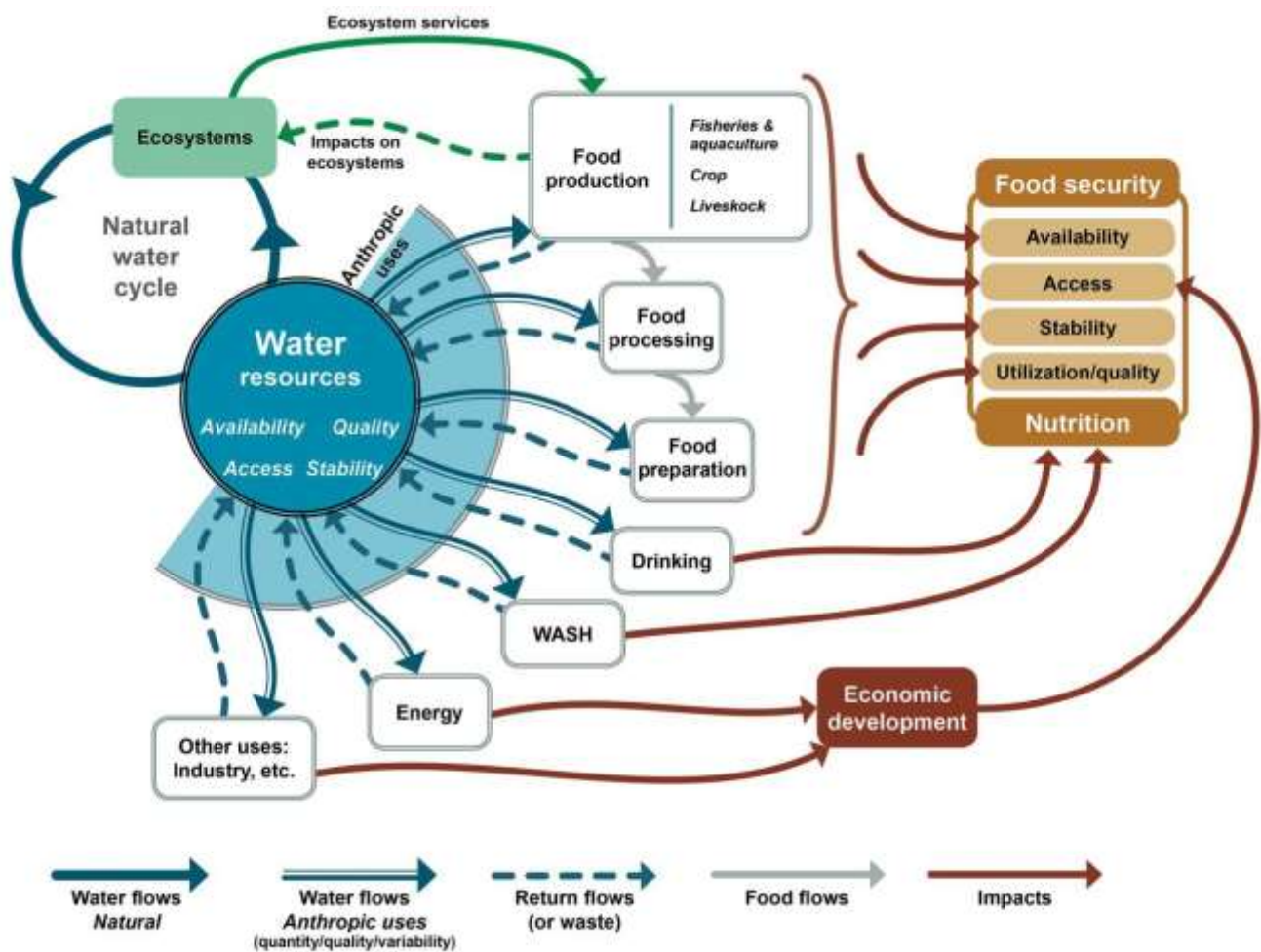


Figure 1 depicts the multiple interfaces between water and food security and nutrition. On the left hand side of the figure, four dimensions of water, considered as a resource for anthropic uses, are highlighted:

1. Availability, in terms of its natural physical availability through rainfall, rivers, aquifers etc. in a particular region.
2. Access: while there may be sufficient water in rivers, lakes and aquifers, issues pertaining to allocation and authorisation to use water, and the infrastructure necessary to use the water where it is required (pumps, pipelines, taps, canals, etc.) may support access to water for food security and nutrition, or hinder it.
3. Quality, water quality in terms of food security and nutrition has different implications according to uses for irrigation, with differences according to crops, for food processing, food preparation, drinking, and also for health and hygiene; On the other hand food production and processing itself has an impact on water quality (pollution).
4. Stability: availability, access and quality of water are variable through time. This results from natural cycles, but also from human interferences and perturbations of the water cycle, through return flows and ecosystem degradation. Different water resources may behave very differently in terms of stability. Reversely, stability the water resource is often determinant for the uses.

These dimensions of water resources in fact mirror those from the definition of food security.

Without sufficient water of an appropriate quality along the food value chain, the food and nutrition security of people is compromised. As always, it hits the poorest of the poor hardest.

Linkages between water and food and nutrition security can be described at multiple levels, including at individual and household level. They are influenced by multiple competitions, by local, regional and global policies and investments, including trade policies, investments in agricultural research and development, sanitation, and other drivers such as climate change and energy costs. All these linkages and processes occur under growing uncertainty.

As the blue arrows representing anthropic water uses indicate, water is necessary for food production (fisheries, crops and livestock), food processing and food preparation. The vast bulk of the water is required for production, with relatively small amounts of water required for food processing and preparation. Uses of water for agriculture, drinking or WASH (domestic water supply, sanitation and hygiene) altogether compete with other uses of water, especially for industry and energy.

Water needed for drinking and for WASH is minimal in quantity in the overall volume of water used globally, but issues of access and quality are paramount.

It has been recently argued that the preponderant concern in the “WASH” use of water has been with ensuring health outcomes, diarrhoea in particular, which is a key challenge for nutrition (see below). However this approach should not lead to ignore other benefits of WASH for food security (Loevinsohn *et al.*, 2014). For example, improved water supply is often used by women to irrigate kitchen gardens or for other productive purposes to enhance livelihoods and food security (Nicol, 2000; van Koppen *et al.*, 2009) and this also leads to improved child nutrition.

Water may be considered a public good and, in many countries, a basic right but poor people are often denied access because water is overpriced. Also women often have minimal control over household finances or spending. Power relations within the household mean that they sometimes cannot make their own decisions about whether to buy water which may force them into a daily trudge (taking precious time) for cheaper or free untreated water, which is likely to result in health problems or increased poverty and destitution. Gender and other markers of identities also continue to mold water allocation and access among users (Mehta, 2013).

Easy access to safe and convenient water supplies is crucial to enhance women's and girls' well-being. Cultural norms in much of the developing world dictate that women and girls are responsible for water collection and they can spend up to 3 hours per day collecting water. This time could instead be used to focus on livelihood and agricultural activities, attending school and to improve maternal and infant health (Mehta, 2014; WHO/UNICEF Joint Monitoring Programme, 2012). Lack of appropriate sanitation facilities at schools also reduces girl child attendance at school during menstruation, adversely impacting on their education.

Finally, water is key to ecosystem integrity, which in turn is central to the food security of smallholder producers who engage in all three types of small scale food production systems—fresh water, brackish water and saltwater fisheries, subsistence crop production and livestock production/ pastoralism). In sum, water is necessary for all the ‘activities, processes and outcomes’ (cf. Ericksen *et al.*, 2010) related to the food system⁴ and the framework indicates multiple entry points for considering water and water use.

1.1.2 Water quality and food security and nutrition

The question of water quality can be differentiated according to uses. For food processing and food preparation, as well as for drinking, water quality is of crucial importance. Lack of access to safe and clean water for drinking and hygiene has been identified long ago as a key underlying cause of malnutrition, particularly in children (UNICEF, 1990). A safe and reliable water supply, sanitation and hygiene practices (WASH) are basic necessities, required to ensure human development and to allow human activity to flourish (Mehta, 2014). Drinking water also provides important micronutrients, particularly for fluoride, calcium and magnesium, with risks of undesirable or excess elements, such as fluoride or arsenic in certain regions (Olivares and Uauy, 2005; Wenhold and Faber, 2009). Bad quality water is a major cause of diarrhoea, which itself prevents absorption of nutrients (Box 1). Several water-related diseases directly lead to food and nutrition insecurity: waterborne diseases such as cholera, water-washed (or faecal-oral) diseases such as environmental enteropathy, water-based diseases such as schistosomiasis and water-related, vector-borne diseases such as malaria.

Box 1 Diarrhoea: a major cause of malnutrition

Diarrhoea, the second leading cause of child death around the world and the leading cause in sub-Saharan Africa, exacerbated by lack of safe drinking water and adequate sanitation facilities and hygiene practices, is both a cause and a result of inadequate nutrition. According to the WHO (2010) food and water-borne diarrhoeal diseases kill an estimated 2.2 million people annually, most of whom are children in developing countries. Repeated bouts of diarrhoea prevent children from achieving normal physical and cognitive development, while poor nutrition weakens the immune system, leading to more frequent bouts of diarrhoea. The result is a negatively reinforcing cycle. In addition, infection impacts negatively on nutritional status by reducing appetite and intestinal absorption of nutrients particularly as a result of environmental enteropathy which is a result of chronic childhood exposure to faecal microbes as a result of inadequate sanitation and hygiene. It is estimated that the provision of safe drinking water, adequate sanitation and hygiene education could prevent at least 860,000 child deaths per annum (Prüss-Üstün *et al.*, 2008) suggesting that interventions on the water supply/sanitation side are important nutrition interventions.

Water quality also matters for agriculture: for example, some crops, such as barley and sugar beet are relatively tolerant to high salt levels, while most fruit and nut trees and several vegetables, such as beans and carrots are highly sensitive to salinity levels (Ayers and Westcot, 1985). The use of treated wastewater for crop production is common in both developed and developing countries, but generally regulated in the former regarding the quality of the wastewater and the type of crops that can be watered, to address health concerns (Ayers and Westcot, 1985). Regulation of irrigation with waste water is, however, weak in most developing countries with potential negative impacts on human health. Jawahar and Ringler (2009) caution that while dietary diversification has improved nutritional and health status in developing countries, it has also added a new range of food safety risks along the value chain, principally caused by poor water management and quality, which affects particularly the consumption of fresh fruits, vegetables, dairy and other animal products.

⁴ The HLPE (2014a) defines the food system as follows: ‘A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes’ (HLPE 2014a: 29). The complexity of food security requires a complex framework that encompasses social, political, economic, and ecological issues and must also include the ‘activities, processes and outcomes’ related to food (Ericksen, *et al.* 2010:27).

Box 2 Is stunting linked with poor sanitation?

Effects of inadequate nutrition in the first 1000 days of a child's life (including gestation) are irreversible (Victoria, *et al.* 2008) and include lower 'educational, income and productively outcomes' (UNICEF 2013a: 5). Height, which is often used as a proxy for child nutritional status, has also been shown to link with both cognitive ability and adult learning levels (Case and Paxton 2006).

Sanitation's causal links with stunting have been demonstrated in both epidemiological literature and in econometric studies of sanitation in India (Spears, 2013). Despite higher levels of wealth, Indian children are shorter than their counterparts in African countries. Spears (2013) demonstrates that poor sanitation goes a long way to account for this difference, with sanitation levels predicting height even when controlling for GDP. He additionally finds that population density interacts with rates of open defecation, multiplying the effects of poor sanitation. This interaction may explain why even Indian children from wealthy households are shorter than international height standards (*ibid*). Despite the link between sanitation and health, particularly stunting, sanitation and faecally transmitted infections have been a blindspot for under-nutrition studies (Chambers and von Medeazza 2013), although recent reviews have drawn attention to water, sanitation and hygiene (WASH) interventions' small but positive impacts on growth for children under five (Dangour, *et al.*, 2013).

On the other hand food production and processing as well as human waste (such as urine and faeces) impact water quality. Nitrogen and phosphorus are key water pollutants stemming from agricultural production. Both livestock and aquaculture production, when done on industrial scale, are associated with significant wastewater discharge along their value chains with potential adverse impacts on human and animal health and the environment (Delgado *et al.*, 1999; Naylor *et al.*, 2000). Appropriate reuse of wastewater, however, can reduce the cost of fertilizer applications, particularly phosphorus and nitrogen (Drechsel *et al.*, 2010).

1.2 Water resources

When we look at agriculture and food security, all forms of availability of water have to be considered: rainfall, runoff and groundwater. Water basins are the pertinent geographic entity to appraise/measure water resources (rainfall, runoff or ground water).

Water is unevenly distributed, in terms of rainfall, runoff, and groundwater. When the resource in terms of rainfall is insufficient for rainfed agriculture, agriculture needs to rely on irrigation. Irrigation is a mean to compensate for scarcity or irregularity of water availability.

There are resources of water of different qualities. This condition their potential uses. And in turn, the quality of the resource is often influenced by uses, such as excessive consumption, return flows of degraded quality (microbial and chemical pollution, temperature, etc.).

1.2.1 Impact of climatic variability and climate change on water resources

Climate change will impact precipitations, runoff, and groundwater tables. It will also impact sea level. All these effects will impact water resources for food production, as well as resources for human use.

Many regions of the world are subject to high levels of inter-annual climate variability with concomitant floods and droughts. In some regions, droughts, or periods of below average rainfall, may extend over several years. There is some evidence that droughts have become more intense in recent decades (UNU-IDHP 2014).

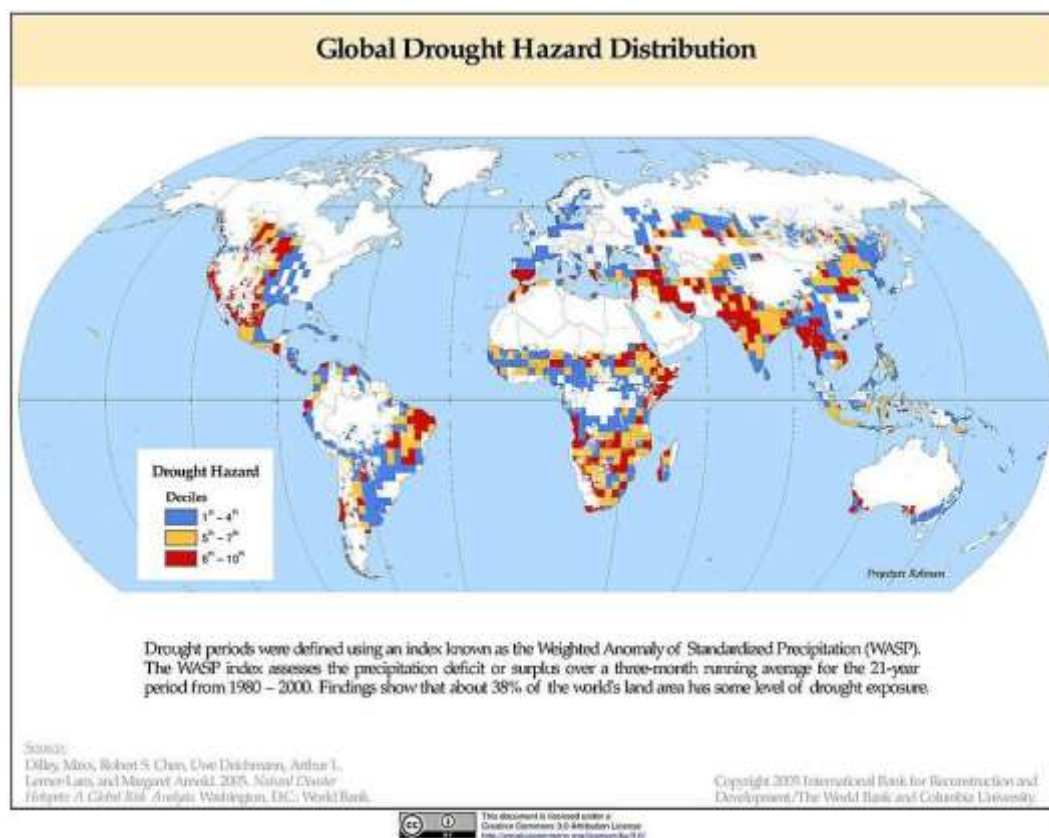
The resulting uncertainty for agricultural production impacts on the willingness of a range of agricultural stakeholders to invest in "potentially more sustainable, productive and economically rewarding practices when the outcomes and returns seem so uncertain from year to year" (Cooper, *et al.* 2008:26). Both floods and droughts have significant impacts on the production of food and on FSN in these areas. While droughts can result in crop failure and the death of livestock, particularly in areas of rainfed agriculture, floods can sweep away villages, roads, crops, livestock and people, wreaking havoc and leaving affected communities without houses, services and food. In addition, floods can result in contamination of water supplies, resulting in outbreaks of disease and lowered nutritional security of affected populations (see also HLPE 2012a).

Box 3 Droughts

According to the FAO, the Horn of Africa has been affected by droughts virtually every year for the past 12 years. Kenya experienced severe droughts in 2009 and 2011, with its agricultural production most severely impacted in 2009 where wheat yields were 45% below those of 2010. Australia suffered multi-year droughts between 2002 and 2010 with a drop in total Australian wheat yield by 46 percent in 2006 (below the 1960-2010 yield trend level). The 2010 drought in Russia, the worst in 38 years, was long, intense, spread over a sizeable area and resulted in serious environmental, social and economic impacts. The 2011 US drought covered the southern states with Texas, Oklahoma and New Mexico most adversely affected while parts of Arizona, Kansas, Arkansas, Georgia, Florida, Mississippi, Alabama, South and North Carolina were also affected.

Source: FAO Land & Water (n.d.)

Figure 2 Global Drought Hazard Distribution



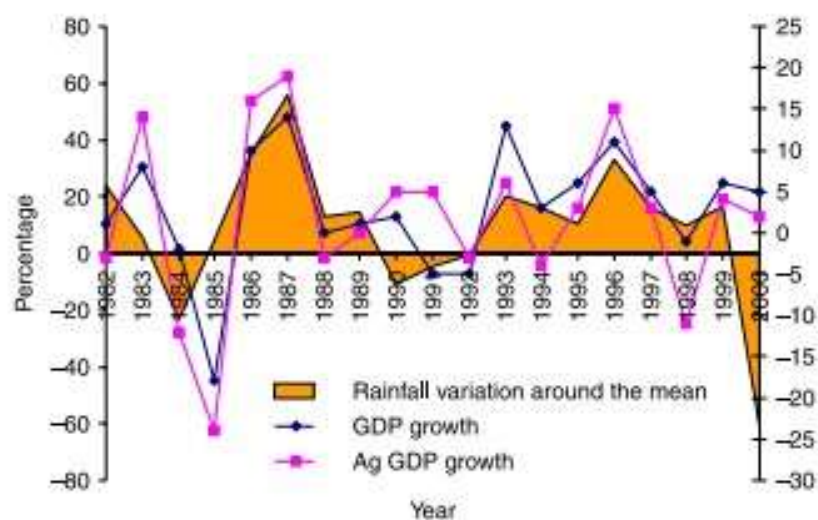
However, there is a further impact arising from areas of high climate variability which impacts on food and nutritional security in these areas. Grey and Sadoff (2007) have tracked the relationship between economic growth and rainfall in several countries that are highly dependent on rainfed agriculture (see Figure 4 for example). What this means is that during periods of drought, not only do poor and rural people experience increased hunger due to crop failure, but the negative impact on the overall economy also reduces the ability of the state to intervene and reduces the buying power of the population to replace failed crops with purchased food. It is estimated that '6 to 8 million people die annually from the consequences of water-related disasters and diseases' (ITU 2014).

According to the IPCC (2014), increased hydrological variability due to climate change will further strain water resources, which poses a risk to crop productivity and therefore to regional, national and household livelihoods. Some areas are very likely to experience an increase in rainfall, other regions are very likely to become drier, but extremes of rainfall and temperature (floods and drought) are very likely to increase in frequency and severity (IPCC, 2011). In regions with high food insecurity and inequality, these changes will particularly affect poorer households (IPCC, 2014).

Predicting with precision the actual impacts of climate change on water availability is difficult, for a number of reasons. The first is that there are a number of global circulation models. Downscaling based on different models can result in significantly different predictions of rainfall changes. As an example Figure 4 shows the predicted variation in rainfall in the Berg River catchment of South Africa under five different GCM models. In addition, changes in rainfall do not result in a simple linear correlation with water availability, since factors such as rainfall duration and intensity, surface temperature and vegetation all play a role in determining what percentage of rainfall is converted into surface water run-off into rivers, dams and wetlands, or into groundwater.

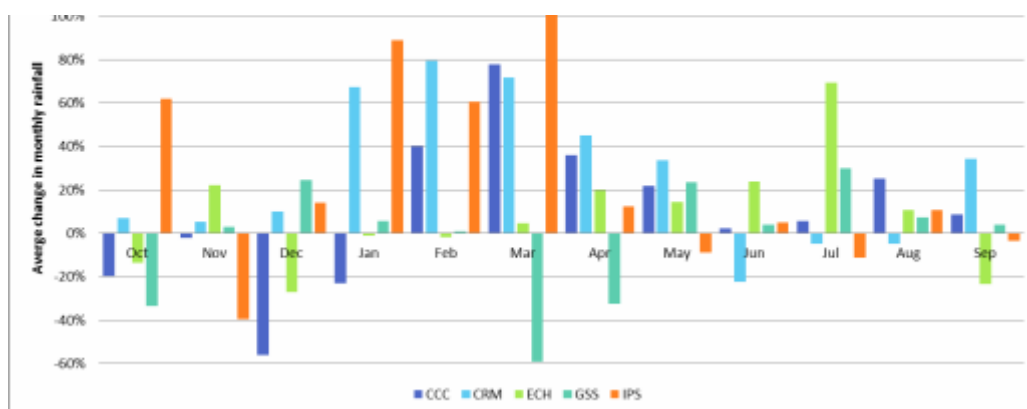
In addition, the impacts of changed rainfall patterns on water quality have not been sufficiently studied, but heavy rainfall may well increase pollutant loadings, which would impact the quality of raw water and drinking water (IPCC 2014). According to the IPCC, climate changes (included changes in precipitation, temperature and radiation) are likely to result in an increase in agricultural water demand in irrigated and rainfed systems (Jiménez et al., 2014). Irrigation demand is projected to increase by more than 40 percent in some areas, with significant regional variance (ibid). This is over and above the increasing water demand for the expansion of agriculture in order to meet the FSN needs of a growing population.

Figure 3 Rainfall, GDP growth and Agricultural GDP growth in Ethiopia



Source: Grey and Sadoff 2007

Figure 4 Predicted rainfall changes in the Berg River catchment, South Africa, under five GCMs



Source: DWA (2012)

Climate change is also linked to exacerbating existing problems in terms of water quality and uncertainties in accessing water supplies (ODI, 2011).

1.2.2 Increasing importance of groundwater resources

In many parts of the world, groundwater forms a critical source of water for domestic purposes and for irrigation in particular.

It is increasingly being used at a rate which often exceeds renewal capacity. According to Döll et al (2012), 35% of all water withdrawals during 1998–2002 were from groundwater and groundwater contributed 42% of all irrigation water use, 36% of domestic use, and 27% of total manufacturing use. Groundwater abstraction is estimated to have increased from 312 to 734 billion m³ annually between 1960 to 2000 (Wada, et al. 2010). Over the same period, groundwater depletion increased from 126 km³ to 283 km³ per year (Wada, et al. 2010). This has resulted in over-abstraction in many areas, particularly in India, Pakistan, the United States and China.

Box 4 Competition for groundwater resources in water-abundant Bangladesh

“Jobeda Khatun, a widow about 40 years old, lives with three of her children, a son aged 20, and two daughters aged 17 and 13. Ten years ago when her husband was still alive [...] they installed a hand tubewell on their homeplot. This privately owned well serves about six households in a cluster. Like many other hand tubewells in the village, their pump becomes inoperative during the dry months of February –April. Jobeda and her daughters [...] must go 500 meters away to collect water from the nearest pump. As they are adult women, local customs do not allow her or her daughters to venture out and collect water from the deep tubewell far away in the fields. [...] and as a landless non-agricultural household they are least favoured in receiving deep tubewell water. [...] Their hand tubewell does not yield water during the dry season due to the operation of mechanized deep tubewells [for irrigation].

“Despite seemingly abundant water, increasing use of deep water table extracting technologies for irrigation takes water away from shallow hand pumps used for domestic water supply.[...] Because groundwater rights are not clearly defined, no one is sure how to deal with the growing problem.”

Source: Sadeque (2000), pp. 269-270

Ground water is also often of special relevance because of its better quality, if preserved from source pollution. It has also long been more stable than rainfall or runoff water in terms of availability, if withdrawals remain sustainable.

1.3 Growing and competing demands

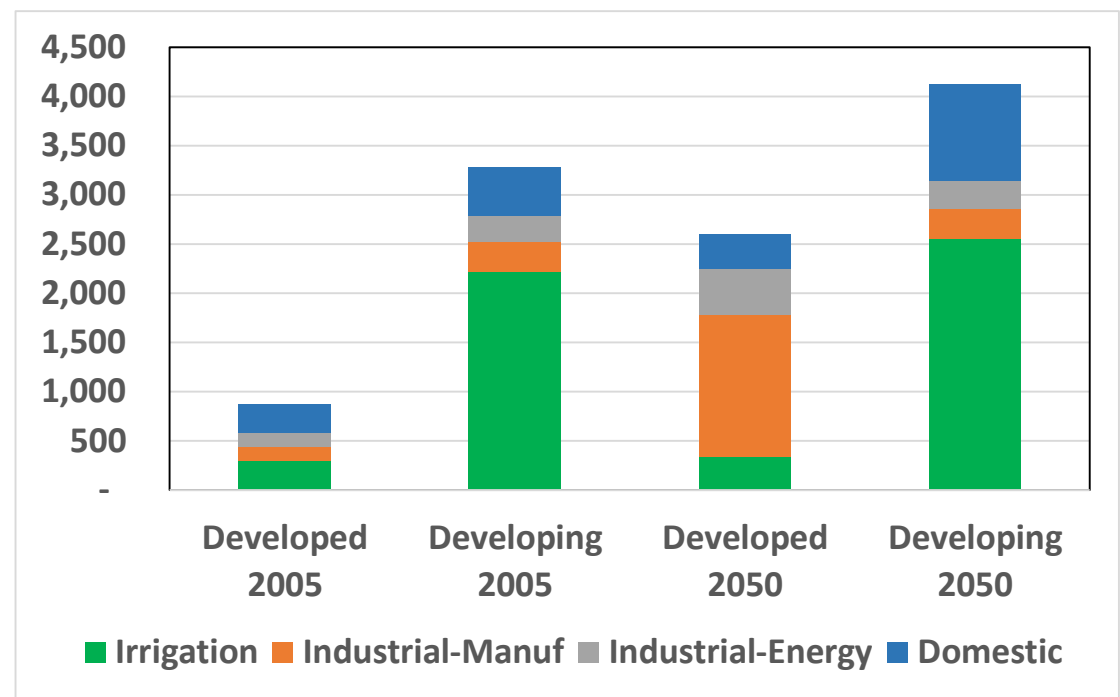
Demand for water from runoff and groundwater is increasing. There are in fact several demands for several degrees of water qualities, according to the different uses of water. And this varies geographically. A demand for water associated for a certain use can translate into a resource for another use. There are increasing issues of water qualities, and tensions on demand for quality water, because of the growth of demand and the rarefaction of the corresponding resource.

1.3.1 Growing global water demand

Economic growth, with its associated growth in most economic sectors, and significant changes in lifestyle of populations, are placing increasing demands on limited water resources. While there have been various scenarios and projections in terms of water requirements by different sectors over various timescales, there is uncertainty with regards to the real demand projections, due to poor baseline data in many countries on current national and sub-national sectoral withdrawals, rapid changes in use patterns informed by different drivers; and high uncertainty regarding technological change (WWAP 2012). As a result, estimates of current and future water demands vary widely. Figure 1 below shows projections of water demand in the key sectors and in different regions of the world (IFPRI 2014). Currently, agriculture is the primary water using sector, accounting for 60% of

total withdrawals (more in developing countries) and around 80% of consumptive use, although this will change over time as indicated in Figure 1.⁵

Figure 5 Global water demand: 2005 and 2050



Source: IFPRI 2014

As a result of growing water demands and only slowly growing supplies, Ringler et al. (2015, forthcoming) found that in 2010, 36% of the world's population, 39% of global grain production, and 22% of global GDP were at risk due to water stress.⁶ If current policy and investments continue, more than 52% of the global population, 49% of total cereal production, and 45% of GDP will be at risk due to water stress by 2050 as a result of an increasing number of areas where water withdrawal levels are above 40% of renewable resources. This has the potential to put agricultural and economic growth at risk, that is, unsustainable and vulnerable to environmental changes and growing competition (Falkenmark and Lindh 1974; Raskin et al. 1997; Oki and Kanae 2006).

1.3.2 Agricultural water demand driven by changing consumption patterns towards more livestock products

The growing water demand of the agricultural sector is directly linked to increased production, which itself is driven by population growth and changing consumption patterns towards more livestock products.

Dietary change is directly associated with increasing incomes, affluence and mobility, combined with demographic transformations such as urbanization (Regmi, 2001). The upward trend in meat consumption offers a good example: it is expected to increase by 2.4 kg per capita by 2023—a total of 36.3 kg per person globally (OECD n.d.). By 2050, per capita consumption of meat is expected to reach 52 kg per annum, according to the FAO (Weis, 2013).

The increasing consumption of meat indicated above, has implications for sufficient water for food production. According to a global assessment of the water footprint of farm animal products one third of humanity's water use is associated with animal sourced food today (Mekonnen and Hoekstra 2012),

⁵ Not all water goes to food crop production, but also into production of biofuels, fibre and tobacco. The impact of the growth of biofuels on water and FSN is addressed in 1.2.7.

⁶ Indicators of relative water abundance or scarcity include various levels of per capita water availability and the share of internal renewable water resources withdrawn. The latter ratio suggests that withdrawals in excess of 40% put agricultural and economic growth at risk, that is, unsustainable and vulnerable to environmental changes and growing competition (Falkenmark and Lindh 1974; Raskin et al. 1997; Oki and Kanae 2006).

It is widely accepted that animal food products require much larger quantities of water per unit of nutritional energy compared to foods of plant origin (Gerbens-Leenes et al, 2013) and that the major component of water use in animal production is feed⁷. Increasing demand for feed grains also results in agricultural expansion into rainforests and other mountainous landscapes, contributing to land-use changes, further altering already disturbed water flows.

Conversely, in many areas, livestock, if managed sustainably, is a mean to preserve grasslands and wetlands ecosystems.

1.3.3 Safe drinking water and sanitation and hygiene practices

As shown above, the provision of safe drinking water and adequate sanitation are critical to reduce water borne disease and negative health impacts arising from poor sanitation, both of which impact negatively on the nutritional security of affected populations as described above. In March 2012, it was announced that the world had met the water Millennium Development Goals (MDG) in 2010 of halving the proportion of people without sustainable access to safe drinking water, well in advance of the MDG 2015 deadline. Between 1990 and 2010, over two billion people gained access to improved drinking water sources, such as piped supplies and protected wells, a reduction of 25% in absolute numbers (WHO 2012). However, 768 million people still use unimproved sources of drinking water. Drinking water coverage is only 56% in Oceania and 63% in sub-Saharan Africa; other regions have coverage rates of 86% or higher (WHO/UNICEF Joint Monitoring Programme, 2012). Figure 4 shows the delivery of safe drinking water in nine regions across the world. Largely, rural dwellers and the poorest of the poor have been by-passed in the achievement of the water MDG. Also achieving gender equality, social equity and sustainability have tended to be overlooked and are only now getting attention around the post-2015 MDG discussions.

Figures 4 and 5 below show that substantial progress has been made in the delivery of safe drinking water and adequate sanitation in the period from 1990 – 2012. However, it is important to interrogate these numbers to understand what they really indicate and what not. While the figures indicate the number of people that have been provided with access to an improved water source, lack of effective monitoring in many developing countries means that these figures do not indicate whether the improved source is (still) functioning, whether the quality of the water provided meets WHO standards, or whether the structures are actually used. As an example, the figures provided by the South African government on the delivery of safe drinking water and sanitation are based on a national collation of figures provided by municipalities in terms of infrastructure provided, and do not reflect the ongoing functionality of the infrastructure or the reliability of the service provided (see Box 5). One of the challenges of high urbanization rates in developing countries is that the delivery of services does not necessarily keep pace with the influx of people, resulting in large informal settlements where people do not have access to safe drinking water or adequate sanitation, with the associated impacts on their food security and nutritional status.

Box 5 Challenges in water service and sanitation delivery in South Africa

“A key issue with access to water is the poor quality of infrastructure. In some cases, the infrastructure that is provided was broken or dysfunctional. In other cases, those businesses contracted to provide infrastructure, did not deliver on their contracts or delivered in a manner which did not uphold human rights. Participants at the hearings complained of an apparent lack of monitoring and evaluation by government, particularly of external contractors. They also highlighted cases of corruption and maladministration. In all nine provincial hearings, people complained of the poor condition of waste and water treatment plants. Many municipalities testified that water treatment plants were collapsing, mainly due to the heavy loads of treatment required.”

Source: South African Human Rights Commission (2014)

⁷ Gerben-Leens et al. note that the water footprint (WF) (expressed as litres per kilo calorie) of pork is two times larger than that of pulses and four times that of grains. Yang and Cui (2014) suggest that to produce 1 kg of beef requires 15.4 m³, as opposed to 1 kg of cereals, which only needs 1.6 m³ (Yang and Cui 2014). The authors further suggest that increased water use per capita due to continued dietary changes might well overtake population growth as the main driver of growth in water use.

Figure 6 Trends in drinking water coverage

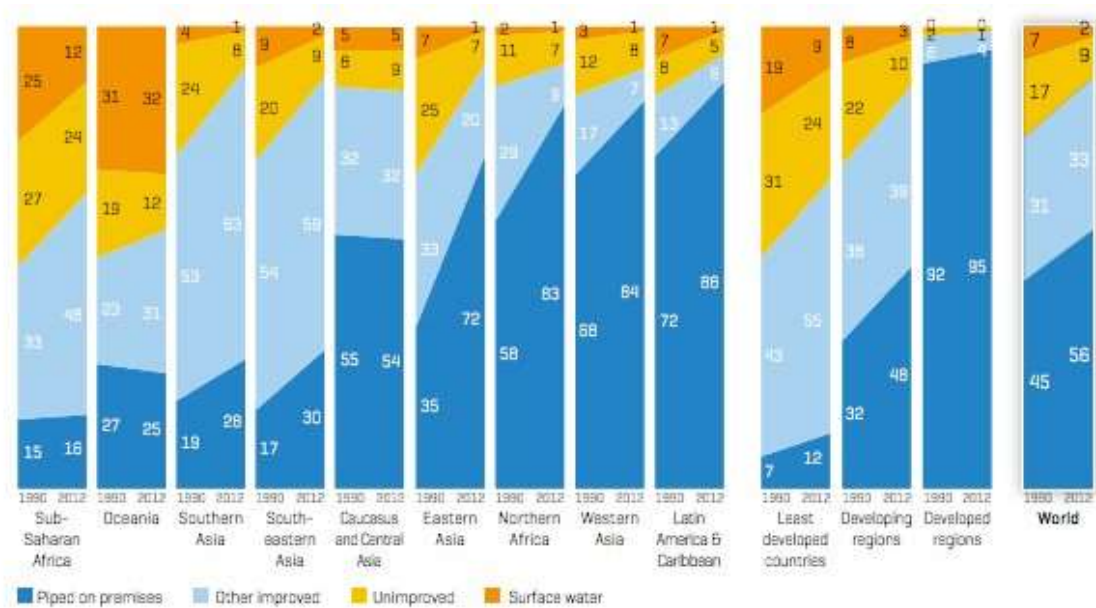


Fig. 5. Trends in drinking water coverage [%] by developing region, 1990–2012

Source: WHO/UNICEF Joint Monitoring Programme (2014)

According to UNICEF, “by the end of 2011, there were 2.5 billion people who still did not use an improved sanitation facility. The number of people practicing open defecation decreased to just a little over 1 billion, but this still represents 15% of the global population” (UNICEF 2013b). India alone has almost 600,000 open defecators. There are also major disparities in sanitation provision between regions, as can be seen in Figure 6 below, and between rural, urban and peri urban areas. Lack of access to sanitation is a particular challenge for women who in many societies have to defecate at night. There are few studies assessing the impacts of lack of adequate sanitation facilities on women. One study focusing on the slums of Kampala, Uganda, found “a firm link between a lack of access to adequate sanitation and women’s experiences of humiliation and violence” (Massey 2011: 3).

Figure 7 Sanitation coverage trends

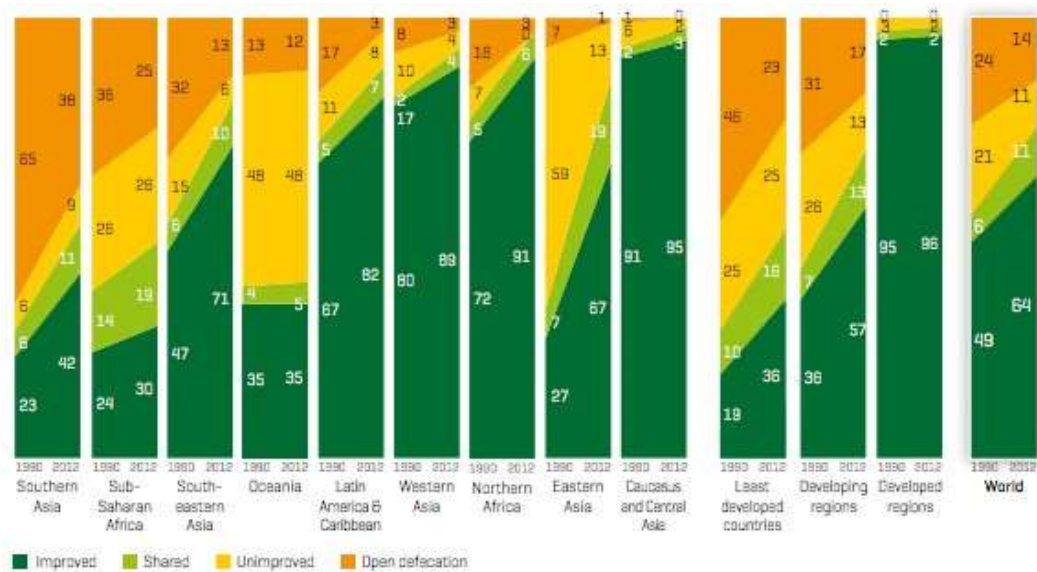


Fig. 13. Sanitation coverage trends [%] by MDG regions, 1990–2012

Source: WHO/UNICEF Joint Monitoring Programme (2014)

The WHO/UNICEF Joint Monitoring Programme (2014) report recognises that despite the fact that progress towards the MDG targets of water and sanitation represents important gains in access for billions of people around the world there are still significant inequalities with marginal and vulnerable groups experiencing much lower levels of delivery than other groups. It should also be noted that the provision of water under the MDGs is only aimed at water for domestic purposes, and does not in any way address the issue of water for productive purposes, including the growing of food. So the water and sanitation MDGs are relevant primarily in relation to water for food preparation and improved hygiene practices, and in relation to the reduction of diseases from poor quality water that impacts on the ability to effectively absorb nutrition.

1.3.4 Water and energy linkages

Within the energy sector, there are critical issues that impact on water use, and vice versa, which ultimately impact on food security and nutrition in terms of the amount of water available to the food and agriculture sector, and in terms of water quality.

Many energy generation systems require water as part of the generation process, including thermal energy generation (including solar thermal generation), hydropower and nuclear plants. The expansion of biofuels (HLPE 2013) and hydrofracking is of concern to many in the food sector, since it is seen as competing with land and water resources. One of the major challenges for water for energy is that it must be provided at a high assurance of supply, meaning that in times of low rainfall water for irrigation is usually reduced before the water for energy production is reduced.

Energy is also required in the water cycle to abstract, distribute and treat water and waste water, including for most forms of irrigation, and for heating water for food production processes, domestic hygiene and food preparation.

There is growing pressure around the world to increase the use of renewable energy generation processes to reduce carbon emissions from power generation. This includes biofuels (HLPE 2013), wind and solar generation, geothermal sources and hydropower. While some kinds of renewable energy, such as wind and solar photovoltaic (PV) power, do not consume much water, other renewable energy processes such as concentrated solar power and biofuels consume significant quantities of water.

Biofuels can add pressure to 'water supply and water quality problems' (HLPE 2013) especially if irrigated (Lundqvist, de Fraiture and Molden 2008). Although regional variation is large, de Fraiture et al (2008) estimate that on average it takes around 2 500 litres of crop evapotranspiration and 820 litres of water withdrawals to provide one litre of biofuel. It is at the country or local level that the trade-offs between water for food and water for biofuels are felt. For example, in India water for biofuels can compete directly with water for food such as cereals and vegetables (ibid). Also as concluded by the HLPE, biofuel production usually does not benefit small-holder farmers in water scarce contexts (HLPE, 2011).

Moreover the increasing use of the drilling practice of hydraulic fracturing, or "fracking,"⁸ as it is more commonly known, raises concerns on its impact on water resources. . Most studies of the impacts of fracking on water have focused on water quality, but some studies have also looked that impacts on water quantity and competition for use with other sectors, including the agricultural sector. There has been little quantification of the actual water use because requirements are dependent on the nature of the shale, well depth, the number of fracking stages and the length of the lateral pipes underground (Nicot & Scanlon 2012). Frac sand mining— an off shoot of hydrofracking industry—is a related sector whose impact of food systems is yet to be assessed as well.

On the other hand, the energy requirements of the water sector are increasing. Higher pollution levels require more energy for treating water, and the increasing need to transport water over long distances also uses significant energy. Groundwater irrigation has increased dramatically as a source of total irrigation water use with the result that energy use for groundwater pumping is now often the largest source of direct energy use in semi-arid and arid developing countries, such as Pakistan. Thus water use practices are contributing to the growth in energy demand.

⁸ 'is the process of injecting a mixture of water, sand and chemicals into wells at high pressure to crack dense rock formations and release oil or gas'

Hydropower also has implications for water and food security and nutrition, because of the large quantities of water stored in dams, the water lost through evaporation from reservoirs, and changes in river flows and dam releases to meet the needs of hydropower rather than downstream farmers or for ecosystem needs. Hydropower is currently being proposed as a climate-friendly option (Allouche et al 2014) and also as a solution to deal with the lack of storage and economic scarcity in sub-Saharan Africa (see Chapter 2). However, hydropower can create conflicts around water for energy and water for agriculture (for dams in Central Asia, see UN Water 2014).

Food processing industries require reliable supplies of water and energy. Closed loop systems for both energy and water are feasible for some processing industries, but require higher initial capital investments. Several companies have started to develop plans to become carbon and water-neutral.

While there are important tradeoffs across water, energy and food, there are also large opportunities for synergies. For example, small run-of-the-river hydropower stations have been built on large irrigation canals in southern Vietnam to harness the energy created by canal flows (Nguyen Vu Huy, personal communication), and Ethekewinin municipality in South Africa is looking at hydropower generation on distribution pipelines on steep hillsides in its area of jurisdiction. Second, the energy embedded in point source waste water can be harnessed and reused as fertilizer on agricultural fields, or used as a direct heating agent. There are many opportunities for jointly improved water, energy and food security. Much of this has yet to be implemented and there are significant challenges in managing competing trade-offs (see Box 8).

1.3.5 Increased interest for water resources by big corporate actors: “water grabbing”?

Over the last decade, there has been increasing corporate interest in water resources, arising largely from the perceived business risks as a result of increasing competition for water, and decreasing water quality. Since 2011, global corporations have spent more than \$84 Billion on how they manage, conserve or obtain water (Clark, 2014). The reasons include having to deal with physical water shortages, the need to ensure sufficient supplies of water for industrial and production processes and concern about water scarcity.

Some argue that the growing corporate involvement in water management is to be welcomed because it will lead to new technological innovation (Clark, 2014), and improved water management in areas of weak governance. Others argue that it poses risks and implications for current and future water and food security (Sojamo and Larson, 2012), through, for example, the potential re-allocation of water to the ‘highest economic value’ having detrimental impacts on local lives, livelihoods and water and food security (Franco et al, 2013).

In recent years, attention has focused on the rapid growth of large-scale land deals around the world (von Braun and Meinzen-Dick, 2009; Cotula et al., 2009; Borras and Franco, 2010; World Bank, 2010; Deininger, 2011; De Schutter, 2011). The rush to acquire land as sources of alternative energy, crops, and environmental services has led to the phenomenon popularly known as “land grabbing” (HLPE 2011). Some studies have underlined that water is often the driving factor behind many of these deals (HLPE 2013). Such deals often exert a great impact on water uses and water rights (HLPE 2011, 2013).

A special issue of Water Alternatives discusses several water implications of land deals on local food production and agriculture (Mehta, Veldwisch and Franco 2012).⁹ The papers show how land acquisitions have led to a significant re-appropriation of water resources and to water tenure relations with implications for basic human rights and local water and food security. In Ghana, Williams et al. (2012) observe how “companies initially leased large-scale lands to grow a crop, *Jatropha*, which is less water demanding but have ended up diversifying into other crops that require full or supplemental irrigation to give optimal yields” (Williams et al, 2012: 256). The issue of land and water grabbing therefore may have significant impacts at the local or national level in terms of access to water for household or national food security.

⁹ See: www.water-alternatives.org/index.php/tp1-2/1881-vol5/213-issue5-2

Houdret (2012) describes how, in Morocco, deep drilling by agricultural investors may intensify water conflicts and increase the marginalisation of small farmers as shallower wells used by local communities may dry up. Bues and Theesfeld (2012) describes how water rights have changed both directly and indirectly on foreign horticulture farms in Ethiopia. Direct changes include new associations reshaping formal agreements and indirect changes to water access and withdrawal rights which are directly tied to land rights. The re-appropriation of resources described are only possible due to sharp power inequalities between resource poor smallholders and large investors and companies (see Chapter 3). In India, planned canals were abandoned and the irrigation potential drastically reduced because of the amount of water diverted to petro-chemical industries and thermal plants owned by major corporate houses (Wagle et al., 2012).

A particular challenge is posed by the imbalance of power between large transnational corporations and under-resourced government departments in developing countries, with the possible outcome that water is, *de facto* regulated and managed by the private sector and not by the state. The competition between large, powerful private sector water users and smaller water users has been studied in several areas. At the same time, in a strong regulatory environment, the water related concerns of the private sector can be harnessed to support improved water management within an equitable and sustainable paradigm. In addition, within the right regulatory environment, there is considerable potential in harnessing the capital and capacity present in the private sector for developing and operating infrastructure, and to improve water use productivity (for a further discussion of the private sector and corporations, see Chapter 3). More work is needed on understanding how best developing country governments can capitalize on these opportunities effectively.

1.4 The dynamics of water scarcities

A key element of the issue of water and FSN is the concept of increasing water scarcity (FAO, 2012a; Falkenmark and Lannerstad, 2005).

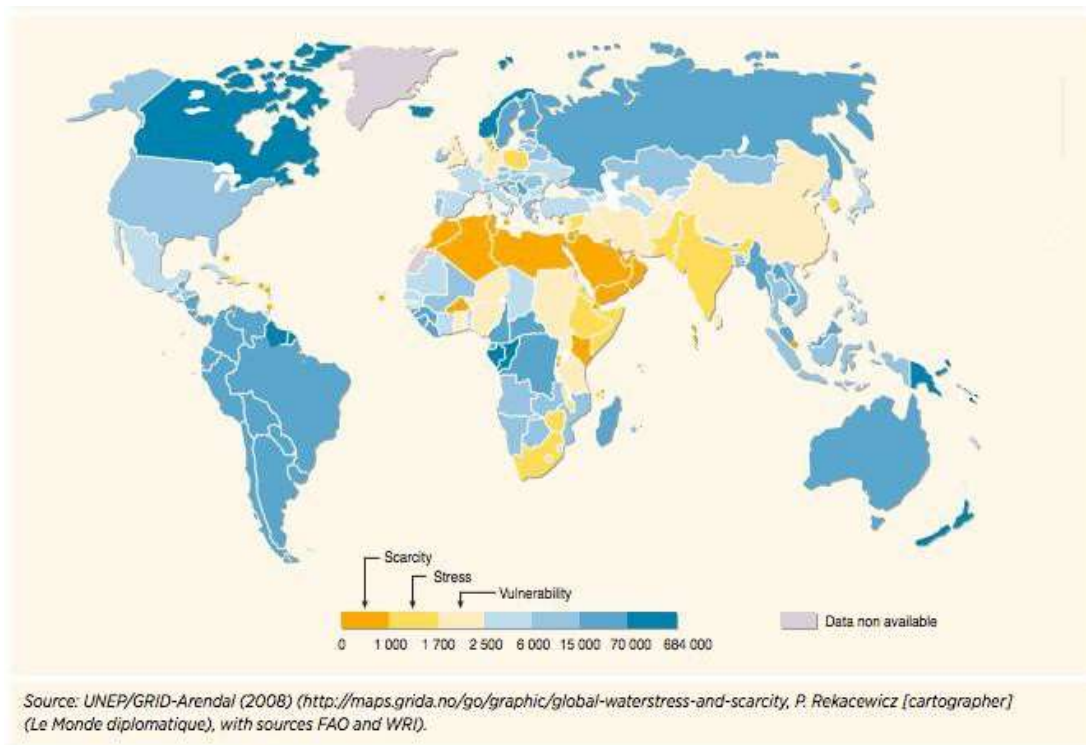
Water scarcity is a complex phenomenon and can be analysed differently from social, political, meteorological, hydrological and agricultural perspectives, although there has been the tendency to direct attention to the lack of supply of water due to natural and economic forces rather than look at human-induced land and water use practices and at socio-political considerations (Mehta, 2005; UNDP, 2006).

Scarcity of water is typically examined through two lenses – the first looks at the amount of water available per capita in a particular area, taking into account the average volume of water available in rivers, lakes, dams, and groundwater aquifers per person. This is considered to define physical scarcity of water. For example, Figure 3 below shows per capita freshwater availability across the world in 2007 drawing on a definition by the Swedish hydrologist Malin Falkenmark (Falkenmark and Widstrand, 1992). Countries are classified according to a 'water stress index' on the basis of their annual water resources and population. This widely adopted definition proposes a threshold of 1700 m³ per person per annum, below which countries are said to be water stressed, and water scarcity is less than 1000 m³ per person per annum.

The second lens is economic water scarcity (CA 2007). Indeed, physical availability of water does not necessarily mean that water is available for use or accessed. In some areas, while there may be a sufficient volume of water available per person, lack of infrastructure means that the water is not available where it is needed, or of an appropriate quality for use. For example, according to UNEP (2011), an estimated 51 million people in the Democratic Republic of the Congo (DRC), around three quarters of the population, had no access to safe drinking water in 2011, even though the country is considered water rich and has more than half of Africa's water reserves.

There are a number of countries, such as the DRC, where the challenge lies in economic water scarcity, rather than physical water scarcity and where with appropriate infrastructure and management, there is sufficient water to provide for the needs of the population and for equitable and sustainable economic development, including improved agricultural yields. In these countries, access to water is determined by lack of investment rather than lack of water.

Figure 8 Freshwater availability (m^3 per person per year, 2007)



Source: UNEP/GRID-Arendal (2008)

But both these lenses generally take an aggregate view of populations lacking access to water, rather than breaking down groups due to gender, caste, race, occupation and other socio-economic categories. Thus, it is important to also focus on the socio-political dimensions of scarcity and how access to water is often determined by social difference as well as by political will, levels of national economic development, and national growth patterns. Thus people's lack of access to water may have little to do with physical scarcity per se but may instead be due to exclusions arising from social positioning, gender or because of the way water is managed, priced, and regulated (Mehta 2014 and UNDP 2006). Furthermore, scarcity can also be induced through policies and planning. For example, subsidised electricity has led to increased pumping for irrigation in India and inefficient use/overexploitation of water resources (Narula and Lall, 2009); subsidized electricity has also led to overuse of groundwater in Mexico (Scott, 2011). In western India, there is over-extraction of groundwater and the growing of water hungry sugarcane in drought prone areas on the part of large irrigators while dryland farmers struggle during droughts to meet their basic food requirements (Mehta, 2005). Finally, decisions outside the water domain such as those concerning energy, trade, and agricultural subsidies, often impact on water supply and demand, and hence on water scarcity (FAO, 2012a).

Water quality in surface and groundwater sources is deteriorating globally as a result the discharge of poorly or un-treated sewage, and effluent from mining, industry and agriculture into water bodies (including permeation through the soil into groundwater), and increased abstraction of water leading to lower dilution capacity.

There are a large number of human activities that impact negatively on the biological, chemical, and physical characteristics of water. The results include contamination of water by pathogenic organisms, unacceptably high levels of trace metals and toxic chemicals; eutrophication from high nutrient levels in the water, and changes to the acidity, temperature, and salinity of water. In addition, many water bodies around the world have been impacted by the presence of alien invasive species, both fauna and flora (Palaniappan *et al.*, 2010).

Sufficient water of an adequate quality is necessary for the survival of all living creatures, as well as being central to the effective functioning of socio-economic systems. Poor water quality impacts on human health, on ecosystem functioning, and on food security and nutrition.

Box 6 Clearing the waters

'Nutrient enrichment has become one of the planet's most widespread water quality problems (UN WWAP 2009), and worldwide, pesticide application is estimated to be over 2 million metric tonnes per year (PAN 2009). Industrial activity releases about 300-400 million tons of heavy metals, solvents, toxic sludge, and other waste into the world's waters each year (UN WWAP Water and Industry). About 700 new chemicals are introduced into commerce each year in the United States alone (Stephenson 2009). Mining and drilling create large quantities of waste materials and by-products and large-scale waste disposal challenges. Widespread lack of adequate disposal of human waste leads to contamination of water – worldwide, 2.5 billion people live without improved sanitation (UNICEF and WHO 2008), and over 80 percent of the sewage in developing countries is discharged untreated in receiving water bodies (UN WWAP 2009). Meanwhile, growing populations will potentially magnify these impacts, while climate change will create new water quality challenges.

Unsafe or inadequate water, sanitation, and hygiene cause approximately 3.1 percent of all deaths – over 1.7 million deaths annually – and 3.7 percent of DALYs (disability adjusted life years) worldwide (WHO 2002). Livelihoods such as agriculture, fishing, fish farming and animal husbandry all rely on water quality as well as quantity. Degraded water quality costs countries in the Middle East and North Africa between 0.5 and 2.5 percent of GDP per year (WB 2007), and economic losses due to the lack of water and sanitation in Africa alone are estimated at US\$ 28.4 billion or about 5 percent of GDP (UN WWAP 2009). Women, children, and the economically disadvantaged are the most affected by water quality impacts. Over 90 percent of those who die as a result of water-related diseases are children under the age of 5. Women are forced to travel long distances to reach safe water. And the poor are often forced to live near degraded waterways, and are unable to afford clean water.'

Palaniappan, et al. (2010:7)

1

2 This section reviews the value and weaknesses of some of the key metrics relevant for water for FSN,
 3 especially in terms of capturing and advancing the interests of poor and vulnerable groups who lack
 4 food security. Many global indices and debates in the water domain are highly generalized and often
 5 too aggregate to take on board local nuances and differences. These have implications for how
 6 problems and solutions around water for FSN are framed and how these affect decision making
 7 processes. Thus, the framings – or understandings and representations – that dominate policy
 8 debates at the international and national levels may be frequently at odds with the perceptions,
 9 knowledge and experiences of local water and food users (Mehta and Movik, 2014). These highlight
 10 the importance of paying attention to the politics of knowledge and data in the water domain and how
 11 current and future 'crises' around land and water are portrayed.

12 Using low quality data can often impede rather than help in activities such as monitoring, evaluating
 13 and cleaning data. There is often a lack of transparency in sharing data, between countries especially
 14 around issues concerning transboundary water resources, poverty levels etc. This can impede co-
 15 operation. Water management often focuses on hydrologic units such as a basin or watershed¹⁰ and
 16 serve well to report on water data. But hydrologic units are often different from administrative units or
 17 country boundaries and often thinking in hydrological, as opposed to administrative units, can be quite
 18 challenging for policy makers and water officials (see Moss 2003 for Europe). Many water
 19 management tools and models approaches ask for a sophisticated knowledge base and assessments
 20 of existing water withdrawals/ use by different sectors (e.g. agriculture, industry etc.). This can be
 21 quite challenging in data-poor environments, especially in sub-Saharan Africa and a lot of financial
 22 and donor resources are used to improve the data base, instead of actually enhancing access to water
 23 or improving water infrastructure. Other key water data challenges include lack of accounting for
 24 small-scale irrigation (see also Chapter 3), and thus underestimation of actually irrigated area; poor
 25 understanding of groundwater use; and poor data quality on sectoral water withdrawals.

26 Assessments of global hotspots of water scarcity, floods and droughts are often very aggregate and
 27 focus on the volumetric aspects of water. There are currently few, reliable statistics at more
 28 disaggregated scales. Much of the available data are either modelled or estimated for hydrological
 29 units or national levels, and then disaggregated using algorithms or statistical tools. They also tend
 30 not to disaggregate users and their entitlements or look at the politics of distribution (Mehta and Movik
 31 2014). Until recently, MDG progress ignored peri urban and slum areas which are some of the fastest
 32 growing areas in the world (WHO/UNICEF Joint Monitoring Programme 2012). Most official indicators
 33 also do not question the time taken by women and girls to collect water. There has also been little

¹⁰ This refers to the area of land where surface water from rain and melting snow or ice converges to a single point at a lower elevation, usually the exit of the basin, where the waters join another water body or flow into the ocean.

comparable international data on gender indicators and most of the agencies lack proper sex-disaggregated data, making it impossible to monitor progress or devise gender sensitive policies.¹¹ Water accounting is a sub-component of environmental accounting, which aims at incorporating environmental information into typically economic accounting and can be done either at the corporate level or for national economies. It is a way to help societies understand how they use their water resources and also help towards creating new policies that aim to create sustainable use of water resources (FAO 2012a). But accounting can be complicated in many ways. It is also difficult to capture the dynamic nature of water uncertainties and variabilities in water accounting.

Two key concepts in water accounting include virtual water and water footprinting. These are discussed in Chapter 2.

Finally, the challenge in painting the global, regional or national picture, as we have done in this chapter, can sometimes lack granularity. Figures on country level water availability, for example, mask regional differences within countries, as well as the differential access to water for poorer groups within countries as well as gendered differences. Similarly, inter-annual averages can smooth out the extremes of climate variability. Areas with high climate variability may experience several consecutive years of below average rainfall, with significant impacts on food production – particularly, but not only, in areas dependent on rainfed agriculture. These issues need to be borne in mind whilst trying to understand the extremely different water contexts across the world and what they mean for FSN. This discussion thus points to the need to highlight the importance of local perspectives and contexts, as well as diverse ways in which local women and men can develop resilient systems to deal with increasing uncertainties. This, alongside governance challenges, will be considered in the next chapters.

¹¹ There have recently been some improvements, however. The WHO/UNICEF Joint Monitoring Programme post-2015 consultation has emphasized issues of Equity, Equality and Non-Discrimination (END) which can overcome some of the issues outlined above. For instance, it has been proposed that intra-household inequality should be addressed through disaggregating data by age, gender, health, disability and so on. How these issues will be taken up in the post-2015 agenda remains to be seen but these do constitute progress in the desired direction. See WHO/UNICEF Joint Monitoring Programme 2012 and Mehta 2013

2 IMPROVED WATER MANAGEMENT FOR IMPROVED FSN

While the management of water for food security and nutrition has been improving over the last decades, as discussed in Chapter 1, with continued rapid population growth in Africa and many other developing regions as well as the emerging wealthier middle class in almost all developing regions, and the high consumption patterns of the developed nations, food feed, fiber and fuel demands and their associated water needs and impacts across the entire value chain continue to grow. At the same time, the demands of other water use sectors such as energy, municipal and industrial demand are also growing. Across the world enough food is produced to theoretically feed the global population, but poorer people, who still may spend half or more of their expenditures on food, cannot always afford food of sufficient quantity and quality, nor is the food distributed effectively to where it is needed. Thus, achieving food security for all requires both better use of existing resources, such as water, to produce more food at lower prices, better income opportunities for the poorest, and improved institutions to make food accessible to those facing chronic shortages. These issues have also been dealt with in the 2012 HLPE Report on Social Protection (HLPE, 2012b).

Even though issues of food security are mainly concentrated in water scarce and underdeveloped countries, access to food, and specifically nutrition security is primarily affected by socio-economic factors, such as class, gender and race, even in developed countries (Lappé et al, 2013; Bassett and Winter-Nelson, 2010). Similarly the inability to produce or to buy enough food is as linked to the risks of water shortages and drought as to other institutional and socio-economic factors (CA, 2007).

Physical water scarcity, especially in dry environments where a fifth of the world population lives, poses one of the greatest challenge to agricultural development and food security. As a result net food imports into these regions have been increasing for decades and are expected to continue to grow. If one adds those regions with economic water scarcity, such in sub-Saharan Africa, then a real challenge to coping with agricultural water demands exists.

Current efforts are largely focused on upgrading conventional approaches to water management, to produce more with less water. This includes seeking to increase crop yields (land and water productivity) through investing in modern irrigation systems. However, these approaches have major limitations. Higher crop yields generally require more water which may not be available, and modernizing irrigation systems helps but may not add substantial and real water savings: while they increase field and farm irrigation efficiency, the overall water savings at the basin or landscape levels may not be proportional. In addition, little progress has been made in water demand management in the agricultural sector through pricing, due mainly to internal politics and cultural factors (Oweis, 2014). However, some areas, including the Middle East and the North African region have developed innovative water reuse technologies that have seen significant improvements in water productivity.

A major challenge, however, is that future improvements in water management will need to respond to increasing risk and uncertainties associated with climate variability and change which, in addition to changing rainfall patterns impact biotic stresses, such as pest and disease. Other important uncertainties are associated with local and global economies. For instance, the grain price hikes of 2007/08 and associated shortages in the international markets led to a flurry of short term initiatives and government policies to help improve food security in many countries. These may not have been necessary if there had been a predictable global policy environment in place to support the progressive realization of the right to food.

Unfortunately, technological advancements are unpredictable and institutional/policy environments, especially at the country level (such as subsidies, land tenure and others) may, if inappropriately designed, present major risks that impact farmers' ability or desire to invest in and gain from improved water productivity.

There are a number of responses to increased risk and uncertainty, which include increased control over uncertain variables, such as precipitation, for example, through the development of storage; farmer insurance, diversification of crops; and international trade. A notable negative and technically inefficient response to the grain shortages and prices hike of 2007 was a strong movement towards achieving self-sufficiency in food production in many water scarce countries such as the Arabian Gulf.

This chapter will attempt to shed light on how the drive to meet world food demands and nutrition security through agricultural production is impacted by water-related uncertainties and will suggest some alternative approaches to reducing risk and improving food security. The discussion will focus on the two main agricultural systems that provide the world's food namely: rainfed and irrigated systems. It will also describe water management challenges and potential for reform in the processing and preparation stages.

2.1 Water for agricultural systems

In rainfed ecosystems water is used directly to support crop production. Irrigated systems make use of ground or surface water sources, to supplement rainfall sources.

Agricultural systems range from fully rainfed to fully irrigated with several combinations in between, such as supplementary irrigation. Globally irrigation accounts for about 60 percent of water withdrawals and about 80 percent of consumptive water use. These figures vary heavily from country to country (WB, 2014), and depends on many factors.

In rainfed systems, the main issue is, and especially in dry areas (and will be even more because of climate change), is to manage the risk (or rain variability).

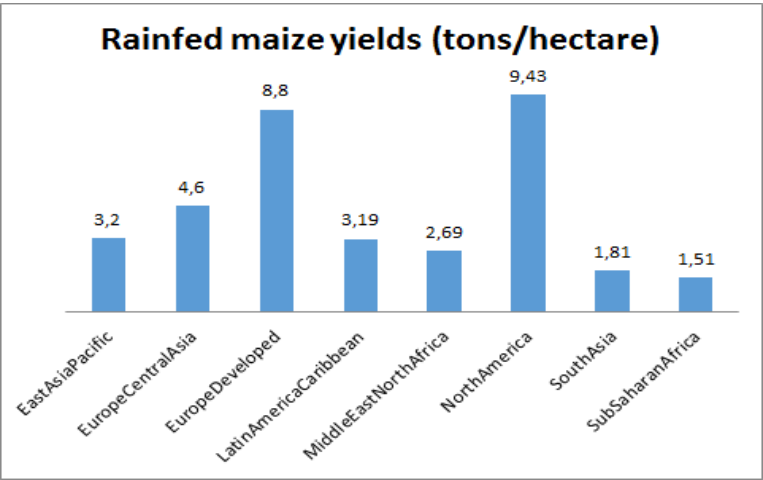
In irrigated systems, the main issue is to sustainably manage the resource, which includes the question of the appropriate system and of the related investments, the issue of efficiency of water use, and of the availability of the resource.

2.1.1 Rainfed agricultural systems

The importance of rainfed agriculture for food security comes from the fact that it is the source of most of the food for poor communities in the developing world and that most of these countries depend primarily on it for their food grains. Almost all land in sub-Saharan Africa (93%), three quarters of cropland in Latin America, two thirds of crop land in the Middle East and North Africa region, and more than half of cropland in Asia is rainfed (FAO, 2002). Women, who make up some 70% of the world's poor (WHO 2000), play a key role in rainfed agriculture. The yield from rainfed agriculture varies widely across regions, as can be seen from Table 1 below.

On average rainfed agriculture productivity (t/ha) is globally less than half of that of irrigated agriculture (Rockström *et al.*, 2010), although the productivity varies enormously across the world. The highest yields from rainfed agriculture are found in the predominantly temperate regions, with relatively reliable rainfall and inherently productive soils, particularly in Europe and North America. However, even in tropical regions, agricultural yields in commercial rainfed agriculture exceed 5–6 metric tons per hectare (CA, 2007). The dry sub-humid and semiarid regions experience the lowest yields and weakest yield improvements per unit of land.

Figure 9 Rainfed maize yields per region 2005 (t/ha)



Source: IFPRI IMPACT unpublished, based on FAOSTAT online data.

1 Key constraints to improving rainfed systems productivity differ greatly from one region to another. In
 2 the arid regions, the absolute amount of water available constitutes the major limiting factor. In the
 3 semiarid and dry sub-humid tropical regions seasonal rainfall is generally adequate, and managing
 4 extreme rainfall variability over time and space is the largest challenge. In the wetter part of the semi-
 5 arid zone and into the dry sub-humid zone, rainfall generally exceeds crop water needs and the key
 6 challenge is the extreme variability in rainfall, characterized by few rainfall events, high-intensity
 7 storms, and the high frequency of dry spells and droughts. Thus, the large observed differences
 8 between farmers' yields and attainable yields cannot be explained by differences in rainfall. Rather,
 9 they are a result of differences in water, soil, and crop management (Wani et al 2009). Soil-moisture
 10 retention and micro-climate management are crucial strategies that can help farmers under all of these
 11 varying conditions. In rainfed farming systems, agro-ecological approaches are particularly suitable for
 12 building healthy soils with higher water retention capacity, which is a must for improving crop
 13 productivity in all types of farming systems, including rainfed systems. (Kremen and Miles 2012;
 14 Hepperly et al 2007; Pimentel et al 2005).

15 It is also well established that soil fertility is a limiting factor in many areas especially in dryland systems
 16 and sub-Saharan Africa. Poor soils are often also associated with poor capacity for water
 17 retention. According to Wani and Röckstrom (2011: 45), nutrient mining is particularly serious in
 18 smallholder rainfed agriculture of Sub-Saharan Africa, where an estimated 85% of farmlands loses
 19 more than 30 kilograms of nutrients per hectare and year.

20 The high risk of water-related yield loss makes farmers risk averse, influencing their other investment
 21 decisions, including labor, improved seed, and fertilizers. Combined with the fluctuations in yields, this
 22 makes it hard for resource-poor men and women in semiarid areas to respond effectively to
 23 opportunities made possible by emerging markets, trade, and globalization. Management options
 24 should therefore start by focusing on reducing rainfall-induced risks. This is where agro-ecological
 25 practices can be extremely relevant, as they help build climate resilient farms, and help farmers make
 26 investment decisions that are less risky, as they have control over more factors of production (Holt-
 27 Giménez 2002; Fraser et al 2011).

28 Livestock are an important part of multi-functional agriculture, providing milk, meat, eggs, cash
 29 income, farm power and manure that can enhance soil fertility, while being nurtured by hay and other
 30 crop residues. They also have important cultural values and are a means for poor people to
 31 accumulate wealth. They are an integral part of both rainfed and irrigated agriculture. However, the
 32 growing demand for meat and milk in the urban areas of the world is being met not through integrated
 33 animal-crop production systems, but increasingly through concentrated animal feeding operations that
 34 create substantial demand for animal feed production, the component of the livestock cycle that
 35 constitutes the vast majority of water use (Peden et al., 2007). This concentration has important
 36 localized impact on water quality (Pew Commission, 2014). Excessive nutrient loading leads to
 37 eutrophication of surface waters, for instance, resulting in "dead zones" in both inland and marine
 38 waters due to algal blooms and resulting in massive fish kills and declines in biodiversity (Pew
 39 Commission, 2014). Better integrating plant and livestock production, at various levels, from farm to
 40 broader schemes can be key to improve nutrient management and water efficiency. Livestock vary in
 41 their efficiency in converting feed to animal products which significantly affects the amount of water
 42 used. Generally though, the water productivity of livestock products is much lower than that of crops.
 43 Further research is needed to assess livestock water productivity and how to improve it.

44 Rainfed agriculture is a risky business and any improvement requires dealing with rainfall variability
 45 and capacity for farmers to adopt improved approaches. If the adoption rates of improved technologies
 46 are low and rainfed yield improvements do not materialize, in a business as usual scenario, the
 47 expansion in rainfed cropped area required to meet rising food demand would be around 53% by
 48 2050 There is, however, little suitable agricultural land left; and further expansion would encroach on
 49 remaining natural forest areas, with large adverse environmental impacts (Wani et al., 2009).

50 2.1.2 Irrigated agricultural systems

51 Irrigation covers about 20% of all cultivated lands and contributes about 40% of agricultural production
 52 (Faurès et al, 2007).

53 Irrigation has been essential in achieving the productivity gains and food price reductions seen all over
 54 the world over the last three decades. Irrigation is also associated with significant multiplier effects,
 55 such as for employment in the lean season, widening of livelihood opportunities through household

1 gardens, livestock rearing, aquaculture and handicrafts, and benefits for health and nutrition (Meinzen-
 Dick
 2 1997a; Lipton et al. 2003; Domenech and Ringler 2013; Rosegrant et al. 2009a).

3 However, public investments in large-scale irrigation have declined substantially over the last two
 4 decades in much of the world; only Sub-Saharan Africa has seen strong increases in investment,
 5 albeit from a small base (Rosegrant et al. 2009b). As aptly put by CA (2007: 30) “The era of rapid
 6 expansion of large-scale public irrigated agriculture is over: for most regions a major new task is
 7 adapting yesterday’s irrigation systems to tomorrow’s needs.” This includes a re-focus on farmer-
 8 financed and managed irrigation, chiefly supported by motor pumps, smarter surface systems;
 9 judicious investment in selected, large-scale systems linked with reservoirs that are often built for
 10 multiple purposes; and reforming water management institutions toward maintaining the ecological
 11 integrity of systems while improving productivity and profitability (FAO, 2006; Rosegrant et al. 2009a;
 12 Wichelns 2014; Faurès et al. 2007).

13 Many irrigated areas in the arid and semi-arid regions face problems of reduced soil productivity as a
 14 result of secondary soil salinization. Salts accumulate in the soil in irrigated agriculture as a
 15 consequence of continuous addition of salts with poor quality irrigation water or due to a rising water
 16 table bringing salts to the surface and it is essential to remove these through leaching to protect soils
 17 and water resources (Rhoades et al 1992). Tens of thousands of hectares of productive irrigated land
 18 are salinized every year to various degrees, affecting the livelihoods of the communities and
 19 household depending on this land. As an example, 50% of the fertile land in Iraq has been salinized
 20 over the last 2 decades due to mismanagement or lack of drainage facilities (Wu et al 2014), and in
 21 Central Asia, the lack of maintenance of irrigation systems is causing salinization of irrigated lands.

22 Two strategies are available to deal with salinity: allowing the land to salinize and then cultivating salt
 23 tolerant crops and halophytes; or controlling salinization through leaching and maintaining highly
 24 productive land. It is estimated that 40-60% of irrigated areas require drainage to avoid soil salinization
 25 (Tanji and Kielen 2002). Unless this is not feasible for some reason, this is the recommended strategy
 26 in irrigated areas, which requires investment in drainage facilities and irrigation management with
 27 appropriate institutions and policies.

28 The challenge for irrigated agriculture in this century is to improve equity, reduce environmental
 29 damage, strengthen ecosystem functions, and enhance water and land productivity in existing and
 30 new irrigated systems. This is possible through linking existing irrigation systems to national
 31 socio-economic conditions and especially by supporting farmers with improved small irrigation
 32 systems and input particularly in sub-Saharan Africa and Southeast Asia (Faurès et al, 2007).

33

Box 7 The gendered nature of irrigation and water management

Globally women own only 2% of land (Urban Institute 2011). Because access to irrigation depends on land ownership and women are much less likely to own land, they are largely precluded from irrigation access. It is largely men and male engineers who dominate the irrigation sector and the implementation of water and sanitation projects (Zwarteveen 2008). Even where the involvement of women is a requirement of the implementing agency it is often tokenistic or women and girls are expected to devote their voluntary labour rather than have any clear influence on decision-making or develop particular skills.

For example, as a rule, men are trained to manage wells, pumps and sanitation facilities and women are required to maintain and clean them, drawing on the traditional imagery of women as the keepers of cleanliness and purity in their families and local communities. Women’s participation in decision-making is hampered by cultural barriers and traditional gender roles and they are often excluded from irrigation or water management committees. Nationally and internationally very few women are represented in relevant ministries and international agencies or bodies (Zwarteveen 2008).

34
 35

Box 8 Changes in irrigation in Spain

Recent shifts in Spain's water management, particularly as it seeks to comply with the EU Water Framework Directives, have led to conflicting developments adversely affecting irrigation. The Shock Plan of Irrigation initiated in 2006 was intended to save water and align with European water policy regulations (Ministry of Agriculture, Fishing and Food and Ministry of the Environment, n.d.). Spain's modernisation of irrigation systems, which refurbished and modernised about 1.3 mill ha of irrigation schemes, coupled with farmers' move from gravity irrigation to drip irrigation, has been shown to conserve water resources. But moving from canals to pressurized conveyance networks and drip irrigation requires substantially more energy (Hardy et al. 2012). From 1970-2007, on-farm irrigation water use decreased by 21% while the cost of energy consumption increased by 657% (Corominas 2010 cited in Stambouli et al., 2014). These changes have meant that now 40% of electricity used in Spain on water-related activities is used for irrigated agriculture (Hardy et al., 2012). At the same time, Spain moved toward a changing energy mix adding more renewable energy sources, subsidized by increases in energy tariffs (using the feed-in regulation) and increasing the electricity tariffs to all Spanish users as well. For farmers the result of these dual developments are ambiguous: while their capital and infrastructure improved significantly, with all the benefits this creates, the cost of electricity has grown significantly. This, and the financial costs of the investments, which were only partially funded by the government is the main drawback of this major policy reform. Less water consumption, greater water and land productivity, more water control and monitoring and better farmers' lives are, however, unquestionable benefits (Garrido, pers com).

Groundwater for irrigation

Thanks to access to new drilling technologies and cheaper pumps, a groundwater revolution has taken place since the late 1980s and early 1990s and millions of farmers and pastoralists in Asia have improved their livelihoods and food security as a result. Groundwater development has been particularly rapid in the Indo-Gangetic plains of South Asia and the North China plains, both areas with high concentrations of poor farmers. The Gulf Countries rely almost entirely on groundwater, although with increasing production of freshwater through desalination. There are estimates that groundwater accounts for 38% of the total irrigated area and 43% of total irrigation volumes (Siebert et al., 2010). While in parts of South Asia groundwater expansion was directly associated with higher water tables arising from leaky public surface irrigation systems (Indo-Gangetic Plains) in other places groundwater use developed due to the lack of available surface systems (e.g. in the Vietnamese Central Highlands for coffee production). In yet other places, easily accessible aquifers have resulted in over-exploitation of groundwater (for example the Ogallala in the US; or much of the groundwater pumping in Bangladesh).

Table 1 Global survey of groundwater irrigation

REGION	GROUNDWATER IRRIGATION		GROUNDWATER VOLUME USED	
	Mha	propn total	km ³ /a	propn total
GLOBAL TOTAL	112.9	38%	545	43%
South Asia	48.3	57%	262	57%
East Asia	19.3	29%	57	34%
South-East Asia	1.0	5%	3	6%
Middle East & North Africa	12.9	43%	87	44%
Latin America	2.5	18%	8	19%
Sub-Saharan Africa	0.4	6%	2	7%

Source: GWP (2012), derived from Siebert *et al.* 2010

Importantly, there is evidence from Asia to suggest that groundwater irrigation 'promotes greater interpersonal, inter-gender, inter-class, and spatial equity than does large surface irrigation' (CA 2007: 32).

The energy-groundwater nexus has created a curious political economy paradox: soaring energy prices may help save the aquifers in those places where energy for pumping is not (highly) subsidized and where groundwater-based livelihood systems are currently under threat from over-pumping of groundwater. Increased energy costs are likely to reduce the amount of pumping done, thus reducing over-abstraction from groundwater.

But in areas with good aquifers and recharge and a high prevalence of poverty, such as the Eastern Gangetic plains, the groundwater potential could be further exploited. Groundwater irrigation remains an important development strategy especially in countries where it is still underutilized such as in parts of Central Asia (Rakhmatullaev et al., 2010, Karimov et al., 2013) and much of Sub-Saharan Africa (MacDonald et al., 2012). Enhancing groundwater management will require interventions on both the supply and demand side. Supply-side measures may include artificial recharge, aquifer recovery or the development of alternative surface water sources, while demand-side measures generally focus on water use rights and permits, collective management, water pricing, legal and regulatory control and water saving crops and technologies (CA, 2007) (see also Box 12).

Box 9 Groundwater regulation

Groundwater is much more challenging to govern than surface water resources because it is not visible, underground connections and flows are seldom well-understood and the interaction between surface and groundwater is also poorly understood. Moreover, individual well owners are often dispersed, might themselves have several wells, and often consider groundwater as private property. It is also generally not directly or easily known how extraction by one party affects others. Groundwater use is also relatively recent, compared to surface water irrigation, and the norms and regulations for its management have yet to mature. This can lead to a 'race to the bottom' where those with the strongest and deepest wells persevere until the resources are exhausted (Bruns, 2014). Attempts at top-down formal regulation of groundwater use, based on well licensing and regulation of water withdrawals, have usually been ineffective (Shah 2009). There are some cases of successful, formalized groundwater management, such as in parts of southern California (Blomquist 1992), but management does not necessarily prevent depletion. The Andhra Pradesh Farmer Managed Groundwater Systems Project (APFAMGS) is one of very few successful, voluntary groundwater governance systems which has resulted in both higher farmer incomes and water savings (World Bank, 2010b; Das and Burke, 2013). The project was implemented through direct community leadership of hydrological monitoring and measuring of local rainfall and groundwater levels. The information was then displayed publicly. Moreover, communities co-developed crop-water budgets and received information on alternative crops and cultivation practices (Garduño et al., 2009). Why did increased profitability not lead to irrigation expansion and further depletion? Bruns (2014) suggests that the creation of common knowledge and shared strategies helped to limit water use and balance water demand and supply.

Sustainable groundwater management requires balancing demand and supply which is dependent on usually uncontrollable natural recharge. However, supply-side measures may be easier to implement than demand-side measures due to local socioeconomic and political factors. The only way to maintain aquifer systems to an acceptable degree may be to control the expansion of irrigated areas, improve practices, and adopt water-use efficient crops. (Shah et al 2007; Rakhmatullaev et al 2010).

2.1.3 Resilience of agriculture to climate variability and change

As discussed in Chapter 1, climate change is causing increased rainfall variability and the frequency of extreme events such as drought, floods, and hurricanes (IPCC 2013). Agricultural losses have been estimated at 10%–20% of production area, with some 1–3 billion people possibly affected by 2080 (Fischer et al. 2002). Hilhost and Muchena (2000) estimate that cultivation potential in Sub-Saharan Africa could decline by 12%, particularly in the Sudano-Sahelian zone. Moreover, by increasing the volatility of crop yields, climate risk has been shown to provide disincentives for investments in soil fertility and agricultural technologies, including improved crop varieties and other yield enhancing inputs (Boucher et al, 2008; Barrett et al, 2007; Vargas Hill and Viceisza, 2011; Binswanger-Mkhize, 2010; Barnett et al, 2008).

The potential impacts of climate change on the two major agricultural systems are very complex and vary from one region to another. For example, rising temperatures and CO₂ levels will harm crop productivity in warm and water scarce environments, while they will increase productivity of crops in cool and water abundant environments for a period at least.

"In the short term, warming may improve agricultural yields in some cooler regions, but significant reductions are highly likely to dominate in later decades of the present century, particularly for wheat, rice and maize. [There are] numerous studies in the scientific literature, showing that, from 2030

onwards, significant losses are to be expected. This should be seen in the context of already existing malnutrition in many regions, a growing problem also in the absence of climate change, due to growing populations, increasing economic disparities and the continuing shift of diet towards animal protein” (IPCC 2014).

Rainfed agriculture will be directly affected by climate change in three ways (Wreford et al. 2010):

- Increased temperature and CO₂ levels will increase evapotranspiration and reduce soil water which will put stress on all plants in dry ecosystems, shortening crop growing periods and reducing yields. In wet and cool agro-ecosystems the same changes may prolong crop growing periods and increase yields.
- Rainfall patterns are likely to change in both dry and wet regions though predictions in rainfall changes lack precision. More serious will be the intensity and distribution of rainfall. Increased intensity will encourage more runoff with higher soil erosion and lower opportunity for infiltration into the soil causing more moisture stress on plants and reduced recharge of groundwater. While this may increase the availability of surface water it may also result in increased floods. Changes in rainfall distribution are likely to intensify drought spells and the duration of droughts, exposing crops to moisture stress, and reducing rainfed yields and quality.
- Climate change will also affect rainfed and irrigated agriculture through impact on biotic factors such as diseases and pests. While it is likely that that these impacts will be substantial there is insufficient information and more research is needed in this area.

Irrigated agro-ecosystems will be affected by climate change in two ways (Wreford et al. 2010, IPCC 2014):

- Blue surface water supply may be higher in some regions as more runoff will be generated as a result of increased rainfall intensity. By contrast, less groundwater resources are likely to be available as a result of reduced infiltration. The overall impact on blue water resources is difficult to predict especially taking into consideration the variations between regions. More modelling work is needed in this area.
- Increased temperature will increase evapo-transpiration so that more water will be needed for irrigation. But increased CO₂ levels will also act as a fertilizer for crops and improve transpiration efficiency causing water productivity to increase. Again, further research is needed to understand the overall impacts of climate change in terms of crop water use.

2.2 Water Use in Food Processing

In this context the term “water use” actually refers to water withdrawals, and there is no available data to separate water use for industrial processing from water use for the other activities listed above (fabricating, diluting etc). The USGS reports that the “industries” that use the largest amount of water are those that produce food, paper, chemicals, refined petroleum, or primary metals (Kenny et al. 2009). In the US, in 2005 the amount of water for industrial use, including processing, was estimated at 70 cubic metres of water per day. Eighty-two percent of this total was supplied through surface water and the rest from groundwater. In the food sector, water use for processing is significantly less than for production, but still significant Table 1 (Kirby et al. 2003).

While relatively low in volume, wastewater discharged from food processing tends to be highly polluting if untreated, and as such warrants analysis. Water use for processing may have different meanings in different sectors. According to the US Geological Survey (USGS) “industrial water use includes water used for such purposes as fabricating, processing, washing, diluting, cooling, or transporting a product; incorporating water into a product; or for sanitation needs within the manufacturing facility” (USGS 2014).

Use of water at the food processing stage includes adding water to food, and the use of water as transport and for cleaning (Table 2). Kirby et al. (2003) estimated that general changes in culture, such as educational and monitoring programmes, and changes in operations (e.g. installation of taps with automatic shut-off systems) could reduce consumption by up to 30%. Further improvements could be achieved through water reuse and recycling, but would require higher capital investments.

Table 2 Water use in selected food processing activities

Industry	Liters per ton of product
<i>Fruits and Vegetable</i>	
Green beans	45,000-64,000
Peaches and Pears	13,600-18,000
Other fruit and vegetables	3,600-32,000
<i>Food and Beverages</i>	
Beer	9,000-14,500
Bread	1,800-3,600
Meat packing	13,600-18,000
Milk products	9,000-18,000
Whiskey	55,000-73,000

Source: Unido

Table 3 Water quantity and quality requirements for selected processes in food processing

Process	Relative water quantity	Water quality
Direct preparation of product	Low	High–Potable
Bottled water	High	High–Potable
Cooling water	High	Medium–High
Product washing	Medium–High	Medium–High
Fluming water	High	Medium–High
Production of ice, hot water, and steam	?	Medium–High
Air conditioning and humidity control	?	Medium–High
Starting-up, rinsing and cleaning of processing equipment	High	High
Cleaning and disinfection of processing facilities	High	Medium
Sanitization water	?	?
Boiler feed water and fire extinguishing	High	Medium

Source: Modified from Kirby et al. 2003; data from Codex Alimentarius Commission 2000

The food processing sector has potentially adverse environmental impacts through the release of wastewater from processing facilities, as well as through the production of solid waste. Wastewater from fruit and vegetable processing may be rich in pesticides and suspended solids. Rinds, seeds and other raw material require storage or composting. Meat, poultry and seafood processing produce wastes that are more difficult to treat and control. Blood and other by-products create a waste-stream high in BOD and that may carry pathogens. The best method for environmental protection and reducing water pollution has been to develop systems to reduce, reuse, recycle and treat wastewater from food-processing. Reduction consists in limiting the amount of waste before it is washed away from the processing facilities. Reuse of waste products through composting, soil additives, or animal feed are approaches that help reduce waste and reuse important nutrients. Wastewater can then undergo an advanced treatment process which may include ozone or chlorine disinfection when needed (e.g. meat by-products) (Unido, n.d.); see for example Box 10.

The above **gives a partial and very incomplete picture** of how much water is used in the food processing, distribution and retail end of the food chain/value chain. In the case of more industrialised food systems where food supply chains have become extremely complicated and geographically dispersed, there is a high probability that the above water use metrics are considerably underestimated.

The approach needs to be based on a more systemic life cycle analysis. All stages involved when moving the food product through the processing, distribution and retailing (and subsequent waste management stages) need to be assessed—so that the analysis covers the water use of all processes involved in the production and delivery of a food product, including water used in manufacturing machines and tools used in food processing and distribution.

This comprehensive approach would lead to a more accurate value for the water footprint, embodied water, or other indicator of water use. The total embodied water or water footprint of any given step in food processing should thus include all stages of the manufacturing process of the machines and tools (e.g. canning units, meat processing facilities, mills....) used in food processing and distribution, - from the water used in mining of raw materials through to manufacture of machines and tools as well as distribution and then waste management.

Box 10 Case study Vissan Slaughterhouse, Ho Chi Minh City, Vietnam

In 1999, VISSAN was the only large, integrated modern slaughter house and meat processing unit in Ho Chi Minh City, processing cows and pigs. But almost all by-products and waste streams generated by the slaughtering process were directly discarded into local water bodies. These included blood, hides, offal, stomach contents and manure, wastewater and hair, leading to a high organic pollution load. A cleaner production team funded by SIDA and UNIDO identified a series of causes of waste generation listed in the table below as well as a series of solutions. Solutions, such as collecting blood for sale as fish meal, and solid waste from offal cleaning for resale as manure brought immediate benefits in terms of hygiene, water use reduction and reduced choking of sewers as well as potential income from sales. Changes in the water pipes used and installation of closed loop cooling systems brought further large benefits in terms of water savings and hygiene. As the polluter-pays principle is not in force in many countries, the identification of win-win approaches such as those that improve the balance sheet of the company while also reducing adverse impacts on natural resources from either over-extraction or pollution will continue to play a major role in managing the rapidly growing number of processing industries in the world.

Source: SIDA/UNIDO/DOSTE. 1999.

2.3 Water re-use

2.3.1 Dealing with wastewater and marginal quality water

In recent years, the use of marginal quality water has emerged as an important source of water. Potential sources include natural brackish water, agricultural drainage water, and treated sewage effluent. Notable amounts of brackish water, mainly in groundwater aquifers, can either be used directly in agriculture or be desalinated for human and industrial use. A number of fresh water aquifers have become brackish as a result of groundwater mining and seawater intrusion. Using brackish water in agriculture can contribute to food production and the environment, but it requires special scheduling to prevent land salinization and degradation of ecosystems, as well as the development or selection of crops that tolerate some level of salinity.

In the last few decades there has been considerable research on the reuse of drainage water in agriculture and its impacts on the environment. In Egypt, the drainage water from agricultural lands is collected by an extensive drainage network and recycled after being mixed with fresh water downstream, until it becomes too saline for productive use. Currently about 5.5 billion m³ of drainage water are reused annually and this is expected to increase to about 10 billion m³ by the year 2017 (Abdel-Shafy and Mansour 2013).

Millions of small-scale farmers in urban and peri-urban areas of developing countries irrigate with wastewater from residential, commercial, and industrial sources, in many areas not treated before use. In some areas there is scope for expanding irrigation on this basis, while in others the challenge is to

get more productivity from existing infrastructure. Many factors prevent the expansion of wastewater reuse, however, including social barriers, technical obstacles, and institutional and political constraints. Utilizing treated sewage water is essential especially in water scarce areas such as the Middle East and North Africa but requires policies to properly control quality and handling in the field (UNDP, 2013). Given the significant health risks associated with wastewater reuse, CA (2007) suggests three approaches to addressing marginal water: 1) reduce the volume of wastewater generation; 2) address risks in agricultural use of wastewater; and 3) improve handling of food that was irrigated with wastewater.

Box 11 Urban agriculture

Urban agriculture has the potential to contribute to food security both directly through producing nutritionally rich food for consumption and indirectly by providing livelihoods to urban poor through producing food for the market (Zezza and Tasciotti, 2010). However, while urban agriculture has been shown to be important to urban poor households' food security by contributing to dietary diversity and calorie availability, these impacts are limited, particularly for the poorest households (ibid). Participation in urban agriculture is correlated with wealth and landholdings since it requires access to land, water and inputs (Frayne et al., 2014), limiting its potential as a solution to food security issues for the urban poor.

Despite these limitations, urban agriculture has seen successes. For instance, in the Kibera slums in Nairobi, Kenya, sack gardening has become increasingly common since it can be practiced with limited space and water (Gallaher et al., 2013). This form of urban agriculture has been demonstrated to have a positive impact on household food security and has enabled these households to skip fewer meals, although its impacts are limited by household access to inputs (ibid). Urban agriculture is also viewed as having positive impacts on food security in developed countries. A recent report on urban agriculture in London called for planning policy that would encourage agriculture in the capital in order to improve food security and meet the demand for locally grown food (London Assembly, 2010). In this context, problems faced by urban agriculture tend to be issues with competition over high priced land, access to irrigation infrastructure and avoiding the use of expensive, potable water, getting food to the market, and soil and air pollution (ibid). Peri-urban agriculture has also received attention from city planners since these peri-urban regions shape cities. Maintaining farmland in peri-urban regions can provide benefits to urban centers, such as environmentally processing waste, ecosystem management and job creation through agri-tourism (Brinkley, 2012).

2.3.2 Desalination

Desalination of salt water is a potential new source of freshwater especially in water scarce countries. Increased water demand coupled with lower production costs due to technological advances has helped in the rapid growth of this sector. Nonetheless, its production is still generally too costly for agricultural use and it has high energy demands. According to Ghaffour et al. (2013), desalination capacity is continuing to grow rapidly in water-short countries where demands on water resources have risen beyond reliable supplies and as desalination costs have declined to less than US\$0.50 in some places. These lower costs are, however, generally associated with energy subsidies and ignore environmental costs. As new technologies develop, costs might eventually drop sufficiently to enable the profitable use of desalinated water for agriculture, possibly using natural gas as a source of energy.

2.4 Improving water management and uses in agriculture and food systems

Without improvements in agricultural water productivity the world will need to substantially increase water withdrawals to produce more food. However, this is not inevitable and world food demands can be satisfied with available water and land resources by increasing water and land productivities through upgrading rainfed and irrigated systems; optimizing virtual water flows (trade) between countries based on comparative advantages; and reducing food demand by adjusting diets and improving the efficiency of food processing and distribution (CA, 2007). We now focus on the agricultural water use aspects of these pathways.

2.4.1 Improving water and land productivities

The water consumed in agriculture is currently estimated at 7,130 billion m³ per annum and with current levels of soil-moisture conservation efforts and productivity, an increase in water supply of 60%–90% will be needed by 2050.

In water scarce regions, as the amount of water available for agriculture is declining due to competition with other sectors, food security is increasingly threatened. If the non-agricultural consumption of water continues to grow at present rates, the share of water for agriculture in several North African countries will drop to 50% in 25 years. In several countries, such as Jordan, marginal-quality water will soon become the major source of irrigation water. Despite its scarcity, water continues to be misused.

New technologies allow farmers to extract groundwater at rates far in excess of recharge, rapidly depleting centuries-old aquifers. Water scarcity and mismanagement will also accelerate environmental degradation, through soil erosion, soil and water salinization, and waterlogging. These are global problems, but they are especially severe in the dry areas (Pereira et al., 2002).

In water scarce areas, there is not much water to divert to agriculture to meet increasing food demand. The only feasible alternative is to increase the productivity of available water.

Improved water productivity reflects the objectives of producing more food, income, livelihoods, and ecological benefits at less social and environmental cost per unit of water used, either delivered to or depleted by the use. The ecological benefits and lessened social/ environmental costs referred to here derive from improving blue/green water productivity, and do not include improving grey water productivity (reducing water pollution, measured in total maximum daily load or TMDL). It simply means growing more food or gaining more benefits with the same amount of or less water. Physical water productivity is the ratio of the mass of agricultural output to the amount of water used, and economic water productivity is the value derived per unit of water used. Water productivity may be measured specifically for crops (crop water productivity) and livestock (livestock water productivity). Equally important is nutritional water productivity (nutrition such as protein per unit of water used) or calories per unit of water used (Molden et al., 2010). Water productivity can evaluate returns to water across all scales and sectors (such as accounting for multiple uses of water) and help relate water productivity to improvements in food security and reductions in poverty (Molden et al., 2007).

There are several important reasons to improve agricultural water productivity (Molden et al., 2007):

- To meet the rising demand for food and other agricultural products from a growing, wealthier, and increasingly urbanized population, in the face of water scarcity.
- To respond to pressures to reallocate water from agriculture to cities and to ensure that water is available for environmental uses.
- To contribute to poverty reduction and economic growth. For the rural poor more productive use of water can mean better nutrition for families, more income, productive employment, and greater equity. Targeting high water productivity can also reduce investment costs by reducing the amount of water that has to be withdrawn
- To reduce the need for additional water and land in irrigated and rainfed systems as a critical response to increasing water scarcity, including the need to leave enough water of good quality to sustain healthy ecosystems and to meet the growing demands of cities and industries.

Droogers and van de Giesen (2010) suggest that water productivity can be enhanced in all types of farming systems, and particularly in livestock systems. The focus should be on areas that are currently at the lower end of the productivity spectrum as the scope for improvement is larger. This would include much of Sub-Saharan Africa, large parts of South Asia and parts of Latin America. Potential gains can be made by adopting integrated approaches and changing cropping patterns to cultivate higher value crops and through reductions in social and environmental costs. With careful targeting, the poor can benefit from water productivity gains in crop, fishery, aquaculture, livestock, and mixed systems

(Molden et al., 2007). Integrated systems also offer a wide range of food-crop choices towards nutrition security. Moreover such practices are particularly suitable for building healthy soils with higher water retention capacity, and improved presence of mycorrhizal fungi, which is a must for improving crop productivity as well as improved nutrition content of food crops produced in all types of farming systems. (Mayer, 1997; Verbrugge et al., 2010). Integrated systems can also support knowledge sharing amongst food producers towards building a sustainable and fair food system (Varghese 2013).

Table 4 Agricultural water productivity (values of produce by m³ of water consumed)

Product	Water productivity			
	Kilograms per cubic meter	Dollars per cubic meter	Protein grams per cubic meter	Kilocalories per cubic meter
<i>Cereal</i>				
Wheat (\$0.2 per kilogram)	0.2–1.2	0.04–0.30	50–150	660–4,000
Rice (\$0.31 per kilogram)	0.15–1.6	0.05–0.18	12–50	500–2,000
Maize (\$0.11 per kilogram)	0.30–2.00	0.03–0.22	30–200	1,000–7,000
<i>Legumes</i>				
Lentils (\$0.3 per kilogram)	0.6 (0.3–1.0)	0.09–0.30	90–150	2,120
Fava beans (\$0.3 per kilogram)	0.6 (0.3–0.8)	0.09–0.24	100–150	2,520
Groundnut (\$0.8 per kilogram)	0.3 (0.1–0.4)	0.08–0.32	30–120	2,382
<i>Vegetables</i>				
Potato (\$0.1 per kilogram)	3–7	0.3–0.7	50–120	3,000–7,000
Tomato (\$0.15 per kilogram)	5–20	0.75–3.0	50–200	1,000–4,000
Onion (\$0.1 per kilogram)	3–10	0.3–1.0	20–67	1,200–4,000
<i>Fruits</i>				
Apples (\$0.8 per kilogram)	1.0–5.0	0.8–4.0	Negligible	520–2,600
Olives (\$1.0 per kilogram)	1.0–3.0	1.0–3.0	10–30	1,150–3,450
Dates (\$2.0 per kilogram)	0.4–0.8	0.8–1.6	25	1,120–2,240
<i>Others</i>				
Beef (\$3.0 per kilogram)	0.03–0.1	0.09–0.3	10–30	60–210
Fish (aquaculture)	0.1 to 2.0			

a. Includes extensive systems without additional nutritional inputs to superintensive systems.
Source: Muir 1993; Verdegem, Bosma, and Verreth 2006; Renault and Wallender 2000; Oweis and Hachum 2003; Zwart and Bastiaansen 2004.

- High priorities for water productivity improvement include (Molden et al 2007):
- Areas where poverty is high and water productivity low, where the poor could benefit—much of Sub-Saharan Africa and parts of South Asia and Latin America
- Areas of physical water scarcity where there is intense competition for water—such as the Indus Basin and Yellow River—especially through gains in economic water productivity.
- Areas where ecosystem functions greatly depend on water availability such as groundwater mining and reduction in environmental flow.

Practices to increase water productivity include improved irrigation uniformity/distribution through better irrigation systems and management, adopting water-use efficient practices such as supplemental irrigation, deficit irrigation and water harvesting and improved cultural practices such as fertility and conservation agriculture. Using agricultural crop residues in animal feed and open grazing may provide a several-fold increase in livestock water productivity

Technologies can be more effective if introduced in an integrated system. Switching to higher value agricultural uses or reducing costs of production; better integration of livestock in irrigated and rainfed systems and using irrigation water for household and small industries can increase water productivity. Such integrated farming systems with better recycling of nutrients (using animal waste for energy generation or fertilising crops; using crop residue as animal feed or for energy generation; using energy generated for use in processing of crops/ animal products) contribute not only to improved nutrient content in farm products, but also help to lower the climate footprint of farming systems, compared to those using single technologies and mono-cropping (Lin et al., 2011; Pelletier et al., 2008; Scialabba and Müller-Lindenlauf, 2010).

According to the CA (2007) higher physical and economic water productivity can reduce poverty in two ways: water saved can be accessed by poor or marginal producers to produce food and generate income; and second, additional production can reduce food prices and increase employment through multiplier effects. This is only possible, however, if water savings are made accessible to the poor.

Livestock consumes about 20% of the water allocated to agriculture (de Fraiture et al., 2007). With rapid increase in animal products this portion is likely to increase in the near future. Increasing livestock water productivity can help total agricultural water needs. Savings in animal water use are

mainly associated with feed consumption. On average 1 kg of animal product uses from 3000 to 15000 m³ of water depending on management and animal efficiency in converting feed to products. Livestock water productivity includes food but also includes other elements that should be taken into account such as transport, plowing, and buffering against drought. (Molden et al., 2010). There is considerable scope for increasing both physical and economic livestock water productivity through, for example, improving feed sourcing, enhancing animal production, improving animal health, and adopting proper grazing practices to reduce rangelands degradation. (Peden et al., 2007).

Better integration of fisheries and aquaculture with water management systems can also improve water productivity. The two major components of water use in aquaculture are the water required to produce feed and that required for aquaculture. Water needs range from 0.5 to 45 cubic meters per kilogram of produce depending on the intensity/extensity of the system used (Verdegem et al., 2006). Fish can often be integrated into water management systems with the addition of little or no water (Prein, 2002). Aquatic ecosystems provide many other services and benefits beyond fisheries such as biodiversity. Considering only the values of fish produced per unit of water is an underestimation of water productivity in these systems (Dugan et al 2006).

Achieving meaningful improvement in water productivity however, cannot be done through technological advancement alone. It requires enabling policies and a healthy institutional environment to align users' incentives at various scales and to encourage the uptake of new techniques and to deal with tradeoffs (CA, 2007: 25-26).

Increasing water productivity is an effective means of intensifying agricultural production and reducing environmental degradation. There is still ample scope for higher physical water productivity in low-yielding rainfed areas and in poorly performing irrigation systems, where poverty and food insecurity prevail. Good agricultural practices—managing soil fertility and reducing land degradation—are important for increasing crop per drop. Livestock, fisheries and aquaculture reveal scope for improvements as well.

2.4.2 Upgrading rainfed agriculture

According to Rockstrom et al. (2010), the scope for improving outcomes on the 70% of rainfed harvested area that produces more than half of the gross value of food is large and attention should be focused on enhancing rainfed outputs through better water management. The scope can be seen when comparing rainfed production in developed with that of developing countries. According to Rosegrant et al. (2002), more than 80% of the cereal harvested area in developed countries remains rainfed, and is highly productive with average yields equal to irrigated cereal yields in developing countries.

The Comprehensive Assessment of Water Management in Agriculture (2007) reflected significant progress in upgrading rainfed systems with minimal increases in irrigated production which reached 80% of its potential. To meet rising demand for food until year 2050, an average annual growth of yield of 1%. Assuming no expansion in irrigated agriculture this will only require an additional 7% to the existing agricultural lands. (Wani et al., 2007).

Despite successes in upgrading rainfed agriculture by research and developments in several countries of the world, through soil- water and crop management practices, supplemental irrigation and water harvesting, these tend to be isolated successes in practice. Adoption rates have been low for four main reasons: low profitability, often a result of fluctuating international markets and/or dumping of agricultural commodities, or due to lack of local processing facilities; poor access to storage or markets; relatively high labor costs; and high risks. What is now needed is to improve farmers' access to markets, credits, inputs, and opportunity for learning from the successes of others through, for example, farmer-to-farmer exchanges. The most important is to improve water availability to crops — because without having water where and when it is needed, rural people risk crop failure and hunger (CA, 2007).

Better management of rainwater, soil moisture, and supplemental irrigation is the key to helping the greatest number of poor people through: reducing yield losses from dry spells; giving farmers the security to risk investing in other inputs such as fertilizers and high-yielding varieties and allowing farmers to grow higher value market crops, such as vegetables or fruits. Such approaches are practiced in many parts of the world. Often these practices are rooted in farmers' experiences and traditional knowledge of their agro-ecosystems, and at times are combined with other principles such as using zero external input, or using only organic inputs. Case studies on such approaches show how they help farmers cope with climate challenges (Wani et al., 2007).

- 1 Supplemental irrigation (SI) is a key strategy, still underused, for unlocking rainfed yield potential and
 2 water productivity in rainfed agriculture. Supplemental irrigation can substantially increase rainfed
 3 production by using limited amounts of water, applied during dry spells, to alleviate soil moisture
 4 stress. The critical importance of supplemental irrigation lies in its capacity to bridge dry spells and
 5 thereby reduce risks in rainfed agriculture. Evidence indicates that supplemental irrigation of 50–200
 6 mm a season is sufficient to double or more the rainfed yields. Such small amounts can be collected
 7 using water in local springs, shallow groundwater, water harvesting or conventional water resource
 8 schemes. Supplemental irrigation allows modifying crop calendars to escape climatic extremes and
 9 adapt to climate change. By reducing risk, supplemental irrigation may provide the necessary incentive
 10 for investments in other production factors such as improved crop varieties, fertilizer, labor, and tillage
 11 techniques and for diversification (Oweis 2014).
- 12 Supplemental irrigation can, in addition to improving rainfed crop yields and water productivity, helps
 13 stabilizing farmers' production and income. For the greatest benefit, supplemental irrigation should be
 14 accompanied by a package of soil and crop management practices. In areas where groundwater is
 15 used policies should encourage deficit supplemental irrigation to reduce pumping and sustaining the
 16 functionality of the aquifers (World Bank 2006).
- 17 Supplemental irrigation is also an effective practice to support adaptation to climate change. It is likely
 18 that drought spells will be more frequent and intensive crops will be more exposed to soil moisture
 19 stress with subsequent yield loss. This can be bridged by limited amounts of supplemental irrigation.
 20 Furthermore it will allow higher levels of CO₂ to act as fertiliser and increase water use efficiency and
 21 yields in rainfed systems (IPCC, 2014, Sommer et al 2011).
- 22 Rainwater harvesting (WH) represents the real recovery of otherwise lost water in rainfed systems and
 23 provides opportunities for decentralized community-based management of water resources. In dry
 24 environments, hundreds of billions of cubic meters of rainwater are lost every year through runoff to
 25 salt sinks and evaporation from bare soil surfaces as a result of a lack of proper management and
 26 sustainable ecosystems development. Through water harvesting, runoff water is collected and stored
 27 for beneficial use, either in surface storage areas, in the soil profile or by recharge of aquifers. Stored
 28 water can be used later if retained in surface or groundwater storage for human, animal or SI use, or
 29 used immediately by crops from soil profile as green water. Often WH halts soil erosion and improves
 30 soil fertility especially when micro catchments types are used. Water stored in surface ponds or
 31 aquifers are often used as a source of supplemental irrigation.

Box 12 Supplemental irrigation package may triple rainfed productivity

Research has shown that wheat yields can be increased from 2 tons per hectare to more than 5 tons per hectare by the conjunctive use and timely application of only 100 to 200 mm of irrigation water. While the limited amount of water available would not support a fully irrigated crop it can substantially increase productivity when used as a supplement to rainfall. Water productivity under Supplemental irrigation is far higher than in conventional full irrigation. Wheat productivity in non rainfed areas is less than 1 kilogram per cubic meter but up to 2 kilograms per cubic meter under Supplemental Irrigation. Thus, Supplemental irrigation also improves the productivity of limited rainfall. (Oweis and Hachum. 2003).

The area of wheat under Supplemental irrigation in northern and western Syria has increased from 74,000 hectares (in 1980) to 418,000 thousand hectares (in 2000), an increase of 470 percent. The estimated mean increase in net profit between rainfed and Supplemental irrigation for wheat equals US\$300 per hectare. Supplemental irrigation with deficit irrigation led productivity in northwest Syria to increase from 0.84 to 2.14 kilograms of grain per cubic meter of water. Many farmers over irrigate their wheat fields, but when there is not enough water to provide full irrigation to the whole farm, the farmer has two options: to irrigate part of the farm with full irrigation, leaving the other part rainfed, or to apply deficit Supplemental irrigation to the whole farm. In areas where water is more limiting than land, applying deficit irrigation increased the benefit by more than 50 percent compared with the farmer's usual practice of over irrigation. (Oweis and Hachum 2003)

'In Sub-Saharan Africa and other tropical semi-arid areas, rainwater harvesting, which collects surface runoff, is used to provide water for Supplemental irrigation. Although seasonal rainfall in these environments is higher than around the Mediterranean, its effectiveness is low because of higher evaporation losses and lower soil-water holding capacity at the root zone. Research in Burkina Faso and Kenya has shown that Supplemental irrigation of 60 to 80 mm can double and even triple grain yields from the traditional 0.5–1 ton per hectare (sorghum and maize) to 1.5–2.5 tons per hectare. However, the most beneficial effects of Supplemental irrigation were obtained in combination with soil-fertility management. The major constraint to Supplemental irrigation development in Africa is farmers' capacity, both technical and financial, to develop storage systems for runoff water'. (Rockströmet al., 2003 cited in World Bank 2006: 210).

Water harvesting plays a crucial role in adapting to climate change and increasing agricultural resilience. By slowing down or halting the increased runoff that will result from increased intensity of rainfall, rainwater harvesting allows more rainwater infiltration, increased soil water storage and better recharging of groundwater. As water harvesting efficiency is dependent on runoff, climate change, by increasing rainfall intensities may in fact provide an opportunity instead of a disadvantage. (Oweis et al 2012).

The objective of increasing investment in rainfed agriculture is to reduce vulnerability to risks and improve productivity. Those are compelling to insure equity and sustainable development. Implementing already developed technologies in rainfed areas is usually cheaper than that in irrigated areas and can be implemented easily with fast returns that help farmers to increase income. Some practices, however, like water harvesting and supplemental irrigation need infrastructure and equipment that can be an obstacle for small and poor farmers (CA, 2007).

In semi arid regions, where rainfall amounts and distribution are not optimal and drought events are both in short and long durations are also subject to future climate change. Farmers under these circumstances are reluctant to invest in inputs or infrastructure to reduce risk creating a circular of risk and poverty. Investing in supplemental irrigation and water harvesting would help farmers overcome both short and long dry spells and sustainably upgrade their rainfed agriculture. (Wani et al., 2007). The right incentives and measures to mitigate risks for individual farmers, water management in rainfed agriculture hold large potential to increase food production and reduce poverty, while maintaining ecosystem benefits include (Rockström et al., 2010):

- Make rainwater available to crops when it is most needed, for example, through storage of precipitation, and more efficient use.
- Building the capacity of water planners, policymakers extensionists and community institutions in rainfed systems
- Use an integrated approach that considers rainwater management in upper catchments in addition to on-farm management.
- Use Learning and Practice Alliances to scale up technologies and practices (see Box 14).

Box 13 Rainwater harvesting improves rainfed systems in Africa and China

In the Gansu Province in China small subsurface storage tanks are promoted at a large scale. These tanks collect surface runoff from small catchments. Research using these subsurface tanks to alleviate the drought spells that stressed rainfed wheat in several counties in Gansu Province (Li et al., 2000) indicates a 20% increase in water productivity. Water productivity increased on average from 8.7 kg/mm/ha for rainfed wheat to 10.3 kg/mm/ha for wheat receiving supplemental irrigation. Incremental water productivity ranged from 17 to 30 kg/mm/ha, indicating the large relative added value of supplemental irrigation. Similar results were observed in maize, with yield increases of 20 to 88%, and incremental water use efficiencies ranging from 15 to 62 kg/mm/ha of supplemental irrigation (Li et al., 2000).

Benefiting from the Chinese experience with subsurface tanks, similar systems are being developed and promoted in Kenya and Ethiopia. In Kenya (Machakos district) these tanks are used to irrigate kitchen gardens, and enable farmers to diversify sources of income from the land. Micro-irrigation schemes are promoted together with commercially available low-pressure drip irrigation systems. Cheap drip kits (e.g. the Chapin bucket kit) save water and labour, and are increasingly adopted among farmers, e.g. in Kenya. Combining WH with drip irrigation can result in very significant water productivity improvements. (Rockström et al., 2001).

In Kenya (Machakos district) and Burkina Faso (Ouagouya), surface runoff from small catchments (1-2 ha) was harvested and stored in manually dug farm ponds (100-250 m³ storage capacity). In 200, seasonal droughts in Kenya and Burkina Faso resulted in complete crop failure for most neighbouring farmers, but the WH system enabled the harvest of an above average yield. The highest improvement in yield and water use efficiency was achieved by combining supplemental irrigation and fertilizer application. It indicates that full benefits of WH for supplemental irrigation can only be met by simultaneously addressing soil fertility management (Rockström et al., 2001).

Box 14 Building solutions with farmers through Learning and Practice Alliances

In East Africa, rainfed farming can be high risk (Rockström et al, 2003; Wani, et al 2009)). Long or short rains fail and crops die or provide consistently low yields. Rain, when it comes, can also be in highly destructive bursts, causing soil compaction and massive run-off. Smallholder farmers face a real challenge, therefore, in capturing, storing and using the resource effectively to help support crop production for their own food security or the wider market for food stuffs and cash crops.

Through Learning and Practice Alliances, CARE has been working with smallholders and local extension staff and researchers in Ethiopia, Tanzania and Uganda to establish and scale up technologies and practices that can enhance the effective management and use of water for smallholder agriculture. This 'water smart agriculture' (CGIAR 2014) entails helping farmers make informed choices about ways of improving the capture and storage of surface runoff, accessing and using sustainably available groundwater and, crucially, maximizing the efficient use of rainfall, or 'green water', with a focus on enhancing soil water retention around crop root systems.

The specific focus of this work under the Global Water Initiative East Africa (CARE 2013) is to seek increased farmer productivity and resilience through empowering women farmers. Though comprising the bulk of farmers in many communities, women often have fewer opportunities to access investments and inputs into their farming (UNEP 2013) and can struggle to 'graduate' to farming that produces a surplus each year. Many of the technologies and practices that are available are simple and low-cost, including rainwater harvesting tanks for dry season cropping in northern Uganda, hillside terracing and 'double digging' to break hard pan soil compaction in the Kilimanjaro Region of Tanzania and the establishment of small-scale irrigation to supplement rainfed cropping in the Amhara region of Ethiopia. CARE's emphasis is on joint learning and peer-to-peer demonstration to help scale up successful techniques and practices and to monitor impacts across seasons and years, encouraging farmers to become investors in innovation.

Further information here: www.gwieastafrica.org; <https://www.facebook.com/GWIEastAfrica>; http://www.iwmi.cgiar.org/Publications/CABI_Publications/CA_CABI_Series/Water_Productivity/Unprotected/0851996698ch9.pdf

2.4.3 Investing in irrigation

Although still needed, investment in irrigation must become more strategic. Irrigation development needs to take into account the full social, economic and environmental costs and benefits of its development and development should be chosen from a range of portfolio options, ranging from small-scale, individual-farmer managed systems to large-scale, reservoir based systems (Wichelns, 2014; CA, 2007; Faurès et al., 2007). At the same time, rehabilitation of existing systems, chiefly through irrigation management reform has started to show promise. Conjunctive use systems, such as those in parts of South Asia have superseded surface-only systems to achieve higher productivity and efficiency. In yet other systems, multiple-uses of irrigation water have increased benefits of irrigation alone (CA, 2007; Meinzen-Dick, 1997a). Given growing water availability under climate change, irrigation systems will be called upon to provide even more water control to compensate for more erratic precipitation, which will come at a cost, given that much of the infrastructure is aging (CA, 2007).

Unless water savings are made in the current system, it will be difficult to achieve substantial expansion. Some measures towards saving water are discussed below.

Increasing irrigation efficiency

This concept is often subject to controversy and misinterpretation. Because only 30%–50% of the water withdrawn from its source is actually evapo-transpired by crops in a typical irrigation system, many conclude that substantial gains in water volumes can be obtained by increasing application efficiency in irrigation. However, as Seckler et al. (2003) state, irrigation efficiency improvements at the system level might yield little real water savings as water is reused many times in river basins; and the concept of water efficiency is therefore site-, scale- and purpose-specific (Lankford 2006). It is, therefore, important to understand the hydrology of the entire catchment or basin before suggesting investments in water use efficiency. Other issues to consider when devising irrigation efficiency improvements include the irrigation design, operation and management, equity in access, energy savings and levels of waterlogging and salinization (Bos et al., 2005; Faurès et al 2007).

Modernizing irrigation systems

Many countries strive to convert traditional surface irrigation to modern systems, such as drip and sprinklers, which achieve higher water application efficiency and yields. The lower efficiency of surface systems is mainly a consequence of low application efficiency. These losses occur at the field level, but often are partially or fully recovered at the scheme or basin levels by recycling drainage and runoff water or by pumping deep percolation losses from groundwater aquifers (In some occasions these losses are not recovered as they may join salt sinks or be stored in unreachable locations). Of course these are important losses to the farmer as the recovery has a cost; still these are not total losses at the larger scale (Oweis 2014).

Reducing field losses by converting to modern systems will increase yields and save some water but will not create substantial additional water resources. In Egypt, individual farmers along the Nile and around the Delta lose on average about 55% of the water they apply through surface irrigation systems in runoff and deep percolation (an application efficiency of 45%). However, the lost water is continuously recycled through the drainage system and groundwater pumping. Only about 10-15% of the Nile water in Egypt is lost to the sea, which brings the system's overall efficiency to about 85%. So understanding the surface irrigation system losses needs to be put in the context of scale to evaluate the real vs paper losses across the system (Molden, et al 1998, Oweis, 2014, Seckler, 1996).

It is well established that modern irrigation systems can achieve higher crop productivity. But this is achieved not by reducing system losses in deep percolation and runoff, but rather through better control, higher irrigation uniformity, reduced irrigation frequency (less crop moisture stress between irrigations), better fertilization (fertigation), and other factors. In some modern systems, such as drip systems, real water saving can be achieved by reduction of evaporation losses, where the wetted soil surface is limited and mulches can be used to further reduce evaporation. The increased land productivity, however, comes at a cost – higher capital, higher energy consumption, and more maintenance requirements. Successful conversion requires a developed industry, skilled engineers, technicians and farmers, and regular maintenance (Oweis, 2012).

Modern systems are meant to be efficient. However, they can be efficient only if they are managed properly. Often they are no more efficient than traditional surface systems because of poor management. Surface systems can perform better if designed and operated properly. The vast majority of irrigation systems worldwide are surface irrigation; this is unlikely to change in the near future (FAO, 1997). Selection of the appropriate irrigation system may not depend solely on its application efficiency, but on other physical and socioeconomic conditions at the site (Keller and Keller 2003).

Modern systems are most successful in areas where water is scarce and expensive, so that farmers can recover the system cost by reducing irrigation losses and increasing productivity. When water is cheap and abundant, farmers, especially in developing countries, have little incentive to convert to modern systems. In fact improving surface irrigation systems through land levelling and better control may be more appropriate for most farmers in developing countries.

Reducing demand through pricing

In many countries water for irrigation is highly subsidized. Farmers have little incentive to restrict their use of water or to invest in new technologies to improve the use of available water. Although it is widely accepted that water pricing would improve efficiency and increase investment in irrigation projects, the concept of pricing presents enormous practical, social, and political challenges, including the difficulties in measuring water and monitoring its use by farmers and the pressures for subsidized inputs. There is also a fear that once water is established as a market commodity, prices will be determined by the market, leaving the poor unable to buy water even for household needs. Downstream riparian countries fear that upstream countries may use international waters as a market commodity in the negotiations on water rights (Altinbilek, 2014)

One cannot ignore these very real concerns. Innovative solutions are therefore needed to put a real value on water in order to improve efficiency, while at the same time recognising cultural norms and ensuring that people have sufficient water for basic needs. Subsidies for poor farmers may be better provided in areas other than water, so that the subsidies do not encourage inefficient use of water. Countries must strengthen the recent trend to recover the running costs of irrigation supply systems. Water pricing and other tools of demand management will reduce the demand for water in agriculture or divert it to high-valued or luxury crops but may not improve agricultural production for food and

nutrition security and/or poor farmers' livelihoods. This will also benefit other water use sectors with little contribution to increasing food production (Perry et al 1997).

In irrigated agriculture water user associations play a central role in managing water at the scheme level and below. In developing countries various levels of success have been achieved, mostly poor performance. The main issues include lack of empowerment and capacity of local communities. Often governments form water user associations but do not give them the authority and power to actually manage local water resources. And when they do, the water user association members need training which may not be enough to run those institutions. There is also a need for means to resolve local conflicts, and improved mechanisms for involving women in running water user associations would (see Chapter 3 for a further discussion of pricing and water user associations).

2.4.4 Investing in Agroecology

Agroecology is an innovative approach to food security that is built on traditional knowledge, enhanced by scientific innovation. It combines the sciences of ecology and agronomy with the political economy of food production and consumption. Although it is concerned with increasing productivity, this approach equally seeks to ensure the achievement of the right to food at the household level including improved nutritional content, and is thus particularly relevant for food security. It focuses on the entire agro-ecosystem (rather than individual plants, animals or humans) in specific socio-economic contexts (IAASTD, 2009; Altieri et al., 2012a). It also stresses the right of people to define their own food and agriculture systems, allows producers to play a lead role in innovation, and places those who produce, distribute and consume food at the center of decisions on food systems and policies. Some benefits include dietary diversity and nutrition security through preserving macro- and micronutrients in the soil; protecting natural resources through using fewer inputs; promoting agricultural resilience through use of diverse farming systems, and providing a sustainable and scalable path to food security through allowing smallholder farmers to lead.

Such an approach to food security also seeks to protect available natural resources, including water. Traditional farming techniques with fewer inputs protect water from degradation due to chemical pesticides (Altieri et al., 2012a), and agroecological methods maximise the productivity of available resources through context-specific soil, water and biodiversity management regimes informed by traditional knowledge (Altieri et al., 2012b). Agroecology's focus on maintaining crop diversity also allows farmers to appropriately utilize available water resources (Altieri et al. 2012b). A study in Argentina comparing traditional agricultural techniques to newer techniques showed that traditional ecological approaches can better preserve available water resources (Abbona et al., 2007); farmer experiences with conservation agriculture in Tanzania have also indicated that agroecological approaches to water management can increase crop productivity (Altieri et al. 2012b).

Particularly in more drought prone and marginal environments, water and land management practices that make use of indigenous technology and involve techniques such as water harvesting, micro-irrigation, mulching and the construction of hill-side terraces lined with shrubs and trees which enhance the ability of the soil to catch and store water can prove highly effective. In Swaziland, the joint government and IFAD run Lower Usuthu Smallholder Irrigation Project combines water harvesting techniques with sound land practices such as minimal tillage, conservation agriculture, rangeland management and forestation to alleviate current and future stresses on scarce water resources while also strengthening the health, livelihoods and food security of participating smallholder farmers (IFAD 2013).

As an approach to achieving global food security with minimal use of external inputs, agroecology is thus more aligned with the earth's carrying capacity and the use of precious water resources within sustainable limits. Some benefits include:

Dietary diversity and nutrition security: Research shows that while a balanced whole food-based diet is the best way to meet nutritional needs, specific vitamin and mineral deficiencies arise when soil contains less than sufficient macro- and micronutrients to grow food that meets these dietary requirements. Agroecological approaches can help build nutrient-rich soil, enabling farmers to produce culturally appropriate, dietary-diverse foods to enhance food and nutrition security.

Fewer inputs: Given the depleted natural resource base upon which agricultural productivity depends, it is critically important to protect this base, including seed varieties, indigenous knowledge and traditional farming techniques. In the face of diminishing fossil fuel resources, developing agricultural systems that do not rely on constant chemical and fossil-fuel-based inputs may become essential. As

an approach to achieving global food security with minimal use of external inputs, agroecology is cost-effective and more aligned with the earth's carrying capacity.

Smaller environmental footprint: Agroecology promotes farming systems that are diverse and thus more resilient to shocks from weather-related events, to stress from climate change, and to attacks from pests or disease. It also reduces our fossil fuel dependency, as well as the environmental - carbon, water and biodiversity - footprints of agriculture.

Sustainable and scalable approach: Nearly half of the world's two billion smallholder food producers are food insecure. As an approach that allows and empowers farmers to lead and claim the process, knowledge and resources, agroecological transitions offer a sustainable and scalable path to food and nutritional security.

2.4.5 Diversifying with fisheries and aquaculture

- The role of fish and fisheries in food security and nutrition has been extensively dealt with in the HLPE Report on Sustainable Fisheries and Aquaculture for Food Security and Nutrition (HLPE 2014b), and it is not necessary to repeat the findings of that report here. However, it would be inappropriate for this report not to note the importance of fisheries and aquaculture in the context of water for food security and nutrition. The water productivity of fish and aquaculture is high compared to other sources of protein and nutrients: high technology cage fisheries can produce up to 100 kg of fish for each cubic meter of water (Dugan et al 2006). Small-scale aquaculture is mostly undertaken by small farmers with wide participation at all levels and scales including farming, processing and marketing, whilst small-scale capture fisheries are often critical to local food security and social structures and have vital gender dimensions based on the role of women in the fisheries.
- When considering the issue of water for food security and nutrition it is critical to recognize the role of fish, capture fisheries and aquaculture in meeting the nutritional needs of poor rural communities in many areas, and also of the world at large, are considered in water policy and practice. Inland fisheries suffer particularly from environmental pressures such as low water quality and quantity, whilst all fisheries are sensitive to the impacts of overexploitation and habitat destruction. As competition for water resources increases, fish, fisheries and aquaculture suffer as the priorities for water allocation are usually focused on other sectors.
- Capture fisheries challenges include sustaining current levels of production and other ecosystem services and improved management of capture fisheries. A wider adoption of improved methods to increase production levels is needed (Dugan et al 2007), and changes in water quantity and flow are often on top of the list of challenges to inland and wetland fisheries. Resolving these challenges will require building partnerships between fishers and other interest groups and sectors concerned with more efficient ways to increase the overall benefits of water productivity to food security and poverty reduction as well as to achieve higher level of integration in agricultural systems. (CA 2007).

2.4.6 Closing the nutrient cycle

A further, critical aspect of improved water management for food security and nutrition relates to closing the nutrient cycle, through recycling nutrients in waste products, whether human, animal or crop waste back into the farming process. This practice, along with other soil management activities, can contribute to improved water productivity, including improved nutrient content of crops.

One final consideration is ecological sanitation or eco-san. This takes an ecosystem approach to sanitation by making use of human excreta to improve soil nutrients and increase food production (Esrey et al., 2001). Additionally, it seeks to do so without using water, making it an important alternative sanitation method in water-scarce areas; its 'close-loop-approach' also protects water from pollution by preventing discharge (ibid).

Such alternative methods are particularly pertinent given the limited availability of phosphate for crop production. Current use of phosphorous in agriculture focuses on rock phosphate, which is a non-renewable resource that some projections estimate will be depleted in 50-100 years, threatening food security (Cordell et al., 2009).

Box 15 Zero budget farming

Around 1998-1999, Tamil women belonging to Women's' Collective, a statewide organization was exposed to "natural farming" techniques developed through decade-long experiments by Subhash Palekar, an agricultural science graduate turned practitioner of multifunctional agricultural systems.

The concept of natural farming is based on the idea that farm inputs should enable "processes of self-replenishment found in nature." It has also been called "zero budget farming" as all inputs can be derived from the farm itself. For him, this makes it distinct from large scale, organic farming, which does not insist on a principle of minimizing the use of commercially available inputs.

In "natural farming" the most important farm inputs are "cow dung" and "cow urine" derived from indigenous breeds of cows. Other important inputs include leaves with different qualities that are indigenous to different sub-agro-climatic regions. Some of these are used (in specific proportions) to make solutions in which seeds are dipped for better sprouting (*Beejamrutham*); others are used as fertilizers (*Jeevamrutham*, *Ghanajeevamrutham*) or pesticides (*puchi*).

The other practices of natural farming which they have introduced include *mulching* (to help develop the micro-organisms in a conducive micro-climate) and *multi cropping* (that enhances the use of the soil and its nutrients through the complementarity between the crops that need varied nutrients, with differing maturity and differing heights) and making borders or buffer strips of pest repellent plants.

"Natural farming" is practiced by Tamilnadu Women's Collective both under rain-fed and irrigated conditions. They have access to two demonstration farms: one in the Cauvery delta where irrigated agriculture is practiced; the other is in semi-arid north-eastern Tamilnadu, with limited access to irrigation. Both of these function as a training field where new members of the women farmer's collectives come for trainings.

Shanta from Vellanikkottam village is a single mother. When her husband deserted her a few years ago she approached WC for help. With the intervention of the court, they ensured that she got part of the family land. She has 2 acres of land, where she grows rice for home consumption, vegetables and pulses both for home consumption and for generating some cash income.

For several years she has been practicing "natural farming. When she started natural farming practices, initially the production went down, but from the second year onwards it has been increasing; now the yields are very good. Initially she did not have enough farmyard manure for all the land, and couldn't convert all lands to natural farming, but a few years ago with a loan from the WC, she has bought a 'malamadi' or mountain cow, an indigenous breed, to help with her natural farming practices. Now she practices natural farming in all of 2 acres. She feels that combining agriculture with animal husbandry (keeping goats, cows and fowls) makes it more viable than just practicing agriculture.

According to the WC women farmers, natural farming practices have shown exceptional results especially under rain-fed conditions. According to Shanta, from Vellanikkottam village in Thurunelveli, even without supplemental irrigation her crops, were able to weather out a low rainfall season and give her better yields compared to earlier years. "Natural farming" increases the water retention in the soil, and helps rain-fed crops that tend to be vulnerable to dry weather conditions if soil moisture is also low. Another farmer, Sahaymary of Thottikalai village, Thiruvallur, described how she got an excellent crop of brinjal (eggplant), while several of her neighbors (who were not members) lost the crop to pests. They commented on the better taste of vegetables and crops grown under natural farming practices conditions. Ponnuthai, the State level secretary of WC, and a farmer herself, said: "Even flowers smell better when grown under natural farming practices."

Source: Varghese 2011

- 1
- 2 Promotion of ecological sanitation methods would help close the current gap between the agriculture
- 3 sector's perception of phosphorous as a valuable fertilizer resource and the WASH sector's perception
- 4 of phosphorous as a water pollutant (Cordell et al., 2009). Estimates based on available phosphorus
- 5 from human excreta in 2009 indicate that this source could provide up to 22% of total global
- 6 phosphorous demand and could be a particularly important source of soil nutrients in regions with
- 7 severe soil degradation (Mihelcic et al., 2011). Although hygiene guidelines should be followed when
- 8 handling human excreta for agriculture, both urine and faeces are high-quality, complete fertilizers that
- 9 have been shown to improve crop production when appropriately applied (Jönsson et al., 2004).
- 10 Tapping into this underutilised resource, therefore, could have important implications for both food
- 11 security and water use.

2.5 Improved efficiency along food chains and in food systems

Certain food products require more water to be produced than others. There are three ways which can enable to improve, from a global, conceptual perspective the water efficiency of the food system. The first one is to improve efficiency in the production and processing at micro level, seen in Section 2.4.

Another way is to opt for the production and consumption of products that are less water intensive (including production and processing): the concept of water footprint of a product has been originally designed in that perspective (see Section 2.5.1).

The third is to produce water intensive products where there is more water available and accessible, and valorize these comparative advantages through trade.

2.5.1 Water footprint

According to Hoekstra et al. (2011), 'The water footprint of a product is defined as the total volume of fresh water that is used directly or indirectly to produce the product. It is estimated by considering water consumption and pollution in all steps of the production chain' (Hoekstra et al, 2011: 46). It amalgamates three components; green water, designating rainwater stored as soil moisture, blue water, for surface and ground water, and grey water, defined by the volume of fresh water required to assimilate pollutants to ambient water quality standards (Hoekstra, 2009). For a determined product, the water footprint can be an indicator of the total water "consumed", rain or irrigation water (blue water) needed for production, and of the water needed to dilute pollutants resulting from the production process (grey water); the three main categories of impact from food production and consumption.

The water footprint is one of several environmental footprints that were popularized in the early 2000s as a result of growing natural resource scarcity, poor governance of these resources and limited knowledge of the relative carbon/water and other natural resources embedded in our goods and services. The major innovation, but also the challenge, of the water footprint concept is to accurately measure how much water is used at different steps along the production process, which is particularly challenging in today's often globalized value chains.

Of particular/popular interest, because of the striking values, is the water footprint of certain food items, such as a steak or a soft drink, but also of irrigated fibre, such as a cotton T-shirt. For example, Erçin et al. (2011) estimate the water footprint of a 0.5 liter soft drink with a sugar content of 50 grams at 169-309 liters per bottle, depending chiefly on the origin of the sugar. For this product close to 100% of the total water footprint is accounted for in the supply chain and not the actual direct product (the 0.5 liter of water in the bottle). Other striking examples include 1 T-shirt (2,720 liters of water) and 1 pair of cotton jeans (10,850 liters of water) (Chapagain et al. 2006); or 1 kilogram of beef (15,415 liters of water) (Mekonnen and Hoekstra 2010).

However, the reliability of the water footprint, as all indicators, very much depends on the precision of the data and the way it is presented. Often, as in the examples presented above a global average figure is used, which does not allow convey the differences of impact between green water in an area where there rain is abundant and water irrigation from a scarce area. Some authors (Antonelli and Greco 2013) propose to distinguish water coming from non renewable sources or from water scarce areas.

Another limitation is that while the actual the water footprint of a crop can vary, depending on the agro-climatic conditions in the farm and the agronomic practices that were used to produce it water footprints of crops are generally calculated using macro-level data, and does not capture these variations resulting from production methods and farm conditions.

2.5.2 Virtual water

The concept of virtual water has been developed to show that trade can compensate water scarcity in a country by enabling it to import products that need much water for their production.

The use of the virtual water concept illustrates the important linkages between agricultural water use and the global economy, showing how existing tangible water shortages can be at least partially alleviated by a combination of economic factors (Allan 2011). In water scarce areas, the concept of

virtual water allows countries to assess the value of producing a specific crop locally vs importing it. Thus, importing water- thirsty crops might be more advantageous can be obtained at lower cost for water-short countries by countries that can then use limited available water to produce more water-efficient, high-value crops with less water consumption and high value especially when having comparative advantage in climate etc. over countries exporting those crops. By importing agricultural commodities a nation saves the amount of water it would have required to produce domestically. For example the water scarce Middle East and North Africa region has had net imports of imported nearly 50 million tons of grains every year (FAOSTAT 2014b). If produced locally, the region would have had to dedicate it would require over 50 cubic km of water to these grains, surely not available. On the other hand, countries in the Americas produce grains in rain fed system with very high productivity and at much lower cost. However, importing virtual water, although logical and more water use efficient, involves the risk of facing market shortages such as those that happened in 2007, as well as or even cases of political sanctions. Arguments are also strong in that local production involves not only biophysical outputs but is also important for the also is a whole social and economic development of rural areas.

2.6 Policy implications

De Fraiture and Wichelns (2010), examining 4 pathways for ensuring that sufficient food is produced, while also protecting the environment and reducing poverty including investment in rainfed agriculture and irrigation, and the role of international trade in adjusting for national disparities in water endowments, find considerable potential for rainfed agriculture if inherent risks could be addressed. They also find potential for irrigation expansion in sub-Saharan Africa and South Asia. They also stress the important role of trade in moving food from water abundant to water-scarcer regions. Combining investments in rainfed and irrigated agriculture with strategic trade decisions would reduce the amount of additional water required to meet food demands by 2050 by 80%. They conclude that land and water resources are adequate to meet global food demands by 2050 if agricultural water management is improved.

One of the crucial aspects to consider in this new scenario is the role of food producers, who are directly engaged in food production and their access to and control of resources (HLPE, 2013a, HLPE, 2011).

A fundamental change in the way water is currently used in agriculture is inevitable. Different strategies are required that both recognize the wisdom vested in food-producing communities such as fishers, aquaculturists, pastoralists and other small scale producers, and enable them engage with their peers to help improve their food and nutrition security while coping with new risks for different situations. Sub-Saharan Africa requires investment in infrastructure, where Asia will need emphasis on increasing productivity (Poteete et al., 2010) relocating supplies and rehabilitating ecosystems. Everywhere, enabling humans and institutions to deal with changes is required (CA, 2007). Listed below are some aspects that need policy changes to create an enabling environment for better water management in agriculture:

- Increased human and institutional capacity for improved management and investment in infrastructure.
- Involvement of the private sector in the planning and implementation of public works and development projects, with special support to strengthen producers' and consumers' organisations.
- Abandoning the divide between rainfed and irrigated agriculture and approaching their development in a broader agro-ecosystem approach that reflects upstream-downstream interactions, optimizes allocations across scales and uses, and ensures attention to ecosystem health.
- Focusing on land productivity in water rich regions and on water productivity in water scarce regions. Ideally in both regions emphasis should move to an integrated approach that encompasses integrated land and water productivity that includes reduction in the grey water footprint of the food-system (Lundqvist et al 2008).
- Revisiting cropping patterns in various settings to benefit from comparative advantages and maximize water productivity.

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- Increasing investment in research in developing countries and providing support to research institutions to tackle local and regional water management issues.
- Developing national water policies that incentivize reduction of the grey, blue and green water footprints of agricultural and food systems, not only in crop selection and farming methods but also in food processing and packaging.
- Exploring issues such as agroecology, urban agriculture and eco-sanitation as ways to improve water productivity and also enhance food security. These approaches also need further public investment and support to become more mainstream.

3 GOVERNING WATER FOR FSN

Water governance is considered to include the political, social, economic and administrative systems that directly or indirectly affect the use, development and management of water resources and the delivery of water services at different levels of society (Water Governance Facility, 2012). Governing water resources implies decisions and processes concerning how water is used, allocated, how needs should be defined and understood and how these are to be met, and by whom – in short, the needs, rights and responsibilities of different actors in society (Movik, 2012a). Governance is polycentric and located across a range of institutional arrangements from local to global, requiring constant negotiations across domains of power.

In this chapter we highlight that:

1) Water governance is often fragmented and can be shaped by politically contested processes. Water is easy to control for the few who have access to land, resources and entitlements and difficult to access for most others.

2) The nature of water resources almost always span across infra-national or supra-national geographical boundaries and areas (surface and groundwater but also upstream, downstream and transboundary) as well as jurisdictional and administrative boundaries, complicating issues of water governance.

3) Finally, land, food and water are highly linked especially at the local level and in the context of local people's livelihoods and survival strategies. But their governance regimes have developed separately, causing ambiguities and exclusions for vulnerable resource users. Access to land and water, or the benefits derived from it—be they energy, goods, services, or for that matter access to nutritious food—is determined by socio-economic considerations, and further influenced by racial/caste/ethnic and gender considerations. Therefore resource governance at local, national and international levels, including the way investments are directed towards the development of the various water-dependent sectors expressing competing demands, needs closer attention in order to ensure that countries are able to ensure the food and nutrition security of their people in a sustainable manner.

We begin with the different regimes and processes regarding water access, use and allocation at the local level before moving to different national and international processes. This chapter captures these various dynamics as well as the diverse positionings, actors, politics and paradigms that influence water for food security and nutrition. It investigates a range of policies and policy processes, including water for domestic use and sanitation as these too have implications for nutrition security in many communities. It then explores potential synergies between right to water and right to food in the context of food security and nutrition. We thus explore how the existing 'right to food' is directly relevant for questions of access to water for food production and other entitlements in the context of food and nutrition security; we also explore whether the right to water can be expanded to encompass uses of water that are directed towards the realization of right to food.

3.1 Local water governance regimes: accessing water for FSN

3.1.1 Multiple ways to allocate and access water

Water has symbolic as well as material dimensions and water allocation regimes are shaped by a mix of politics, power and discourses realms (Cleaver, 2000; Mosse, 2003; Mehta, 2005; Movik, 2012; Derman & Hellum, 2005). Access to water in everyday contexts is usually mediated through institutions, gender, social and power relations, property rights, identity and culture. Water is allocated through a variety of mechanisms. The structure of any system of water allocation is influenced by the existing institutional and legal frameworks, the water resources infrastructure as well as the traditional water use patterns and customary rights to existing water resources. Three key allocation mechanisms have been identified: (1) government or public allocation; (2) user-based allocation; and (3) market allocation (Dinar, Rosegrant and Meinzen-Dick, 1997).

While any combination of these three allocation mechanisms can accompany a new infrastructure development, the role of the state is particularly strong in intersectoral allocation, as the state is often the only institution that has jurisdiction over all sectors of water use. User based allocation requires collective action institutions with authority to make decisions on water rights and requires strong, but not necessarily formalized, property rights to water. Market-based allocation refers to an exchange of

water-use rights. Most water allocation situations represent a mix of these three allocation mechanisms.

Under growing water scarcity, the combination of appropriate mechanisms might well change, requiring a supportive enabling framework that allows flexible incorporation of elements of these three approaches (Rosegrant et al., 2009a), as well as that of traditional or customary water uses (Varghese, 2013).

Access to water at the local level largely depends on technologies and institutions of acquisition, storage (for example, small or large dams), and regimes of distribution, allocation and rationing, some of them based on a range of property regimes (for example, riparian, prior appropriation, licensing or permit systems and customary law, see Section 3.3. and Movik, 2012b). But at the local level too customary law and practices, kinship networks, gender, caste, patronage (Cleaver, 2000; Mosse, 2003; Movik, 2012b) tend to dominate in practice. It is also important to note that many small-holder cultivators, most women and pastoralists have use rights in customary arrangements that are largely invisible to policy makers and these play a critical role in ensuring their food and livelihood security.

Box 16 Men-oriented water management policies unfit to the realities of the farm household in sub-Saharan Africa

Policies on water, land and food security in Sub-Saharan Africa still reflect discriminatory gender conceptions on force during the build-up of the colonial state. At the time, the male European rulers promoted their elite notion of the unitary household, headed by the men as the single breadwinner, entitled to exclusive individual control over all productive resources, including land, water infrastructure, other agrarian technologies, education, and skills, and also control over their wives' labor and off-spring. Women were excluded as supposedly dependent, non-earning housewives (Rogers 1981). Until today, public support for ploughs, power tillers, fertilizers, irrigation pumps, and financing facilities are primarily allocated to men as the supposed head representing all household members (World Bank, FAO & IFAD, 2009). Resource entitlements, irrigated land and membership of Water User Associations are also vested in men as the rule, and only by exception to women heading households (Van Koppen, 2002). Women are, at best, the target group of domestic water services, supposedly fully responsible for the health of all household members (Van Wijk-Sijbesma, 2002).

This conception clashed, and continues to clash with rural and peri-urban realities in most of agrarian Sub-Saharan Africa. Here, kinship and household relations and land and water tenure are essentially dynamic collective arrangements. Both women and men have resource use rights that ensure the tiller's control over the produce, while protecting communal interests (Dey, 1984; Van Koppen, 2009). In bilateral and patrilineal societies women's control over the fruits of their labor and off-spring is negotiated, even if skewed, at marriage through bride wealth and later through the allocation of own plots the output of which women control, and otherwise. Under matrilineal land tenure, women's stronger land rights further strengthen women's bargaining powers to maintain control over the fruits of their labor (Peters, 2010). Matrilineal tenure remains being ignored, even though it is widespread in countries like Ghana, Malawi, Mozambique, Tanzania and Zambia. In that sense, not much has changed since colonial rulers' fierce ideological efforts to fit communal matrilineal farming into an "administrative box" of a male household head's individual 'ownership' and control over natural resources, newly introduced technologies, and women's labor power. Land, water and food security projects that follow such male-biased targeting strategies eroded women's resource rights and, hence, interest and motivation to provide labor. Men failed to fill that gap. Public resources are wasted. In contrast, when projects vest resources in the tillers, often women, public resources are well used.

For example, in Burkina Faso, the EU supported project 'Opération Riz' aimed at improving the agronomic practices and water management in rice valleys. With some variation along ethnic lines, rice was mainly cultivated by women, who also had strong land rights and managed water infrastructure. In some cases, male land chiefs were even forbidden to enter the valleys, as 'this would cause inundation'. Yet, in the first schemes, the project re-allocated the improved land to 'male household heads who would also take care of the cultural, intra-household affairs'. As women refused to provide labour on men's fields, and men were more interested in their traditional upland activities, the first schemes collapsed. In later schemes, the improved plots were given back to the original women cultivators and other volunteers (mainly women). With control over the output, women not only produced well, but also ensured regular canal maintenance (Van Koppen, 2009).

3.1.2 Complex shifts in the nature of water rights

Water rights, as distinct from the right to water,¹² are usually competing and overlapping and entail a mixture of formal and informal arrangements (Meinzen-Dick & Bruns, 1999). We have seen above (Box 16) how customary water rights are often crucial to ensuring water for food security especially in the case of women. Traditionally there have been two types of water rights.

1. Riparian doctrine allows any landholder access to any adjacent water source for reasonable water use (as long as it does not affect the reasonable water use of another adjacent riparian landholder). Under this law, the riparian landholders could use water for all ordinary and domestic purposes, provided the quality of water downstream was not negatively impacted.
2. Prior appropriation law (first in time, first in right), that first evolved in the western United States, recognizes the water rights of the first person (“senior appropriator”) to claim the water, provided it is put for ‘beneficial use’ (a clause that primarily covered commercial, agricultural, domestic, industrial use). Several states in the west use a combination of these two in managing their surface waters. In many states, groundwater too is governed by prior appropriation law.

From a governance perspective it is helpful to identify the main difference between riparian rights on the one hand and prior appropriation rights on the other in terms of the sub-rights within each. Schlager and Ostrom (1992) have identified five property rights as most relevant for conceptualizing the use of common-pool resources. These are: the rights of access, the right to enter a defined physical area and enjoy non-subtractive benefits; withdrawal, the right to obtain resource units or products of a resource system ; management which is the right to regulate internal use patterns and transform the resource by making improvements; exclusion, the right to determine who will have access rights and withdrawal rights, and how those rights may be transferred; and alienation, the right to sell or lease management and exclusion rights (see also Ostrom and Hess, 2007). While riparian law involves the rights of access, withdrawal, use and management, the prior appropriation law involves two additional rights: that of exclusion and alienation. This allows the prior appropriation right-holders to treat water as if it were private property (Varghese, 2013). Unlike riparian law, where the water right is attached to a land right, and obtaining a water allocation is conditional on the transfer of land, under the prior appropriation doctrine the water right can either be transferred along with the land or it can be sold or leased separately if the transfer does not impinge upon the rights of other appropriators. This decoupling of water from land was a necessary condition for the development of a water market in the western United States. However a similar “de coupling” has been seen recently in some riparian law states in the United States, where a specific “use” like extracting and selling or diverting water out of a watershed might allow water to be severed from land as long as it is reasonable when balanced against other in watershed uses (Varghese, 2013). This has implications for water for food security and nutrition, as outlined below.

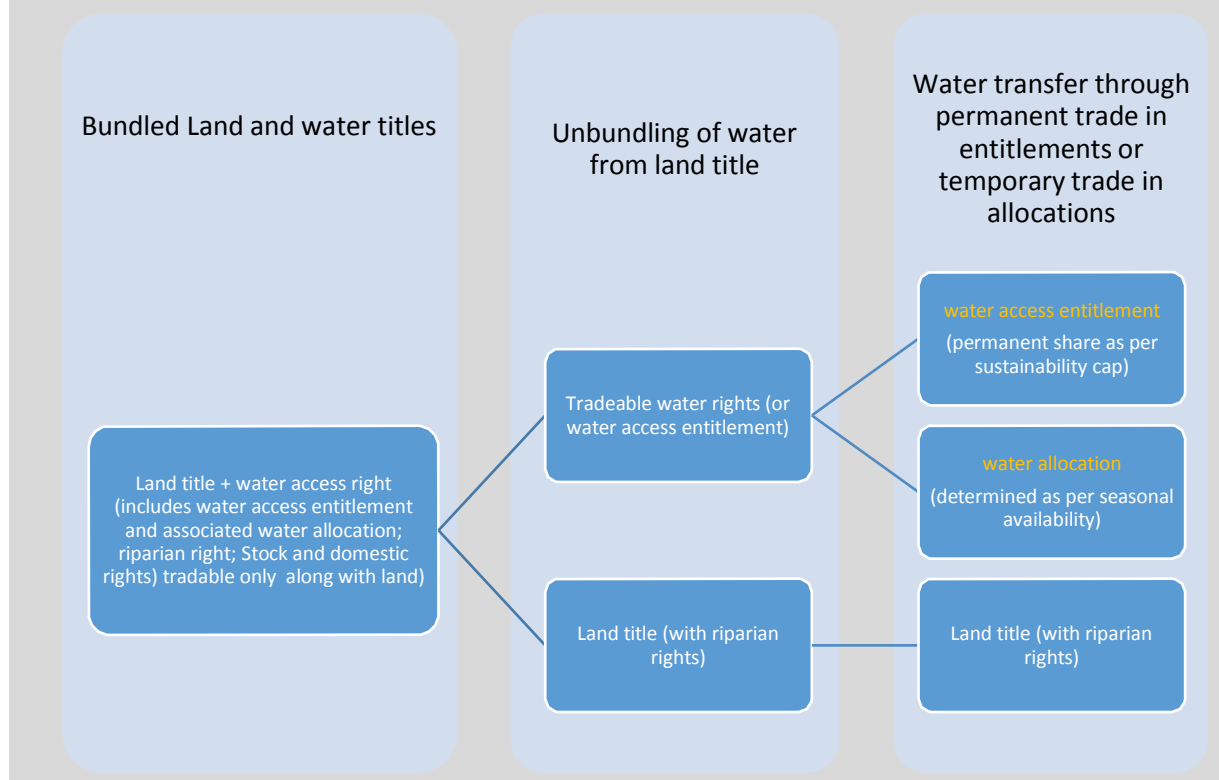
Many countries are exploring the possibility of (or have already) “de coupling” water rights from land as part of the wider water reform process that has taken place since the early 1990s (see below) not least in response to the increasing scarcity of water (Saleth and Dina, 2000). The introduction of formal water rights or entitlements is seen as creating security for water users, promoting efficiency of use, and opening opportunities for water markets.

Since the enactment of new national water reform legislation in 2007- 2008, Australia embarked on a water policy reform, in the face of problems resulting from past approaches, essentially related to over-allocation of water entitlements that resulted in unsustainable water use, inadequate attention to the need for more water to be retained for non-consumptive environmental flows and the prospect of all this getting worse with climate change further reducing water availability over time. The rebalancing of entitlements to attend to environmental pressures and risks is an important and difficult aspect of these reforms. The innovative reform was one of the first to introduce water trading (see Box 17). As the developments of the reform are still being operationalized, costs of full implementation, impact in terms of priorities in water use - such as towards higher value crops or non-food crops such as flowers, possible speculation from outside investors, as well as impact on access to water for indigenous groups’ are still unclear (Jackson and Altman, 2009; Varghese, 2013).

¹² See further below a detailed discussion on the Right to Water, that is protected under international human rights law, that several countries have now incorporated into national legal framework.

Box 17 Australian water governance regime

For more than a century Australia's greatest system of rivers and aquifers, the Murray-Darling Basin, was managed between five states and territories, each of which has had competing interests. The over allocation of water resources, combined with record low inflows and the onset of climate change, were amongst the rationale for an extensive reform of the water governance, "*to promote the use and management of the Basin water resources in a way that optimises economic, social and environmental outcomes*" (Australian Water Act 2007). The Australian strategy is the most developed in terms of separation of the water access right from land title. It includes tradable water rights, and further unbundling of the water rights that "may contain a combination of water access entitlements; water supply works rights and water use rights" (Australian Government, 2014).



1

2 **3.1.3 Fragmented and/or overlapping institutional arrangements**

3 Attention to water rights emphasises the importance of institutions in water management (Roth,
4 Boelens et al. 2005). Common Property Resources (CPR) analyses have made important
5 contributions in focusing attention on the importance of informal institutions in natural resource
6 management (Ostrom, 1990). However these approaches have looked at purposive institutions,
7 indeed frequently assuming that institutions emerge (are crafted, in Ostrom's terminology) specifically
8 to perform certain water resources management functions. This contrasts with other approaches which
9 look at the complex matrix of institutions in which people live their lives, and in which water
10 management is located. As recent approaches concerning 'bricolage' highlight (cf Cleaver 2012), it is
11 wrong to presuppose a non-interactive divide between formal and informal institutions that fails to
12 capture empirical realities in which interrelationships and overlaps link various institutional domains. In
13 this 'messy middle', institutional arrangements may be highly contested, and beset by ambiguity and
14 openness to divergent interpretations (Mehta et al, 2012; Cleaver 2012).

15 This is particularly important for the water reform processes taking place around the world which call
16 for the creation of new institutions such as water user associations (WUAs). It is important to note that
17 the institutions created are not just formal ones (supported by laws and so on) but also include
18 negotiation arenas through which different stakeholders in water management defend, increase and
19 influence access to water (Meinzen-Dick and Bruns 1999; Spiertz 1999). In many parts of the world,
20 countries tend to have plural, overlapping and competing formal and informal legal and customary
21 systems, and most countries in Sub-Saharan Africa are characterised by primarily informal water

users' practices (Biswas 2004; Shah and Van Koppen 2005). There are a large number of customary and traditional water use such as pastoralists, those engaged in freshwater fisheries or in traditional agricultural practices and there are informal and formal arrangements of water use, some of them serving multiple functions. Such multiple use of water systems (MUS) currently provide the more vulnerable users with low cost services for domestic water, water for agriculture (irrigation, rain fed), homestead, garden, water for cattle, habitats for fish and other aquatic resources and rural enterprise water supplies (van Koppen et al 2014a).

The study of legal pluralism especially in the water domain (Derman et al. 2007; Meinzen-Dick and Pradhan 2001; von Benda-Beckmann 2001; Spiertz, 1999) highlights how newly crafted water rights and institutions co-exist with a range of (often invisible) pre-existing customary arrangements and how diverse institutions and property regimes create different sets of cultural practices and discourses. While different legal and institutional arrangements can create uncertainty and ambiguity, the informal arrangements often offer routes to livelihood security, enable multiple uses of water and lead to multiple outcomes and compromises in complex settings (von Benda-Beckmann 1981; van Koppen et al. 2005; Chimhowu and Woodhouse, 2006).

As discussed in Chapter 1, the legally complex situations around water tenure can be challenging in present contexts of new land acquisitions (so called grabs) taking place around the world. New commercial users usually coexist with complex non-registered users who are invisible. This legal pluralism can be both enabling and disabling but largely it is difficult for local users to defend their claims. Thus future water allocation policies must recognize the range of customary rights and right holders that are often ignored when new infrastructures and water allocation mechanisms are developed. They should specify the means of the allocation of rights, such as allocation based on historical use or other needs such as ecosystem reserves, and where necessary, those who are allocated rights should be provided with support so they can enjoy these rights.

3.1.4 Water re-allocation and conflicts

Contemporary re-allocation of water from agriculture to cities and industry has impacts on a range of stakeholders and can cause local level conflicts. Water transfers take place through administrative re-allocation, market-based transfers or collective negotiation. In administrative re-allocation the state re-allocates water, ostensibly for 'public' purpose. However, here the focus tends to be on more powerful stakeholders such as cities and industry, with marginal and 'invisible' rural users (i.e. fishers, fish farmers, homestead gardeners, dryland users) often losing out (Meinzen-Dick and Ringler, 2008). In formal and informal market-based transfers water or land is sold or leased; for instance, states in the western United States use various types of market-based transfers to re-allocate water. Finally, transfers can also take place through collective negotiations with communities: between users and state or between old and new users. These can be favourable for all, but non-irrigation uses are not often considered. Usually, re-allocation occurs through a combination of the above methods; illegal means of transferring water are also common (ibid).

Table 5 Principle mechanisms for water reallocation

	Administrative reallocation	Market-based reallocation	Collective negotiation
Examples	China; South-to-North transfer	Chile, western United States, New Mexico	Tanker's association, Kathmandu; California municipalities
	India; National River-Linking Project Bhavani, NIA (Philippines)		
Third-party effects	Seldom taken into account	Sometimes taken into account, depending on statutory law	Can be taken into account if reallocation is small scale
Compensation for users	For visible, easily identifiable users; beneficial use rights, low levels	Yes for those who directly transfer water	For whole communities, but maybe in alternative form
Public response	Protest more likely if transferred to industries	'Privatization' of water may prompt protests	Probably most positive response

Source: Meinzen-Dick and Ringler, 2008

Poorly managed water transfers can have negative effects on rural livelihoods and on food prices. Decisions are often made by governments and agencies without consultations or without offering adequate compensation. Even when recognized irrigators are compensated, the impacts on many other rural water users, such as livestock keepers, are not addressed.

The re-allocation of water in conflict situations is not uncommon. Conflicts can exacerbate unequal access to water and maintain structural inequalities. These can have significant impacts on local level water and food security.

3.2 Water reform processes

3.2.1 From New Delhi to Dublin

Water management and governance have evolved considerably from the 'hydraulic imperatives' and supply-driven approaches that dominated in the 1950s-70s, in which it was largely an issue of getting the technical solutions right and of building infrastructure (i.e. large dams). A supply-dominated paradigm dominated until the UN 'Water Decade' (1981-1990) which aimed at achieving universal coverage to drinking water and sanitation by 1990. At the end of the decade the target remained far off. To assess what had happened and to look towards future pathways for collective action, in 1990 the UN held a global consultation in New Delhi hosted by the Indian Government (Nicol et al, 2012).¹³

The New Delhi Statement, with its focus on equity and universality, was rapidly overshadowed by the 'Dublin Statement' of 1992 – an important turning point in the discourse on water governance. The statement emerged from the International Conference on Water and the Environment (ICWE) held in Dublin in January 1992. It was organised by water experts and held under the auspices of the World Meteorological Organization. The conference culminated in the formulation of the Dublin principles which recognised (1) the finite nature of water and its key role in sustaining life, development and the environment; (2) the importance of participatory approaches in water development and management; (3) the central role played by women in the provision, management and safeguarding of water and (4) the economic and competing values of water and the need to recognise water as an economic good (International Conference on Water and the Environment, 1992). It is this fourth principle that has made Dublin a focus of policy differences and global fault lines ever since. Declaring water an 'economic good' in Dublin remains to this day deeply controversial. Some argue that it also provides a solid building block for a global discourse that prioritises the economic use of water, e.g. in commercial agriculture, industry, manufacturing, mining, hydropower and other capital intensive activities are deemed to be more important users of water than smallholder agriculture and enterprise, community drinking water, traditional fisheries and female headed agriculture (Franco et al, 2013; HLPE 2013a). The controversial declaration of water as an economic good must be seen as a logical next step from the sustainability paradigm that has its roots in the late 1970s. The sustainability perspective amongst others raises the question of financial sustainability, i.e. the ability to generate finances to sustain and maintain a particular use. Nobody will deny the importance of highlighting the economic values of water, however there are many water needs and uses that lie outside the gamut of economic valuation including social, cultural and symbolic values.

3.2.2 Water reform processes and Integrated Water Resources Management (IWRM)

The elaboration of the 1992 Dublin principles has led to water reform processes (often donor led) around the world. One key concept has been the wide-spread adoption of the Integrated Water Resource Management (IWRM) approach. It is considered to be the key water governance framework. The most frequently used definition of IWRM comes from the Global Water Partnership and is defined as "a process which promotes the coordinated development and management of water, land and

¹³ Under the slogan, 'Some for all rather than all for some', the New Delhi Statement stressed (1) Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes (2) Institutional reforms promoting an integrated approach (3) Community management of services, backed by measures to strengthen local institutions and (4) Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies (Nicol et al, 2012).

related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP 2000).

The IWRM paradigm is the most influential policy model currently being implemented in basins around the world, including in Africa. 80 per cent of countries around the world have IWRM principles in their water law or policies and two-thirds have developed IWRM plans (Cherlet 2012). Despite the potential of integrating water services and management, land and water issues as well as water with other key sectors such as agriculture, health and development, IWRM, though highly attractive globally, is an abstract approach it remains unclear what should be integrated and by whom (Biswas 2004; Bolding, et al., 2000; Conca, 2006; Molle, 2008; Mehta et al., 2014a).

Permit systems are an integral part of IWRM frameworks and compulsory licensing systems that have been drawn up in many countries. Van Koppen (2007) shows how formal administration-based water rights systems in Sub Saharan Africa have tended to dispossess the informal majority by design, as "permit systems boil down to the formal dispossession of rural informal water users who manage their water under community-based arrangements" (Van Koppen, 2007: 48). Water rights that have historically been arranged locally are now declared subject to formalisation under national law. Existing rights are cancelled-out with the promise to include them in the new law. In practice many of these rights are not (and often cannot) be included in the registration leading to a weakening of the position of historical smallholder use. Complicated and expensive license registration procedures ensure that water permits "favour the administration-proficient" (Van Koppen, 2007: 46).

Small scale water use, mostly for drinking water, but sometimes also including small productive use, is in many systems excluded from compulsory licensing, granting it a status of priority use, or setting it aside as a sort of common pool resource (Hodgson, 2004). In practice this creates pluralistic legal systems in which traditional legal systems are left to govern the thousands of smallholders that are deemed uncontrollable under the registration system (Meinzen-Dick and Nkonya, 2005). In South Africa this is part of the *reserve* or in *general authorisations* (Van Koppen et al, 2009), in Mozambique it is called *uso común*, or common use (Veldwisch et al., 2013), elsewhere sometimes also referred to as 'primary uses' or in Islamic law as a 'rights to thirst' (Meinzen-Dick and Nkonya, 2005).

It is questionable whether these *de minimis* rights provide any security in practical terms, as this type of "entitlement cannot lawfully prevent anyone else from also using the resource even if that use affects his own prior use/entitlement" (Hodgson, 2004: 92). Formal permits with state backing create first-class rights in comparison to any other right (Van Koppen, 2007). The exemption from a need for a permit keeps small scale users from being registered as users, which makes it easier to overlook them in planning and allocation procedures (Van der Zaag et al., 2010; Borrás et al., 2012; Veldwisch et al., 2013 for Mozambique). In Kenya nomadic livestock keepers and fisher folk without formal water licences were dispossessed of their traditional rights when large scale investors started developing the Tana River Delta (Duvail et al., 2012). Williams et al. (2012) demonstrate for three cases in Ghana that smallholders were not even aware that their historic agricultural water rights are not recognised in national legal frameworks and that this favours commercial and large scale users of land and water. In the context of limited registration of smallholder water use, poor hydrological knowledge, and/or weak enforcement, permits provide an 'easy way in' for newcomers, while giving them the formal backing of the state (Van Koppen, 2007). Furthermore, one of the challenges of IWRM is that in its original conception, it almost entirely ignored the issue of infrastructure. As will be discussed, in sub-Saharan Africa, the hydraulic mission is by no means over – in fact, it has barely started. Water storage levels are very low in an area of extremely high climate variability, with significant negative economic and social impacts during the dry season and during droughts. In SSA, it has been argued that IWRM did a great disservice to the region by ignoring infrastructure and many in the region feel that the need for infrastructure, or the continuation of the hydraulic mission, is top of the agenda (Van Koppen and Schreiner 2014).

Box 18 Administrative water law: Dispossession and discrimination of poor women and men

Contemporary statutory water law in Africa and Latin America has its roots in European civil-law, administration-based permit systems. The introduction of permit systems served, above all, to formally vest ownership of the continents' water resources in the overseas colonial rulers, declaring that only permitted water uses were lawful. At independence, ownership shifted to the new governments. Especially in Sub-Saharan Africa, the laws remained largely dormant until permit systems were revived under IWRM. This risks enforcing this colonial legacy in rural areas, where water use is governed by living customary water laws, and where permits had hardly reached. Imposing one legal system, permit systems, dispossesses those with customary entitlements. Moreover, permits intrinsically discriminate small-and micro-scale users. Especially women are discriminated as men are supposed to represent their wives in this administration. Further, governments lack the capacity to process the tens of thousands applications from all small-scale users who are formally obliged to apply for a permit. Micro-scale users who are exempted from that obligation are categorically relegated to a second-class entitlement. Anyhow, vesting exclusive entitlements in individuals or small groups erodes the collective customary arrangements in which water is seen as a common and shared resource. This fear was also expressed by villagers in the Uluguru mountains in Tanzania who operate complex networks of many local farmer-managed springs, canals and wells for highly productive irrigated horticulture and cropping and domestic uses. Government wants to vest permits only in the few formalized male-dominated water user groups. Villagers predicted that this would create 'chaos' as the majority would continue managing water according to their informal local laws, also when that would be declared as illegal water use. These villagers were adamant that permits should be vested in local government (Van Koppen et al 2014).

In South Africa's National Water Resources Strategy, the ranking of priorities in water allocation gives a high priority to water used for poverty eradication and redress of inequities from the past. However, this has little meaning as long as a similar permit system as in Tanzania exists. This also declares small-scale informal water uses that are vital for food security as unlawful by lack of a permit, while the legal status of micro-uses that are exempted from an obligation to apply for a permit, is weak (Van Koppen and Schreiner 2014).

3.2.3 From centralisation to decentralization

In some regions, water reform has led to the devolution of water resource institutions that seeks to transfer rights and responsibilities to local user groups (Meinzen-Dick 1997b; Hooja and Pangare, 2002) resulting in community-based organisations replacing state agencies in governing their own resources. While decentralised systems have often succeeded in successfully managing water resources locally, they have not necessarily promoted social and gender equity or participation. They have also often ignored the fact that local communities are made of various interest groups and often ridden with conflicts (Mosse, 2003; Mehta and Movik, 2014).

In the water sector decentralisation in practice means the re-organisation of water from administrative units (regions, provinces, districts) to with hydrographical boundaries: watersheds, catchments or basins. This provides an opportunity to deal with the dislocated effects of water use (pollution, downstream reduced or peak flows, timing peak uses and releases) but at the same time cuts water management somewhat loose from other processes of governance. Decentralisation policies and approaches often involve the setting up of Water Users Associations (WUAs), Catchment Management Platforms (CMPs) and/or River Basin Organisations (RBOs) which are now important exemplary 'models' in the water sector (Molle, 2008).

A large body of literature highlights the mixed experiences with user involvement in water management at all levels of governance (e.g. Cleaver, 1999; Wester et al., 2003; Boelens, 2008). It is beyond the scope of this report to fully engage with this, but it is important to stress that the involvement of local users in water management does not prevent strong actors to capture unfair shares of water while excluding others from access to the resource. Rather, the setting of user participation often becomes the forum through which the resource capture is taking shape, often facilitated by excluding the informal, legally not-recognised water users (Warner et al., 2008) as detailed above. Kemerink et al. (2013) analyse in detail for a case in South Africa how, despite the best of intentions, a policy of user participation in water management through the establishment of a Water Users Association (WUA) is used by the most powerful actors in the catchment to maintain the status quo of a highly unequal water

distribution pattern established in the Apartheid era. The next section further develops some key fault-lines and controversies in the water sector.

3.3 Contestations around water

3.3.1 Valuing and pricing water

Water pricing policies can improve efficiency and sustainability when combined with appropriate supporting policies (Rosegrant and Cline, 2002). But there are significant barriers to using direct pricing of water, especially in developing countries. Water pricing may conflict with the idea that the provision of water services is a basic right to all individuals if water prices rise to a level that low-income households cannot afford (see 3.4.3). The high costs of measuring and monitoring water use, where infrastructure and institutions are weak, can also be a major constraint to implementation of water pricing. Adding to the difficulty of pricing reform, both long-standing practices and cultural and religious beliefs have treated water as a valuable, but free good. More than ordinary people, it is also entrenched interests that benefit from the existing system of subsidies and administered allocations of water. Water pricing is now generally well established for the domestic sector, where it can contribute to cost recovery and water savings. But it still remains controversial regarding its impacts on the poor (see 3.4.3). Water pricing remains limited in irrigated agriculture, for various reasons. In public surface systems, such as the Indus Basin Irrigation System, for example, farmers are not in control of when and how much water arrives at their field intake (Akram, 2013). As such, they see little motivation to pay for a service that is not on-demand. Moreover, in many cases, prices high enough to induce significant changes in water allocation (or recover capital costs) can severely reduce farm income, and as such price irrigators out of business (de Fraiture and Perry, 2007). It is important to note that domestic, industrial and irrigation usually get bulk water deliveries whereas mining and fracking generally directly take water out of streams or groundwater. The latter is rarely metered, measured or priced, especially when there is no bulk supplier.

3.3.2 The question of storage and hydropower

If there is one issue that has deeply divided the water sector it is the issue of large dams and the role they play in enhancing water and food security. Until a few decades ago, the large dam¹⁴ was universally considered to be the panacea for water and food security. The proponents of large dams focus on the benefits of hydropower and irrigation and downplay the social and environmental costs. These views have been contested by academics, scientists and members of voluntary agencies who have highlighted the problems of involuntary resettlement and environmental damage due to large dams and the benefits claimed in relation to irrigation and food security. As a response to this controversy and in response to social movements fighting for the rights of displaced groups, a unique multi-stakeholder process, World Commission on Dams was constituted by the World Bank, social movements representing displaced people and several international NGOs to investigate the myriad aspects of dams concerning economic growth, equity, food security, environmental conservation and participation. It concluded that while dams have made a considerable contribution to human development, in too many cases unacceptable costs were borne in social and environmental terms. The Commission also argued that water and energy needs could often be met through alternative solutions that would fare better than large dams on equity and environmental grounds (WCD, 2000). The World Bank, which was a founding member of the WCD, rejected its conclusions alongside key dam-building nations such as India, China and Turkey as well as the International Commission on Large Dams and the International Commission on Irrigation and Drainage.

In recent years, dams have made a comeback (Molle et al., 2009). The World Bank has (re)argued that investment in dams is necessary for economic growth (Calderon and Servén, 2004). In the wake of climate change, hydropower is seen to be a clean and renewable source of energy (World Bank, 2009). In Sub Saharan Africa there is a strong position that there is immense storage potential that has not been realized, and that in the face of high seasonal and inter-annual rainfall variability (and where droughts may last for several years) and significant vulnerability to climatic shocks medium to large dams may still have an important role in ensuring water security. But controversies remain around the world. There are now many studies on the proliferation of dams on the Mekong river

¹⁴ According to the World Commission on Dams, there are currently over 800,000 dams in the world of which 45,000 are large. large dam has a wall height of more than 15 meters (WCD, 2000)

1 (spurred on not only domestic and international capital). They highlight how their impact on artisanal
 2 fishing communities poses a serious threat to the region's food security. If all of the 88 dams planned
 3 for the Mekong river basin are to push ahead, fish stocks are estimated to drop by 40% by 2030
 4 (China Dialogue, 2012). This loss of fish stocks would necessitate a switch to (industrial) livestock
 5 rearing, counteracting any claims that these hydropower projects would reduce carbon emissions
 6 (Eyler, 2013).

7 Around 40-80 million people have been displaced by large dams globally (WCD 2000). In India a
 8 large proportion of these have been from tribal communities. Displaced people not only lose their
 9 lands, but also lose access to common property resources such as rivers, forests and grasslands, all
 10 of which are vital sources of nutrition. Studies have shown that people displaced by the Tehri Dam in
 11 North India had to shift food production practice from subsistence-oriented farming that included
 12 hunting and fishing to dependence on cash crops and buying food from markets. This led to a shift
 13 from protein-rich diversified diet to a lower-nutrient diet high in carbohydrates, leading to problems
 14 concerning malnutrition (Bisht 2009). Furthermore, upon resettlement the land allocated may not be of
 15 good quality, yields are often poor and water quality is also often inferior. In Gujarat, resettled villagers
 16 felt that the poor quality of water in the handpump and the loss of the free-flowing river had led to
 17 chronic diarrhoea, dysentery, colds, nausea and even an increase in mortality (Mehta 2009). The
 18 resettlement literature acknowledges that health problems and food insecurity can increase after
 19 displacement (ibid).

20 A recent study by Ansar et al (2014) draws upon cost statistics for 245 large dams built between 1934
 21 and 2007. Without even taking into account social and environmental impacts, the study finds that "the
 22 actual construction costs of large dams are too high to yield a positive return" (Ansar et al., 2014: 44).
 23 This study also found that dam construction costs were on average more than 90% higher than initial
 24 budgets, while 8 out of 10 suffered a schedule over-run, thus seriously questioning their
 25 economic/financial viability (ibid).

26 A middle ground is actually to avoid talking about dams but instead to speak about storage (Allouche
 27 et al 2014) and a continuum of storage options that include a '*continuum*', of water storage options that
 28 include natural wetlands; enhanced soil moisture; groundwater aquifers; ponds and tanks; and large or
 29 small dams/reservoirs (McCartney and Smakhtin, 2010). Each has a role to play in contributing to
 30 food security and water security. However, it is mostly the large options that are given importance in
 31 planning and assessment purposes (ibid) instead of equal attention to alternative storage options that
 32 have fewer social and environmental costs associated with them.

Box 19 The costs and benefits of large dams as related to fisheries

The costs and benefits involved in large dams are complex, particularly as they relate to fisheries. Often consideration of these costs and benefits involves trade-offs between effects on national development or effects on fishing communities (HLPE 2014b). In terms of national development, dams have been viewed as necessary in order to provide for increasing food, water and energy needs of growing economies (Narayan 2001). India in particular faces difficult decisions, with increasing water needs for irrigation, industry and human consumption (Wate 2012). Large dams have been viewed as a one method for providing water for irrigation and water for cities (Wate 2012), and hydropower dams provide for increasing energy needs (Erlewein 2013).

However, although large dams in India undergo environmental impact assessments prior to construction, the effects on the environment and on communities, particularly cumulative impacts, are not given sufficient attention (Erlewein 2013). Cumulative impacts include dried riverbeds, sediment build up or blockage, changes in water temperature and changes in microclimate (ibid), which cause declines in fisheries and in biodiversity among fish (Kelkar 2014). Beyond the negative impact on fish, dams also impact the people who depend on fisheries for their livelihoods. In a survey among fishers and fisher groups in the Gangetic Basin, there was a widespread understanding that dams and their impact on river flows were a main cause for declines in fisheries and fish resources, which negatively impacted the livelihoods of these communities (ibid). Although large dams have particularly large impacts, for instance in terms of sediment fluxes (Gupta, Kao and Dai 2012), small dams also adversely affect communities, particularly if they interfere with those communities' only water source (Erlewein 2013). Traditional fishing communities' generally marginalised status and the lack of any post-dam construction compensation for them indicate that the concerns of these communities may not be given adequate attention when considering the trade-offs related to dams (Kelkar 2014).

3.3.3 The role of the private sector and growing corporate involvement in water management

In the early 1990s a number of transnational water corporations that were primarily operational in Europe sought to provide water in cities across the globe (Varghese 2007). The main reason for the increasing privatization of the water sector was that the public sector lacks finances for all the massive investments entailed (World Bank 1994) and can often be too bureaucratic and inefficient. Private sector involvement in water provision was also imposed on many debt-ridden countries in the course of the economic restructuring of 1990s. There are also strong arguments saying that poor people are willing to pay for water (Altaf, Jamal, and Whittington 1992) and, relatively speaking, poor people pay far more than the rich for water. The UNDP's Human Development Report in 2006 notes that 'the poorest 20% of households in Argentina, El Salvador, Jamaica and Nicaragua allocate more than 10% of their spending to water. In Uganda water payments represent as much as 22% of the average income of urban households in the poorest 20% of the income distribution' (UNDP 2006: 51). Power relations within the household mean that women cannot always make their own decisions about whether to buy water, which may force them into a daily trudge (taking precious time) for cheaper or free untreated water, which is likely to result in health problems or increased poverty and destitution (Mehta 2013).

Experiences with privatization of water have not always been poor-friendly (Bakker 2010; Finger and Allouche 2002; McDonald and Ruiters 2005). One reason has to do with the nature of water markets. The high level of monopoly and low competition do not naturally lead to high responsiveness to user needs and there is often no incentive to service non-profit-making sectors (such as rural areas and the urban poor) or to invest in unprofitable sectors (such as wastewater and sanitation; see Finger and Allouche 2002). Often prices have been raised beyond agreed levels within a few years of privatization, and people who could not pay have been cut off. Water privatization has been controversial with strong civil society protest. Some contracts with transnational water corporations have failed, such as the one in Cochabamba, Bolivia, in 2000. In recent years, there has been a retreat of the private sector and in some areas there is a conscious programme of re-municipalisation (Pigeon et al 2012). The Pinent Masons Water Yearbook (2012) estimated that 909 million people or 13% of the world's population were served by the private sector (including but not confined to multinational water corporations) in one form or another in 2011.

These debates echo the controversies around the Dublin principles: namely those who see water as a public good that should be provided at an affordable rate for the poor, by the state, and those who see a major role for the private sector in the provision of services, including, at its most extreme, through the ownership of the infrastructure assets. There are, however, a number of different models that offer different levels of private sector involvement, in order to support government capacity in services delivery, including management contracts, and the role of the private sector in infrastructure construction. This debate has primarily played out around the issue of municipal and domestic water provision.

In 2007, the UN Secretary General launched the CEO Water Mandate, described as a unique private-public initiative focused on the role of business and water (UN 2010a). As of 2013, at least 100 major companies had signed up to the Mandate (Newborne and Mason 2012). In recent years water has been identified by the private sector more generally as a significant business risk, as well as a business opportunity. In response the private sector has increasingly been active in this regard, both within factory boundaries, extending out to the catchment level, and even in national and international water governance. The Water Resources Group, a group of multinational companies concerned about water issues, launched at the World Economic Forum, promotes water governance with a focus on economic efficiency in water use (Varghese, 2012). Newborne and Mason (2012) argue that given the growing interest and involvement of large corporations in water management issues, it is important to monitor progress achieved by companies in reducing water use in their own plants and premises and supply chains as well as look at partnerships and relationships with local communities and monitor issues such as inclusion as well as local impacts. As already discussed, using economic water efficiency as a criteria can be detrimental to the food and nutrition security of rural small-holder food producers, whilst beneficial to agricultural operations engaged in producing raw materials for value chains. This is because the application of formal water authorisation systems in many developing countries can exclude the rural poor and leave them with weaker entitlements to water than those who have access to formalised entitlements (Varghese, 2012).

This chapter has so far discussed the various dimensions determining access to water at the local level alongside the various contestations around how water should be governed and by whom. These contestations manifest themselves in policy choices and concrete programmes at the national level to which we now turn.

3.4 National Policies and processes that affect water for food security

At the national level, there are a range of policies that impact on the realm of water and FSN as well as a suite of government agencies at the national, sub-national and local levels. The FAO in its Food and Agriculture Policy Decision Analysis, has categorised the policy decisions that impact on food and agriculture at the national level, into consumer-oriented policy decisions, producer-oriented policy decisions and trade-oriented and macro-economic policies (FAO n.d.(b)). Those that have the most direct impact on the water/FSN interface are summarised in Annex 1.

While many of these policies have direct relationships to land, water and agriculture, some have less immediately obvious impact on water use and FSN, such as import and export restrictions and subsidies. If, however, used appropriately, most of these policy tools can be beneficial to effective use of water for food security and nutrition of not only smallholder producers but for all citizens (apart from those that explicitly ignore the interests of poor water and land users). The import and export policies relate closely to the issue of virtual water which has been addressed in Chapter 1.

The most critical policy interface for water and FSN relates to the issue of water allocation between and within economic sectors and how this relates to food security policy. This is particularly true where there are constraints on water availability, and choices must be made whether to allocate water to agriculture, or to other water use sectors such as the industrial, power generation or municipal sectors. In addition, where water is allocated to agriculture, the choice must be made whether it is allocated to large irrigation schemes, or to small holders, or to a range from small to large. For example, if national policy is to grow sufficient food for at least a large portion, if not all, food security requirements, then the allocation of water must take this into account, particularly where irrigation plays an important role in ensuring food security.

While the water implications of such decisions are specifically considered in some countries, in others there is a lack of integration in decision-making, with decisions on irrigation, industrial or power generation development being taken in different departments with little consideration for the cumulative impacts on water demand or water quality. It should be remembered that water quality impacts derive not only from waste discharge by a particular user, but also as a result of reduced river flows and hence reduced dilution of existing waste discharge. A further challenge is that the irrigation sector, which generally offers lower direct economic returns than industry, power generation or mining, tends to be the first sector to face water rationing in times of poor rainfall and is usually the sector from which water is taken to reallocate to other sectors. In areas of water abundance, these challenges do not apply as there is sufficient water to meet all of the competing demands from the various sectors.

The institutional complexity regarding water allocation decisions is exacerbated in some countries where water management is a devolved function to state or provincial level, resulting in the need for both horizontal and vertical integration in decision-making.

While the table in Annex 1 indicates the complexity and specificity of national policies that impact water and FSN, the case studies of Bangladesh, Jordan and Tanzania are illustrative of different approaches to such policies and also highlight the various trade offs around policies and programmes concerning water and land for food security and nutrition. They also show how disconnected and disjointed water and food security concerns can be in national contexts and how local water FSN issues are affected by a range of wider socio-political as well as macro considerations.

Jordan

Jordan has long faced water scarcity (per capita of 150 m³ annual compared to world average of 7000 m³), necessitating early adoption of strict water management policies (Wardam 2004). All water is state-owned and use is strictly governed; agricultural use is limited through allocations and tariffs (ibid) with some recent reallocations of water from agricultural use to urban use (Alqadi and Kumar 2014). Water policy has focused on managing water for efficient use (Wardam 2004), focusing on mega-projects like desalination projects, micromanaging supplies, and exploiting available resources, particularly through wastewater reclamation for agriculture (Alqadi and Kumar 2014). Use of

1 wastewater for agriculture has been increasing, which has significantly reduced the agriculture's use of
 2 freshwater (Alfarra, Kemp-Benedict, Hötzl, Sader and Sonneveld 2011). However, even with these
 3 strict controls, concerns regarding food security remain. In particular, since Jordan imports 90 per cent
 4 of its food, the population is vulnerable to global price shifts (Alqadi and Kumar 2014). Additionally, the
 5 increasing population and large number of refugees resulting from regional tensions mean that Jordan
 6 continues to face a water crisis that requires further policy work to maintain water and food security
 7 (ibid).

8 **Bangladesh**

9 Bangladesh's National Water Policy in 1999 aimed to shift from focusing on water management for
 10 food production to focusing on an integrated water resource management (IWRM) model in order to
 11 pursue economic development and thereby achieve food security (Ahmad 2003). Bangladesh has also
 12 seen recent intensification of agricultural production through irrigation (ibid). However, although the
 13 National Water Policy and the 2001 National Water Management Plan have sought to address 'minor
 14 irrigation and water management issues', the overall management of irrigation and water management
 15 does not have a strong place in policy (FAO 2012b: 182). For instance, 90 per cent of Bangladesh's
 16 surface water resources originate outside its territory, but few agreements have been made regarding
 17 these resources even though food crops rely heavily on readily available water (UN 2003).
 18 Additionally, although surface water is regulated, groundwater use is not clearly governed, which leads
 19 to competition and overuse as well as perpetuating inequality through unequal water access (Sadeque
 20 2000). Overuse of groundwater has caused environmental problems as well as threatened
 21 'sustainability of agricultural production' (Ahmad 2003: 122), which in turn threatens national food
 22 security.

23 Bangladesh has been self-sufficient in cereal production since 1996 (UN 2003). It has also made good
 24 progress achieving the water and sanitation MDG, especially sanitation. At the household level, a
 25 fragmented legal framework, lack of regulation and overuse of groundwater has had a role in the
 26 current issue of arsenic-contaminated drinking water (UN 2003; Alauddin and Quiggin 2008), which
 27 impacts food security in that water as a food is contaminated. There is additional concern that arsenic-
 28 contaminated irrigation water could contaminate food produced with it (UN 2003). Inequality also plays
 29 a role in household food security in Bangladesh, particularly inequality of land ownership (Ahmad
 30 2003). Besides landlessness, a study of adaptive capacity in a coastal region in Bangladesh found a
 31 perception that food insecurity is highest for those working in agriculture and is linked with their
 32 vulnerability to salinity intrusion (Saroar and Routray 2012: 186).

33 **Competition over water in Tanzania**

34 In Tanzania, the government owns all land and water, and water extraction is fee-based and requires
 35 a permit (Lein and Tasgeth, 2009). The 2009 Water Management Act regulates use for 'sustainable
 36 management and development of water resources' (Tanzania Parliament, 2012). Although customary
 37 rights are recognised, the tension of recognising them alongside formal rights has meant poor
 38 treatment of customary users of land and water (Vorley et al., 2012). Legislation favours 'the estate
 39 sector, formal irrigation and hydropower over farmer-managed irrigation' (Lein and Tasgeth, 2009:
 40 210) despite the fact that smallholders produce most of the food in the country (Vorley et al., 2012),
 41 and farmer and community water management play key roles in local farming systems (Lein and
 42 Tasgeth 2009). Although the recent National Irrigation Act 2013 is designed to increase food
 43 productivity for sustainable development, concerns have been raised that it will lead to land grabs and
 44 continued tension (Makoye, 2013).

45 Additional policy tension stems from competing uses for water. Food security as a national priority has
 46 led to a national irrigation plan and the recent National Irrigation Act, but the energy policy emphasises
 47 hydropower development, thus setting up competing water demands. (Lein and Tasgeth, 2009). While
 48 the 2002 National Water Policy notes the need for consideration of 'water for food security, energy
 49 production and other economic activities' (Ministry of Water and Livestock Development, 2002: 14)
 50 integration of decision-making in this regard has been weak. The lack of coordinated policies
 51 regarding competing water uses has caused concern, particularly with growing interest in biofuel
 52 production and its demands on water (Sosovele, 2010). In addition, the *Kilimo Kwanza* policy of 2008,
 53 also known as the 'Agriculture First' vision, calls for a greater role for the private sector and
 54 commercial agricultural development. Despite smallholders' livelihoods being protected on paper by
 55 two Land Acts, loopholes in the law have led to vast tracts of 'Village Land' being transferred to
 56 'General Land' for investors, and there have been cases of water permits granted to companies to
 57 grow sugarcane for ethanol production even sufficient water available for such operations. These

issues have caused conflicts between farmers and pastoralists and displacements from local land and water resources as well as livelihoods (Van Eeden, 2014).

Linking water and food security in Bolivia

The new Constitution Bolivia adopted in 2007 makes provisions for the human rights to food and water (UNHRC, 2008a), and the Zero Malnutrition Program, aimed at achieving those rights, recognises several links between water and food security. Potable water, sanitation, irrigation and small-scale agriculture are all given attention in the multisector Program launched by Evo Morales in 2007, although these areas received less funding than many local actors believed necessary, with funding instead focused on infrastructure (Hoey and Pelletier, 2011). Bolivia's attention to water for domestic and agricultural purposes in its food security and nutrition initiative is especially pertinent given the context of rural poverty and past and controversial attempts at water privatisation. Bolivia also has practices that explicitly recognize the rights of nature (e.g. Pachamama and Buen Vivir. see Walnycki 2013).

Although Bolivia is rich in mineral resources, extreme poverty remains high at 31.8 per cent of the population in 2005 (ODI, 2010), and poverty is concentrated among indigenous communities and subsistence farmers (UNHRC, 2008a). Climate change, and the combination of changes in rainfall and dependence of small farmers on rainfed agriculture makes these farmers' nutritional status even more precarious (ibid). Additionally, national prioritisation of industrialisation, agriculture and extractives leads to competition over water, including tension over water availability for food (Walnycki, 2013). In some areas, the granting of water rights to mining projects has led to depletion and contamination of groundwater sources used by quinoa growers (ibid) and indigenous peoples.

While the right to water is constitutionally recognised, in practice community providers fill the gap in water provision and management in peri-urban areas (Walnycki, 2013). For community providers, the problem is not just water access, but also water quality (Mehta et al., 2014b). Aquifers for these peri-urban areas are shared with other communities as well as industry and farmers and safeguarding the source in terms of quality and quantity is challenging (Walnycki, 2013). Although community mobilisation around water does lead to provision for peri-urban areas, tensions remain regarding competition between rural water use for agriculture and urban water use (Fabricant and Hicks, 2013). The current legislative system has yet to adequately address competition over water uses (Walnycki, 2013).

Growing more for less water in China

China's food security policy is that 95% of food should be produced internally. China feeds 20 per cent of the world's population on 10 per cent of the world's farmland and using 6 per cent of the world's freshwater (Doczi et al., 2014). China's economic growth and poverty reduction in the 1990's were driven in part by expanding agricultural production, which increased by over 130% (measured as value added per worker). The total irrigated area also increased, although agricultural water-use intensity has declined (water use per hectare of irrigated land decreased by 22% nationally since 1990), which has kept total agricultural water use fairly steady.

The food security policy and a focus on developing the rural areas has been high levels of public investment in agriculture and water sectors. Government investment in agriculture increased from \$15 billion to \$124 billion in 2012. Investment in research and development of new techniques as well as charging prices for water that farmers can pay, even though a gap exists between charge structure and practice such that farmers often don't get charged (ibid).

Despite these successes there are several challenges. These include clashes between economic and environmental targets, with economic targets tending to take priority. Groundwater is not effectively regulated, leading to increased problems. Wide spread social inequalities are make balancing water efficiency and equity difficult. There are also issues concerning water pollution from rapid industrialisation, urbanisation, and agriculture. Surface water pollution is improving, but groundwater pollution is getting worse. Increasing competition for water is being driven by coal-fired power plants that are being built in some water stressed areas and increasing consumption of meat (see Chapter 2).

3.5 The emergence of a global water governance regime?

As discussed in this chapter, the allocation and use of water are not technical matters, but often driven by political and economic interests. Taking this view, an analysis of the key players and the power relations at the global level becomes a useful tool in understanding the water and FSN debate. While most solutions to water challenges or exploitation of water-based opportunities take place at the local, national or regional level, there is a complex network of players at the global level that inform the dominant policy discourse in the water arena. Contemporary water governance at the international level is an arena characterized by a high degree of political contestation, competing regulatory actors and processes, and therefore a great deal of institutional ambiguity with few agreed rules or procedures regarding decision-making (Franco et al., 2013).

When dealing with the issue of water for food and nutrition security, it is important to recognise that water resources often transcend national boundaries, making their management and use a function of transnational agreements and relationships. There are 276 transboundary river basins in the world, and 46% of the world's land surface falls inside these basins.

One important principle in this regard is Article 2 of Rio Declaration on Environment and Development in 1992, claiming that *"the States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction"*.

In 1997 the UN adopted the Convention on the Law of Non-Navigational Uses of International Watercourses. Despite its adoption in 1997, it is only came into force in August 2014 after sufficient countries ratified it. It imposes an obligation on UN member states to consider the impact of their actions on other riparian states and sets out the principles of reasonable and equitable use of shared water resources (Green Cross, n.d).

Because there are very few formal agreements, there is no clear-cut global water regime with agreed-upon rules of the game providing normative prescriptions, clear expectations and institutionalized relationships (Conca, 2006). Partly this is because water is not really a global issue or a 'global public good' (cf. Mehta, 2003) but instead highly localised and at best regional in scope. Even though the 'global' nature of water is difficult to capture, there is an emerging global regime. Examples of these include the dams movement, international consensus around IWRM and the global struggles for water justice. The key global actors include the UN system, intergovernmental organisations and international financing institutions (such as the World Bank and the Global Environmental Facility), international non-governmental organisations (such as the Global Water Partnership, World Water Council, World Wide Fund for Nature), and international network of these organizations (such as IUCN), global knowledge networks (such as the CGIAR research bodies and programmes), and private sector actors.

At the level of the UN, UN-Water is the inter-agency coordination mechanism covering all freshwater and sanitation related matters, particularly in relation to the implementation of the MDGs and the Johannesburg Programme of Action. Its work also covers surface and groundwater resources and estuaries, in terms of quality and quantity issues, infrastructure development and also covers water-related disasters and extreme events in relation to their impact on human security. But it remains a virtual institute with not much influence. The World Health Organisation, UNICEF and UNEP all have a role to play in the water sector, the first two focus primarily on issues of safe drinking water and sanitation and they both monitor progress around access to water and sanitation via the Joint Monitoring Programme. Water Supply and Sanitation Collaborative Council was set up in 1990 following a UN mandate to continue the work of the decade of water supply and sanitation and now primarily focuses on access to basic sanitation.

A number of donor agencies and international financing institutions, play a significant role in the water sector, through the provision of financing for water management and infrastructure, and through their influence of global and national policies in relation to food and water. These bodies include the World Bank, the International Financing Corporation (which provides financing to the private sector), regional financing bodies such as the African Development Bank and the Asian Development Bank, and international co-operating partners such as DFID, USAID, and GIZ. The Chinese government has also become a major player in financing and developing water-related infrastructure, including in Africa.

1 The role of the World Bank has been particularly controversial around both the hydropower and
2 privatization debates.

3 There are significant research bodies operating at the global level that are important in the water
4 sector, not least the 15 CGIAR centres and the associated multi-centre research programmes. Of
5 these, the International Water Management Institute (IWMI) is focused entirely on water, and largely
6 on water and agriculture e. However, other CGIAR centres, and several of the multi-centre research
7 programmes also deal with issues of water. The challenge, as with all research programmes, is
8 ensuring that the research is translated into practice at scale.

9 The private sector is a strong player in the hydropower sector, and the multinational agricultural and
10 industrial sectors. The World Water Council, which hosts the tri-annual World Water Forum, was
11 founded in 1996 by a group that included the International Commission on Irrigation and Drainage, the
12 International Union for the Conservation of Nature (IUCN), the International Water Association (IWA),
13 Suez Lyonnaise des Eaux, the United Nations agencies UNDP and UNESCO, and the World Bank.
14 Members of the current Board of Governors include four categories: intergovernmental institutions,
15 governments and government authorities, enterprises and facilities, and civil society organisations and
16 water user associations. The latter grouping, however, does not include any groups that represent the
17 interests of marginalised and poor communities in developing countries. It was only at the sixth world
18 water forum that some attempts were made to bring grassroots civil society organisations and
19 representatives of social movements into the mainstream. Forum but even here as before, civil society
20 discussions were held in a separate venue, distinct, and sometimes a considerable distance, from the
21 main venue. Whether this was driven by civil society, or by the Forum organisers, it represents the top-
22 down nature of the water sector and problems concerning transparency and accountability (Mukhtarov
23 and Gerlak 2013).

24 Counter-balancing the private sector discourse, water has been a key focus of social movements
25 around the world. The issues that have mobilised communities have included not only struggles
26 against bottled water, mining related pollution, the displacement caused by large dams and the
27 privatisation of water services amongst others. The focus has often been to safeguard local
28 livelihoods, food and water security as well as strengthening the capacity of the public utility to fulfill its
29 responsibilities and re-municipalize privatized water systems. Many struggles focused on food
30 security issues also recognize water as crucial for the realization of right to food. For example, La Via
31 Campesina, the international peasant's movement, that is strongly focused on issues of land rights
32 and sustainable agricultural practices, refers to the issue of water amongst the resources that need
33 protection from corporate control. It calls for peasants and small farmers to retain the control over
34 'commons' such as water, biodiversity and agricultural knowledge. The social movements are growing
35 in strength, not least due the power of social media and the internet in linking erstwhile isolated
36 groups.

37 Finally, current water policy debates are abuzz with new concepts and ideas. Long dominated by
38 IWRM, terms such as water security (Cook et al 2012; UN) and 'nexus' thinking, such as water-food-
39 energy or water-land-climate and similar constellations are increasingly gaining ground. (Hoff 2011;
40 WEF 2011) It is hard to disagree with the strong interconnections between water, food, energy and
41 climate change and the need to pay more careful consideration to the trade-offs between these
42 different resources as nexus proponents have argued. In fact, such trade-offs are commonly made on
43 an everyday basis in poorer communities at an individual and family levels, and at times even at
44 community levels. There is also a need to break down sectoral, policy and disciplinary silos.

45 But as Allouche (2014) argues, there is still no clear idea about how to ground the nexus in local and
46 regional issues and it is assumed that decision making tools based on modelling can easily provide a
47 valuation of different resources and provide the mechanisms to decide on allocation and tradeoffs. In
48 the water domain, this has rarely been the case. Finally, global or national priorities often do not match
49 with local priorities and needs and nexus thinking often tends to ignore the political nature of allocation
50 and decision making (ibid).

51 3.5.1 International Processes and agreements that impacts water for 52 food security

53 Globally, numerous competing governance mechanisms have emerged around the issue of global
54 capital engaging with local natural resources. High profile governance initiatives addressing land use,
55 management and access in relation to agriculture thus include, among others: (1) the World Bank led

1 ‘Principles of Responsible Agricultural Investment’; (2) the CFS endorsed ‘Voluntary Guidelines on the
2 Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food
3 Security’ (VGGT); (3) the CFS process on Principles for Responsible Investment in Agriculture and Food
4 Systems, and (4) more lately the G8’s ‘Land Transparency Initiative’ or G8LTI. None of these
5 initiatives deal much or at all with issues of water access, use and distribution of benefits and burdens.
6 Although ‘tenure security’ in the land, fisheries, and forestry sectors is a major concern in all of these
7 initiatives, they are not necessarily
8 referring to the same thing,. These
9 governance initiatives have tended to not address a wide and deep range of issues
10 related to water.
11 The VGGT warrant special attention since they constitute the most recent site of struggle between
12 competing views and interpretations of natural resources. And the way they should be governed
13 (Suárez, 2013; Seufert 2013). The VGGT mark an important step forward in elaborating a human rights
14 based approach
15 to the governance of tenure as they are ‘the first international instrument which applies an ESC-Rights
16 based approach to
17 the governance of land’ (Suárez, 2012: 37). During the final negotiations, the effort by civil society to get
18 water into the
19 guidelines ran up against opposition and resistance from other participants who denounced water and
20 water governance as ‘too complicated’. This poses a major ambiguity since water is indeed deeply and
21 inextricably interconnected with other natural resources.¹⁶

Box 20 Sustainable Development Goals (SDGs)

A process is underway globally to replace the Millennium Development Goals (the first phase of which is to be completed by 2015) with Sustainable Development Goals. A wide process of consultation and engagement has been implemented to develop these SDGs, with the intention that they are approved by the UN before the end of 2015. The proposed goal for water is much broader than the MDG water and sanitation goals. While the MDGs focused on domestic water supply (and sanitation which was added at the WSSD in Johannesburg in 2002) the SDGs are likely to be focused on water supply, sanitation and hygiene; sustainable water resources management; and the reduction of pollution, within the context of water security. There is reference in the discussions around the SDGs to equitable access to water. “In order to achieve water security for all, the following potential targets were proposed: equitable and universal access to safe and sustainable water, sanitation and hygiene; ground and surface water should be developed and managed sustainably and in an integrated manner to satisfy human needs while respecting ecosystem requirements; and all used water and wastewater should be collected and treated before it is returned to nature and managed under principles of pollution prevention and safe reuse.” (UN Technical Support Team n.d.: 5) What is not expanded on, however, is what equitable access to water means, particularly in the context of FSN, and whether there is an implication that poor women and men should have access to sufficient water to meet their food needs, or whether it simply refers to sufficient safe water for domestic purposes. Moreover the SDGs focus on water security (along with food and energy security) seems to be a shift away from rights based approaches to development to one framed by the nexus approach promoted by the World Economic forum (Allouche, Middleton, Gyawali 2014).

20
21 International human rights law has moved increasingly toward establishing a
22 broader concept of land, water, and associated resources such fisheries and forests as matters of
23 human rights. This has for instance led to the inclusion of access to land as part of “the right to feed
24 oneself” (Künnemann and Monsalve Suárez, 2013). Although there is as yet not distinct human right to
25 land, the pressure to establish such a right remains (Borras and Franco, 2010). We now turn to a
26 detailed discussion on the right to water and the right to food.

¹⁵ No mention of water is made beyond a single reference to the governance of water and other “associated natural resources”, such as for instance fisheries, by national states on basis of their own “different models and systems of governance” (Committee on World Food Security (CFS) and FAO, 2012: iv).

¹⁶ This leaves small scale fishers vulnerable to other governance initiatives, which have the potential to facilitate “ocean-grabbing” (see World Forum of Fisher Peoples (WFFP) and World Forum of Fish Harvesters and Fish Workers (WFF) 2013).

Box 21 Relevant international human rights instruments, agreements and texts applicable to water policies and other measures to enhance food security

The Universal Declaration of Human Rights <http://www.un.org/en/documents/udhr/> in particular Article 25: Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care

The Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) (UN 1979) <http://www.un.org/womenwatch/daw/cedaw/text/econvention.htm#part1> (see Preamble and Article 14 (on rural women): To enjoy adequate living conditions, particularly in relation to housing, sanitation, electricity and water supply, transport and communications

The UN Declaration on the Rights of Indigenous Peoples (UNDRIP) (UN 2007) http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf, in particular Articles 8, 20, 21, 23, 25, 27, 32 stressing the rights of indigenous peoples to have redress from dispossession and their rights to development, subsistence, health, water, sanitation etc.

The International Covenant on Economic, Social, and Cultural Rights (ICESCR) (UN, 1966) <http://www.ohchr.org/EN/ProfessionalInterest/Pages/cescr.aspx> (Article 11 as well as General comments 12 and 15).

The Voluntary Guidelines to support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security (the Right to Food Guidelines) (FAO, 2004)

<ftp://ftp.fao.org/docrep/fao/meeting/009/y9825e/y9825e.pdf> - see discussion to follow. Guideline 8c explicitly acknowledges that access to water in sufficient quantity and quality for all is fundamental for life and health and that states should strive to improve access to, and promote sustainable use of, water resources and their allocation among users giving due regard to efficiency and the satisfaction of basic human needs in an equitable manner.

The UN's 2010 binding resolution on the human right to water and sanitation (UN, 2010b); <http://daccess-dds-ny.un.org/doc/UNDOC/LTD/N10/464/64/PDF/N1046464.pdf?OpenElement> see Section 3.7 for a fuller discussion.

Conventions and other binding or non-binding instruments

The Ecosystem Approach Principles adopted by the Convention on Biological Diversity <https://www.cbd.int/doc/meetings/cop/cop-09/media/cop9-press-kit-ea-en.pdf>, especially

Principle 1: 'The objectives of management of land, water and living resources are a matter of societal choice.' 'Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized'... 'Decisions should be based on, and contribute to, inter-sectoral communication and coordination' with clear implementation guidelines (p. 9)

Principle 2: 'Management should be decentralized to the lowest appropriate level' Rationale: decentralized systems 'lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interests.' With recognition of the various communities of interest in management

The Convention to Combat Desertification (UNCCD, 2012), <http://www.unccd.int/en/about-the-convention/Pages/Text-overview.aspx>

Prologue: Mindful that desertification and drought affect sustainable development through their interrelationships with important social problems such as poverty, poor health and nutrition, lack of food security, and those arising from migration, displacement of persons and demographic dynamics, see in particular Articles 4: 1, 5, 10, 17 18, 19, 21 etc.

The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) (UNECE 1998) <http://www.unece.org/fileadmin/DAM/env/pp/documents/cep43e.pdf>

Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitats) (The Ramsar Convention on Wetlands, n.d.) http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671_4000_0

UN convention on shared water courses (UN Watercourses Convention 2014)

<http://www.unwatercoursesconvention.org/the-convention/> (especially <http://www.unwatercoursesconvention.org/the-convention/part-ii-general-principles/>)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty negotiated at the United Nations Conference on Environment and Development (UNCED) in 1992. Its objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UN 1992).

3.6 The right to water and the right to food

A rights-based approach to water and food security implies that people's access to water and food is protected by law and legal mechanisms. It helps to focus on key questions such as: Who produces food and for whose benefit?; and, what are the social, economic, political, cultural and investment barriers that prevent individuals and communities from realising their right to food? Such a framework also helps to ensure accountability and public participation in decision making around food production and nutrition security, and ensures that those most affected by food insecurity, particularly women, are given priority (UNHRC, 2008b). The discourse of rights is based on the notions of rights holders and duty bearers (UNDP, 2006). All human rights – whether Economic Social and Cultural Rights (ESCR) or Civil and Political Rights (CPR)– are either positive rights, which requires the duty bearer to take action to help fulfill those rights; or negative rights, which requires the duty bearer to refrain from doing harm to an individual's or group's claim to those rights (also known as the rights of non-interference); or requires the duty bearer to prevent third parties violating these rights (such as non-discrimination or freedom) (UNCESCR, 2012). In the last decades, there has been a growing recognition of that both positive and negative rights are inter-related, inter-dependent and indivisible. Amartya Sen sees human rights as entitlements to rights to certain specific freedoms, i.e. capabilities (2004). In this case, capabilities include both functioning (i.e. having access to basic rights such as food and water) as well as having the *opportunity* to have, say, a good and safe supply of water and the ability to choose different combinations of functionings. Thus, genuinely protecting people from water and food related injustices has a lot to do with human rights, local agency and the right to determine and set one's own priorities and strategies.

3.6.1 The Right to Food

The right to food is referred to in the text of the Universal Declaration of Human Rights (UDHR) 1948 and is also part of the International Covenant on Economic, Social and Cultural Rights (ICESCR) 1976. Writing on the transformative potential of the Right to Food, the UN special rapporteur on the Right to Food drew on the General comment No 12 on Right to Food (UNCESCR, 1999) and defines it as the right of every individual, "alone or in community with others, to have physical and economic access at all times to sufficient, adequate and culturally acceptable food, that is produced and consumed sustainably, preserving access to food for future generations (UNGA 2014)."

The General Comment on right to food further states that the right to adequate food imposes on the State Parties the obligations to *respect*, to *protect* and to *fulfil*. States' obligation to *respect* existing access to adequate food requires States parties not to take any measures that result in preventing such access [UNCESCR 1999; E/C.12/1999/5 para 15]. Similarly "the obligation to *protect* requires measures by the State to ensure that enterprises or individuals do not deprive individuals of their access to adequate food." Further, the obligation to *fulfil* (*facilitate*) means the State must proactively engage in activities intended to strengthen people's access to and utilization of resources and means to ensure their livelihood, including food security (UNCESCR 1999 E/C.12/1999/5 para 15)." Here too, extrapolating on these obligations to respect, protect and fulfil the means of food-production, it appears that the State Parties have an obligation to protect the water resources from being diverted for other purposes, so that there is adequate access to water for subsistence farming and for securing the livelihoods of indigenous peoples.

In the case of indigenous peoples, the realization of right to food is dependent on recognizing not only their individual rights but also upholding their collective rights –the right not to be subjected to forced assimilation or destruction of their culture, their right to self-determination (by virtue of which they freely determine their political status and freely pursue their economic, social and cultural development), the rights to their lands, territories and resources, the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, (as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines etc.) and their right to non-discrimination (UNGA, 2007). Thus in the case of communities with distinct cultural traditions –most of them small-scale producers, pastoralists, fisherfolks etc–the call for food as a human right is intrinsically connected to the call for eliminating harmful policies and practices that prevent them from exercising their right to self-determination (FAO 2009). <http://www.fao.org/docrep/016/ap552e/ap552e.pdf>

Moreover, the Right to Food also implies that the accessibility of food must be "in ways that are sustainable and do not interfere with the enjoyment of other human rights" [emphasis added]

(UNCESCR 1999 E/C.12/1999/5 para 15). This implies that the activities and processes undertaken towards the realization of the right to food, must respect the environmental limits (such as minimum flow requirements) and the carrying capacity of resources, must not be at the cost of other human rights such as the right to water (priority for drinking water and sanitation in the community) or right to health (such as protection for agricultural workers from agro-chemicals). The special recognition given in General Comment 12 to the term sustainability when it comes to access and availability of food, implies that food should be accessible for both present and future generations (General Comment 12, paragraph 7). This could also be relevant for water use in agriculture (Windfuhr 2013). For example, if water resources are overexploited leading to depletion or salinity in soils, food security cannot be sustainable.

The General Comment on the right to food states that “Finally, whenever an individual or group is unable, for reasons beyond their control, to enjoy the right to adequate food by the means at their disposal, States have the obligation to *fulfil (provide)* that right directly. This obligation also applies for persons who are victims of natural or other disasters.” [E/C.12/1999/5 para 15]. The Voluntary Guidelines on the right to food are a key implementation guide for the right to adequate food (VG 14 UN – Doc E/C.12/1999/5). They call on states to develop strategies to realize the right to food, especially for vulnerable groups in their societies. No such guidelines exist for the right to water.

3.6.2 The Right to Water

The now globally endorsed human right to water has been the result of intense global struggles since decades and is a relative new-comer. Unlike the right to food, it was not explicitly acknowledged in the 1948 Universal Declaration of Human Rights. At the turn of the 21st century, there still remained a lot of resistance to the human right to water on the part of some nations and corporations (Sultana and Loftus, 2011; Mehta, 2014). On November 27, 2002 the United Nations Committee on Economic, Social and Cultural Rights adopted the General Comment No. 15 on the right to water.¹⁷ The Committee stressed the State’s legal responsibility in fulfilling the right and defined water as a social and cultural good and not solely an economic commodity. In July 2010 access to clean water and sanitation was recognised by the General Assembly of the United Nations as a human right. In September the UN Human Rights Council affirmed by consensus that the right to water and sanitation is derived from the right to an adequate standard of living, which is contained in several international human rights treaties and that is both justiciable and enforceable (UN, 2010c). It is important to note that like the right to food, having the right to water doesn’t mean it will be available for free to all. Instead, it implies obligations to respect, protect and fulfil the right to water. But it does mean that market-based mechanisms such as pricing tools should not harm people’s basic rights to water.

As elaborated in the General Comment on the human right to drinking water and sanitation entitles everyone to **sufficient, safe, acceptable, physically accessible and affordable** water for basic personal and domestic use. [UN CESR 2002;E/C.12/2002/11 para 1]. Further, the normative content of the right to water includes the right to maintain access to existing water supplies necessary for the right to water, the right to be free from interference, such as arbitrary disconnections or contamination of water supplies, as well as the right to a system of water supply and management that provides equality of opportunity to enjoy the right to water [E/C.12/2002/11 para 10]. It is stressed that water should be treated as a social and cultural good, and not primarily as an economic good. Also the realization of the right to water must be done in a sustainable manner, ensuring that the right can be realized for present and future generations.

While the General Comment recognizes the centrality of water to help realize many of the Covenant rights –such as for the production of food; for ensuring environmental hygiene; for securing livelihoods; and to help enjoy certain cultural practices – it still emphasizes that in the allocation of water, priority must be given to the right to water for personal and domestic uses (UNCESR 2002;E/C.12/2002/11 para 1). In short the right to water is a right whose fulfilment is expected to act as a catalyst towards the fulfilment of other rights, such as right to food, right to health (for sanitation and hygiene), right to adequate standard of living etc.

Noting the need for sustainable access to water resources for agriculture to help realize the right to adequate food (general comment No. 12; 1999), the General Comment on the right to water suggests ensuring that “disadvantaged and marginalized farmers, including women farmers, have equitable

¹⁷ General Comment 15, The right to water (arts. 11 and 12 of the International Covenant on Economic, Social and Cultural Rights), U.N. Doc. E/C.12/2002/11 (Twenty-ninth session, 2002)

access to water and water management systems, including sustainable rain harvesting and irrigation technology”. Taking note of the duty in article 1, paragraph 2, of the International Covenant on ESCR, which provides that a people may not “be deprived of its means of subsistence”, it further suggests that “States parties should ensure that there is adequate access to water for subsistence farming and for securing the livelihoods of indigenous peoples.”

In asserting this the General Comment on the right to water refers to the ‘Statement of Understanding accompanying the United Nations Convention on the Law of Non-Navigational Uses of Watercourses (A/51/869 of 11 April 1997), which declared that, in determining vital human needs in the event of conflicts over the use of watercourses “special attention is to be paid to providing sufficient water to sustain human life, including both drinking water and water required for production of food in order to prevent starvation”. However, these provisions are advisory in nature rather than these being included within the scope of the right to water itself (UNCESCR 2002).

3.6.3 Unresolved matters concerning the right to water

While the right to water now enjoys global recognition, it still remains conceptually ambiguous (Sultana and Loftus, 2011). There have been many debates regarding whether or not it is compatible with water privatization (Box 22). It is also unresolved, how much water should constitute the ‘right to water’. Evidence from the water sector in setting up standards around what constitutes a ‘basic water requirement’ varies greatly by country and by institution. Basic water requirements have been suggested by various donor agencies and they range from 20 to 50 litres a day, regardless of culture, climate or technology. Usually, though culture, climate, livelihoods, whether urban or rural do matter. The WHO prescribes between 20 – 100 litres a day (WHO, 2003) but recognises that below 50 litres can only reach a ‘low’ level of impact and that 100 is the minimum required for basic food and personal hygiene, though this amount excludes water for productive or survival activities such as growing food (Mehta 2014). Clearly, the low end provision takes a very narrow view of the water needs of the poor, inimical to the capability approaches focus on human flourishing and freedoms which should also take into account livelihood and subsistence needs. Also men’s and women’s ability to function on the basis of the same allocation of any one resource varies dramatically. People ultimately need different basic amounts of water to enjoy the same standard in terms of capability.

Box 22 The right to water in South Africa

South Africa was one of the first countries that explicitly recognised the right to water, and its Free Basic Water policy provides a minimum of 25 litres per capita per day based on a household size of eight people free to all citizens (McDonald & Ruiters, 2005). But implementing the right to water in South Africa has been fraught with difficulties and there are huge debates regarding whether they have had a significant impact on improving the well-being of poor South African citizens and how equitable they are (ibid, see also Flynn & Chirwa, 2005). One, there have been heated debates about whether the right to water is compatible or not with parallel trends of water privatization which have resulted in pre-paid meters, cut offs and disconnections etc. which have been interpreted by many to run contradictory to citizens’ basic right to water whilst also creating new forms of poverty and ill-being (Flynn & Chirwa, 2005; Loftus, 2005; McDonald and Ruiters 2005). There have also been debates concerning the sufficiency of 25 litres per day per person, especially if the household number is large. In rural areas, this has not been deemed to be sufficient for poor people to successfully maintain their livelihoods and escape the trap of poverty and HIV/AIDS. Others have argued that most poor households in South Africa do not enjoy a ‘healthy environment’ on the basis of the 25 litres provided. Instead, more like 80 – 100 litres are required per person for basic personal and food hygiene and this does not even take into account water for subsistence, so crucial for poverty reduction and survival (Flynn & Chirwa, 2005). South Africa, the first country to recognize right to water in its constitution, is also the only country that recognizes right to water for ecosystems to maintain a minimum flow (Ziganshina 2008) through its unique concept of the ecological reserve.

Other unresolved matters regarding the right to water concern the place of the right to sanitation. We have already discussed how sanitation was initially absent from the MDG discussion and only added in 2002. The General Comment No. 15 also doesn’t adequately mention sanitation. The Special Rapporteur on the right to water, Catarina de Albuquerque has recently stressed the need to separate out the two. Even though they are sometimes related because poor sanitation negatively affect water resources, they demand different state action and governance systems (UN 2009 See A/HRC/12/24, see also Ellis and Feris, 2014, who call for delinking the right to sanitation from the right to water).

Critical for our report are emerging issues regarding expanding the scope to address the importance of adequate water for ecosystem sustenance and subsistence agriculture which we elaborate below.¹⁸

3.6.4 Convergences and conflicts

Both the General comments on the right to water and the right to food converge in the prioritizing of the right to water including sufficient water to produce food. For example, the General Comment NO. 15 highlights how the right to water is inextricably related to the right to food and stresses that priority should be given to water resources required to prevent starvation and disease (UN, 2003 – E.

CN.4/2003/54) and the General Comment no. 12 notes the importance of ensuring sustainable access to water resources for agriculture to realize the right to adequate food. Both rights are also governed by humanitarian law and it is acknowledged that the destruction of water resources and distribution points during conflict situations can kill more people than actual weapons (UN, 2003). International water course law also clearly states that in the event of conflicts, human needs must be prioritized and attention should be paid to providing sufficient water to sustainable human life (ie both for drinking water and water required for producing food to prevent starvation, *ibid*). This is critical because 250 rivers on earth cross international boundaries and provide water for 40% of the world's population.

Both rights also suggest that State parties should ensure that there is adequate access to water for subsistence farming and for securing livelihood needs of indigenous peoples, and that water should not be diverted for other needs at the cost of these communities.

In addition, 'human rights standards stipulate that the direct and indirect costs of securing water and sanitation should not reduce any person's capacity to acquire other essential goods and services, including food, housing, health services and education' (COHRE, AAAS, SDC and UN-HABITAT 2007).

There is a tension present between such a reading and the international focus on environmental sustainability and protection of ecosystems where the setting aside of sufficient water to maintain aquatic ecosystem functioning may be seen to be in conflict with the right to sufficient water to grow food. Should this indeed be the case, the state is obliged to ensure that the right to food is met through other means.

Often difficult choices have to be made at the individual or household level when water is scarce. For example in rural areas women often have to decide how much time to spend on water collection (right to water) vs. food production or fuel gathering (right to food); or whether a girl child should help collect water (right to water) or go to school (right to education); similarly in urban slums poor families have to apportion the money for meeting their food requirements vs. their water needs. Here, these rights are not in conflict with each other; rather each of these rights is being violated simultaneously.

On the other hand at community or society level these rights sometimes conflict with each other. At times, especially under water scarce conditions, when states attempt to fulfil the right to water obligation towards the urban community, it can result in the violation of the right to food or right to water of the rural communities. With increasing urban migration and related urban development water is often diverted away from rural areas and agriculture, including subsistence production systems, to meet the urban water needs. In fact many communities find both their right to water and the right to food violated as States pursue policies that protect the interests of their more powerful stakeholders or try to fulfil the right to development of some citizens (24X7 water, energy, infrastructures) over others who need to give up their lands and water resources in this process. Finally, investments in agriculture to ensure the right to food can also affect some people's right to water or damage ecosystems.

These are competing trade-offs and pathways with different outcomes for different social groups. According to Windfuhr (2013), decision making needs to be determined by taking into account the priorities of vulnerable groups and their basic human needs. While domestic needs (i.e. water for drinking, bathing and hygiene) are usually given most priority, it is also important to prevent starvation and water for agriculture should first and foremost be allocated to disadvantaged and marginalized groups (something which is rarely the case in reality).

¹⁸ Also, see Ziganshina (2008) that uses two case studies – one from SA and other from Uzbekistan—to argue in favour of expanding the definition of right to water to include water for ecosystems and water for subsistence production in addition to right to water for drinking water sanitation.

Another point that needs to be stressed is that the mandate of the Special Rapporteur on the right to food also includes tracking violations and this has been a powerful tool to counter-act food related injustices. The Special Rapporteur for food can respond to allegations with respect to violations and also can write to relevant governments to ask them to take action to ensure redress and accountability (UN 2003). The Special Rapporteur for water lacks this explicit mandate and thus far has largely focused on 'best practices.' This is probably due to the controversial nature of the right to water and the initial resistance to its existence on the part of many players. So far the human right to water has not been deployed to focus explicitly on water management issues or the water implications of land acquisitions because of its limited scope to domestic uses of water. This is in sharp contrast to the special Rapporteur on the right to food who has in recent years frequently commented on land acquisitions and grabs and their impacts on local people's food security (Franco et al., 2013).

3.6.5 Rights under threat

While there have been several international initiatives to protect the interests of the investors under the binding agreements such as those on trade and investment, there appears to be a lacuna in international agreements or covenants that protect communities affected by such international investments. In the context of increasing international investments and associated human rights violations, as well as other impacts on the lives and livelihoods of local communities, defining the extra-territorial obligations of the investors/home States is becoming important.¹⁹

In addition, with increasing globalisation, the right to food of many communities are constantly under threat not only by the actions of national actors but also actors accountable to other states. Thus there is a need to look at the human rights obligations of states towards persons outside their territories, including the extra territorial private sector impacts.

ETO Consortium is an international network working on extra-territorial human rights obligations of states (ETO) Consortium, n.d.). Their terms of reference are based on the Maastricht Principles on Extraterritorial Obligations in the Area of Economic, Social and Cultural Rights, an international expert opinion (issued in 2011) which can serve as a source of international law according to art.38 of the Statutes on the International Court of Justice. The Maastricht Principles on ETOs lay down the States obligations to respect, protect and fulfill ESCRs extraterritorially. Several principles are especially relevant in the context of the right to food and the right to water: "States have the obligation to protect individuals ESCRs by regulating non-state actors (Principles 23-27). States are obliged to regulate and/or influence the business sector in order to protect those affected by them outside their territory."

In the context of human rights violations associated with IFI investments States Parties have asserted in their submissions that "the right to life not only emanates from specific international human rights treaties but that it now constitutes a general principle of international law. On account of this, the rights bind the entire international community and not just States Parties to human rights treaties." (Gibney, and Vandenhoe, 2013) , Extending this argument would imply that extra-territorial obligations needs to be assessed not only in the context of agriculture related investments but also other investments including that through development cooperation, or international trade when it these impacts the rights (right to food, right to water, right to life) of local communities. The land acquisitions on the part of foreign investors around the world are a good case in point. In some cases, there can be violations of both the right to food and the right to water (see also Chapter 1). The HLPE (2011) report on Land tenure and international investments in agriculture states: "As with land deals in general, little evidence exists which document the rights gained by investors over water. But the evidence which exists indicates that small-scale farmers may suffer greatlyAs a result, awareness of water issues is paramount and because acquiring water rights is such a key issue in investment projects, they will invariably impact on water management for many inhabitants both up and downstream" (HLPE, 2011:22).²⁰

¹⁹ This section is based on the work of the ETO consortium, especially their work on right to food. <http://www.etoconsortium.org/en/about-us/eto-consortium/>

²⁰ In 2011, participants from 25 countries from four continents raised the issues of human rights violations taking place through land deals around the world and asked of governments to fulfil their obligations under the Universal Declaration of Human Rights, UN ESCR and UN CPR as well as raised the issue of extra-territorial obligations (see *Workshop on "Land Grabbing in Africa – Dangers and Challenges, M'bour, Sengall, WSF (2011)*)

3.6.6 Growing calls to expand the right to water or have a separate right to water, sanitation and water for the realization of right to food?

There have been growing calls to elaborate a human rights perspective to land and to water that is both more interconnected, more social justice oriented and encompasses productive uses of water (Franco et al., 2013). While policy makers tend to separate out water services from water resources or water for domestic and productive purposes, the capabilities approach helps break down such distinctions between it argues that the right to life includes the right to livelihood (ie water for production, see Mehta 2014). Such a broader conceptualization is also more true of how water is understood and embedded in the daily lives of local women and men around the world (see Box 23).

While discussing water as a human right in the Middle East and North Africa (MENA), Brooks (2007) argues that this concept is very old in MENA and goes back at least to the Code of Hammurabi in Babylon. But the UN focus on the household and domestic uses of water is not very useful in a region characterized by sharp competition where average annual supply for the region is well under 1500 cubic metres per capita. Thus, he advocates consideration of the right to water to grow food and the right to water for a liveable environment (that is, water to support the ecosystem) (ibid). Water's greatest use is for growing food and he argues that everybody should have a right to a sufficient quantity of water of decent quality" to enable the growing of enough nutritious food for a healthy life" (Brooks 2007: 233). This aspect of the right to water, of course, still needs to be worked out and is difficult to define. For example, the right to enough water to grow food in a home garden changes with climate, soil, urban vs. rural, etc but still could be a highly efficient way to grow food. This issue warrants further research (both conceptually as well as in terms of the policy and practical implications).

Water for ecosystems has been recognised in South Africa and some countries in the MENA region. This right is not for individuals since the ecosystem is a commons. It would be especially difficult to implement in drier countries, and marginalised groups may suffer, but it is an important right to consider, particularly since healthy ecosystems are necessary for human's lives, food security and livelihoods. Brooks also questions the approach of interlinking water, food and health, and instead advocates for the separation of water for household use (drinking water), water for food, and water for ecosystems. Separation of these issues could allow for clear goals and monitoring. Clearly, all these issues demand further attention and research and could be taken up by CFS and governments. We now turn to Chapter 4 where we discuss various action points for different actors arising from the different issues raised in this and the previous chapters.

Box 23 Multiple water use services

Research on multiple water user services (MUS) shows that when communities invest in infrastructure, they build cost-effective multi-purpose infrastructure in order to enable a broad range of uses for multiple dimensions of wellbeing, which all directly and indirectly contribute to food security. Moreover, communities efficiently use and re-use multiple water sources. They manage these sources in conjunction, thus mitigating water variability and protecting against too much water. In contrast, the fragmented set-up of the public water sector implies that the different departments, divisions and programs operate in parallel as top-down silos, focusing on one single use only, either for water services for domestic uses and sanitation, or for irrigation, or for capture fisheries, fish farming, etc. The domestic sector seeks to reach everybody, in line with the human right to water for domestic uses and sanitation of 2010. However, the productive sectors have hardly any ambition to meet at least everybody's basic productive water needs for basic food security. Food insecure women

and men remain hidden behind the discourse of monolithic, homogenous sectors especially interested in aggregate production figures. So there is no public 'owner' taking responsibility for water development to contribute to the human right to food and an adequate standard of living (Van Koppen et al., 2014a). One solution is to 'climb the multiple use water ladder'. Instead of providing only 20 or 50 litres per capita per day, supposedly only for domestic uses, up to 50 or 100 litres per capita per day is provided to promote homestead-based productive uses. The incremental investments in such expansion can be repaid from the incremental income in half a year to three years (Renwick et al., 2007). This builds on what people in practice already started doing with their water services supposedly for domestic uses only. Hall et al. (2013) found in Colombia, Kenya and Senegal that between 71 and 75 % of households were engaged in productive activities. Piped water supplies were a more important source than other water sources: between 54 and 61 % of households used piped water for these productive activities. In Senegal and Kenya, this happened even though households only used a median of 23 and 31 lpcd respectively, so barely more than the 20 lpcd that are globally seen as the minimum for domestic uses only. This underscores the importance of small-scale productive uses for food security.

DRAFT RECOMMENDATIONS

(Work in progress - D R A F T)

Water is essential for all life, and is a fundamental aspect of food security and nutrition. This is because water of sufficient quantity and quality is an essential input to agricultural production as well as to the preparation and processing of food. Safe drinking water and sanitation are fundamental to the nutrition, health and dignity of all. Water is what brings life to ecosystems, such as forests, lakes or wetlands that provide poor people with nutrition, and is fundamental for all other productive sectors, including energy and manufacturing. At the same time, water is a resource under stress and there are competing uses of water from off-stream agriculture, domestic and industrial uses as well as in-stream demands for fisheries, aquaculture and many environmental services. As a result of rapid increases in non-irrigation demands and the relatively low value of water in irrigated agriculture, water is increasingly being transferred from agriculture into the domestic and industrial sectors as a result of growing urbanization and industrialization. But demand in the agricultural sector continues to grow as well due to dietary shifts toward more water-intensive foods such as livestock products, sugary foods and fruits and vegetables. Rapidly growing demand faced with limited supplies will increase tension over water accessibility, with largest adverse impacts for the poorest.

Millions of people around the world lack access to safe drinking water and adequate sanitation facilities, affecting their nutritional and health status. Finally, increasing pollution from industry and agriculture as well as unsustainable water management practices in many parts of the world are rendering water unfit for use adversely affecting human and ecosystem health. In the light of these crucial linkages and problems, below are formulated some DRAFT actions and recommendations in the following proposed key areas.

1. Water and sanitation deserve a central position in food security and nutrition strategies and there needs to be more joined up thinking and action around water / sanitation and food security and nutrition

Food and nutrition security strategies need to adequately take account of the necessary, underlying water resources, both in terms of quality and quantity; so that these are available along the food value chain as well as for drinking and sanitary purposes. Similarly, economic development strategies should assess impacts on water for food and nutrition security.

At the national level, ministries and departments dealing with agriculture and food and those managing the environment and water resources, as well as those in charge of health very often do not adequately coordinate their efforts and actions. Water and land tenure and use right systems are seldom coordinated, which can lead to sub-optimal outcomes on the ground, especially for small or marginalised farmers and food producers.

Major global initiatives around water, land and food governance are not adequately integrated. For example, the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security adopted by CFS do not address the link with water. Finally, the role of sanitation in reducing malnutrition and enhancing human well-being is not adequately acknowledged.

States should:

- Ensure that water concerns are incorporated in food security and nutrition strategies and policies at the national and sub-national levels
- Similarly, the need for sufficient water resources of adequate quality and quantity needs to be integrated in climate change and fisheries and aquaculture strategies.
- Work towards meeting universal access to Water, Sanitation and Hygiene (WASH) goals, which is an important element of FSN. Countries that have not yet achieved universal access are called to action. Universal coverage requires locally adapted and accepted solutions that empower communities, especially women, to take control of WASH.

States, international donors, the UN and NGOS should

- Commit, as a priority, to providing funding and institutional support to universalise access to water, sanitation and hygiene.
- Acknowledge the importance of sustainable water management in achieving food and nutrition security in ongoing discussions and future implementation of the Sustainable Development Goals (SDGs)
- Recognize the linkages between access to water and food and nutrition security for the poor, and the particular needs of women for water access due to their primary role as caregivers.
- Include energy and climate change concerns in the development of enhanced water-for-food policies, investments and institutions.

The CFS should

- Promote such joined up thinking in future deliberations on FSN. The close links between food security and water need to be recognised, given that violations in people's right to food are often linked to problems related to poor access to and control over water as well as poor water quality.
- Raise awareness at the international level for alignment of food security and nutrition policies with water policies and investments and also make the necessary linkages with energy and climate change;

2. Access to sufficient and safe water by poor women and men needs to move up to the top of political agendas for long-term FSN

Problems and solutions around water for FSN are often conceptualized and framed in ways that neglect the needs and interests of poor, food insecure and marginalized women and men. Thus, poor women's and men's capabilities and entitlements to water and food are neglected. It is important to address current inequalities in global and national water and food supply, consumption and related distributional processes and focus on enhancing equity/ gender and social justice around water for FSN.

States, NGOs and international donors should ensure that national water and food-related policies and programmes:

- Recognize women's key roles in agricultural and food systems and the need for women to have equal access to men to land and water entitlements and technologies to access these vital resources;
- Serve to revitalize rural economies, support minority cultures and promote sustainable livelihood practices;
- Revisit subsidy and policy regimes that favour rich producers and farmers at the expense of the food and water insecure; and those that waste and degrade water resources
- Address issues of dietary change and consumption practices, particularly more than proportional appropriation and consumption of natural resources as well as food in wealthy countries, high food waste in these same countries; and impacts on the food and water insecure.
- Support the collection of data that distinguishes water and food needs and uses by gender, location and economic status to understand distributional and equity issues concerning water and FSN.
 - Make the 'invisible' users of land and water as well as food producers - to indigenous peoples, fishers, fish farmers, pastoralists and

small-scale food producers who largely lack formal access or titles to land and water - more visible in policy processes and programmes.)

3. Addressing water quality

Water quality is generally the key water challenge in most industrialized countries. However, increasingly, water quality is also constraining developing country agriculture and economic growth and is furthermore becoming a major public health threat due to growing demands and degradation and reduced dilution capability of available water supplies and lack of investment in treatment.

However, little information is available on the relative level of water quality impairment. Additionally, the impacts of climate change on water quality are poorly understood.

States should:

- Invest in water quality monitoring and management to address FSN and public health challenges;
- Incentivize reduction of pollution in agricultural and food systems, both on-farm but also from food processing and packaging as well as reducing industrial effluents and domestic waste; and invest in adequate treatment options.
- Implement the polluter-pays principle as a tool to reduce pollution and to provide revenue for rehabilitation of polluted water resources.
- Close the nutrient cycle in water and wastewater management.
- Develop and implement water-neutral industrial and domestic water use and wastewater strategies and aim for water and agricultural management options that minimize runoff of pollutants.

States and national and international research institutes and agencies should

- Conduct further research on the relationship between water quality and food security and nutrition, including on how climate change is likely to impact on water quality and thereby on food security and nutrition.

4. Ensuring sustainable use of groundwater

The sustainable use of groundwater is critical to the production of food, as well as for industrial and domestic uses in many parts of the world. However, the sustainability of groundwater use is poorly understood in many developing countries. Groundwater degradation depletion (using nonrenewable groundwater resources) approximately doubled between 1960 and 2000, and currently a significant amount of irrigated food is produced from non-renewable groundwater sources. This share might well increase given growing pressures on water resources. When groundwater wells run dry, poor men and women are most affected.

States should, with the support of international cooperating partners:

- Enhance groundwater mapping and assessment of the sustainable use of aquifers and groundwater development to enhance long-term livelihood and food security
- Enhance the monitoring of groundwater use and levels to better assess the risk of groundwater depletion on food security and support optimal groundwater stewardship approaches
- Develop and support groundwater governance approaches that empower groundwater users to manage the resources sustainably.

National and international institutions should:

- Conduct research on sustainable groundwater use, including artificial recharge options, and research to understand the impacts of climate change on groundwater and the role of groundwater as a buffer for extreme events in different localities in the world.

5. Addressing changing diets

The inter-linkages between rising animal food demand, scarcer land and water resources, climatic shocks and food and nutrition security have been identified as a critical emerging area of further study. The role of dietary change in increasing the demand for water for food production and processing needs greater attention.

States should:

- Use regulation and incentives to ensure responsible food consumption, attention to water use efficiency and quality throughout the food chain, and reduce pollution from food systems. Recognize the key linkages between water and other components of the aquatic ecosystem, such as fish, in meeting the demand for fish as food.

The Private sector should

- Be encouraged to develop products that use lower water inputs and reduce adverse water quality impacts.

R and D institutions should

- Conduct further research to understand livestock water productivity and how best to enhance such productivity while reducing the negative impacts of intensive livestock farming and aquaculture on water quality.

6. Fostering sustainable investment, innovation and technologies to improve agricultural water management productivity

Agriculture accounts for about 60 - 70 percent of global freshwater withdrawals and 90 percent of freshwater consumptive use. Rainfed systems also use large volumes of precipitation. Thus, marginal improvements in agricultural water use could go a long way in improving the sustainability or security of water and food. If and how agricultural water investments are deployed has important implications for gender, nutrition and health outcomes as well as for environmental sustainability (such as remaining forest cover), and hunger and poverty reduction.

States, community groups and NGOs should:

- Ensure that water use and agricultural production policies in water scarce areas shift focus from land to water productivity. In water scarce regions, water, not land, is the most limiting resource for agriculture and is decreasing while food demand is increasing. Focusing on water productivity requires changes in strategies of agricultural production including water allocations to more valuable uses, shifting cropping patterns towards more water use efficient crops, using water management options like deficit irrigation; adopt modern irrigation technologies; and reforming institutional arrangements such as water user associations.
- Explore and promote different agro-ecological approaches that can encourage innovative and creative interactions among small-scale producers and their natural environments. These include developing agricultural policies that incentivize recycling of biomass within the agroecosystem; using agricultural investments and extension work to help small-scale producers improve soil and water conditions through agroecological practices;
- In water-scarce countries, consider importing food as a key food and nutrition security strategy.

The global and national agriculture and water research community should:

- Continue to research and produce guidelines and easily accessible information on farming practices that improve water use productivity and reduce water pollution
- Examine the resilience of these institutions, technologies and investments for improved water productivity to climate change.
- Promote research and the application of agro-ecological approaches

National governments, international finance organisations, NGOs and international cooperating partners should:

- Allocate more resources to upgrade rain fed agriculture as it holds great potential to increase food production especially for the poor. This includes supporting and reforming local institutions, investing in supplemental irrigation and water harvesting and adjust policies to encourage adoption of improved technologies and additional inputs.

The CFS should:

- Encourage a dialogue on and promote ecologically sustainable farming systems, which reduce water requirements, improve nutritional diversity, and protect ecosystem functioning, and conduct research to better understand the barriers to uptake and how to address them;

7. Locally appropriate solutions

Water management decisions are specific to local or regional conditions, and no single approach suits all conditions. States and other authorities have different implementation capacities, they have

different water management priorities, face different climatic and hydrological conditions, different levels of socio-economic development, within different national development pathways, etc. Decision-making on water development and management approaches should be inclusive, and ensure, in particular, that the voices of the poor, the marginalized and the food and water insecure are clearly heard in the participatory processes.

States should:

- Focus on developing water management approaches that serve the specific needs of their country, and work effectively within national constraints and opportunities.
- Engage closely with food and water insecure groups to understand their existing coping strategies and their priorities and needs and to build on these rather than bringing in external solutions that might not be sustainable or meet the real needs of the communities.
- Prioritise agricultural, water and energy policies that promote local food production, local energy security and local water security, based on relative comparative advantage
- Given that most countries share at least some common water resources, engage with upstream and downstream neighbours to jointly develop water, energy and food security strategies that meet the needs of all countries on shared water systems without degrading the environment.

8. Research, development, innovation and monitoring

There are a number of areas that have been identified in this report in which further research is required.

National and International R&D institutions should:

- Move beyond examining narrow linkages (e.g. WASH and diarrhoeal outcomes) to also focus on the multiple benefits arising out of water and sanitation interventions.
- Undertake further research on measures that adequately reflect water quantity and quality, but also energy and land implications of alternative water for food security strategies, taking into consideration social, economic and ecological aspects;
- Examine which economic incentives, such as water pricing, payment for environmental services, and others can best support the human rights based approach of water and food, and ensure a reduction in inequality and promote the interests of the poor.

States and donors should

- Provide adequate investment in developing countries and support to developing country research institutions to tackle local and regional water management issues is required from the international research community, international donor organisations, and national governments.

The CFS should

- Set up a programme with the international research community to investigate how best to translate existing and new research and knowledge into change on the ground.
- Work with the FAO and others to develop new water and food security metrics that focus on issues concerning long term sustainability, issues of equity and inequality (on the basis of nationality, gender, location, ethnicity etc), and that are useful in the face of macroeconomic drivers of change as well as increasing climate variability etc.

The **monitoring of water resources** is critical for the sustainable management of these resources, and the protection of both water users and aquatic ecosystems, especially due to uncertainties arising through climate change. With the developments in ICT, there is a rich area of innovation possible in the field of monitoring, looking at how both technology developments and citizen science utilising technology such as remote sensing to provide data to government departments, and cell phone connectivity for small farmers which allows farmer to provide information on local water availability and quality and to receive information on rainfall, temperature and markets.

States, international donors and national and international research institutes should:

- Research innovative methods for monitoring of water use, precipitation, river flow etc as well as how to provide small farmers in particular with the necessary information to improve productivity, access to markets etc. In this process, the use of open source software should be the basis of all developments in this field.
- Ensure that the gender dimensions are addressed in developing ICT based approaches to monitoring and communication. It is critical that the approaches used actively include women.

States should

- Examine closely the options that are already available for different approaches to monitoring and to providing appropriate information to small farmers in order to enhance water productivity in the agricultural sphere and to improve incomes and food security of small farmers.

9. Gender equality in land and water

In most parts of the world, the introduction of formal rights to land, fisheries and water has discriminated against

access to these resources by women, with entitlements generally being recorded or recognized as belonging to the male 'head of the household'. This has negative impacts on the FSN of female-headed households and female decision-makers in married households and leads to gender bias in the benefits derived from farming. There is considerable evidence that access to equal resources by male and female farmers would substantially increase the production of crops, particularly in sub-Saharan Africa.

Furthermore, women and girls in many developing countries face the daily burden of water collection which negatively impacts on their health and nutritional status and restricts their time to engage in productive activities and develop intellectual and other capabilities.

States and international donors should:

- Actively pursue the equitable allocation of land, fisheries and water rights to women and men. Women at the local, national and international level, should moreover be accorded the same access to climate information, training, finance, markets and agricultural inputs as men.
- Monitor water use, access to water and food security and nutrition in a gender disaggregated manner to enable the development of appropriate support programmes to ensure gender equality.
- Take into account women's and girl's specific and culturally grounded needs and interests around WASH with an aim to end gender discrimination and promote gender equality; and end the drudgery and health risk associated with collection of drinking and domestic water from remote, often unsafe places.

The CFS, national and international R&D institutions and global agencies should:

- Ensure that all research on water and food security issues is conducted in a gender-sensitive manner. International data need to include gender indicators around water, food and land. Efforts should also be made to collect sex-disaggregated data in order to monitor progress and devise gender sensitive policies. Sex-disaggregated data are essential if gender is to be considered and to 'count'.

10. Water governance

Effective water governance is crucial to ensure equitable and gender just decision making and allocation processes around water. In reality, though, water governance processes tend to be highly political and are often fragmented. The politics of allocation are often biased by the ability of powerful actors to influence decision making processes making water or ocean grabbing increasingly key issues to be addressed.

Water, food and land governance regimes tend to be highly disconnected and not adequately joined up, often disadvantaging marginal land and water users. While programmes such as IWRM and nexus approaches exist to break down existing silos, they are often imposed by external agents and are difficult to implement. Water reform processes have often not served to enhance the water and food security of poor people. Finally, large scale land acquisitions that have been taking place in recent years have often tended to exclude local populations from their lands and water resources and also increase local level conflicts.

States should:

- Coordinate land and water governance processes in a way that promotes the interests of marginalised and poor users of water and fisheries, in particular those whose rights are enshrined in customary arrangements
- Put in place mechanisms to protect the rights of their citizens to land, fisheries and water in the course of large scale land and water acquisitions by domestic and foreign investors
- In the course of re-allocations and the diversion of water from local users, fair and just compensation should be provided to ensure that local people do not face water and food insecurities.

States and civil society should:

- Ensure the participation of affected communities, including prior and informed consultation about risks and rights, when decision making on water re-allocation and various sectoral tradeoffs are being considered.
- Highlight the multiple linkages and bring together the domestic and productive uses of water for FSN as experienced directly by local users / producers of water and food. Governments and NGOs should, in this regard, promote a multiple use approach to water provision, which addresses the domestic and productive water-use and water-based

needs of communities; 19

The private sector should:

- Uphold local people's rights to water, food , fisheries and land and be held accountable when local violations to water and food rights take place (e.g. in the course of water privatisations as well as land acquisitions)
- Work toward operating in a water neutral way and develop equitable partnerships with local communities and officials

States and international donors should:

- Ensure that water reform processes are not imposed in a top-down manner on national and local contexts in ways that can be difficult to implement due to lack of national and local capacity or in a manner that can override local rights to water and food (especially of users such as indigenous peoples, pastoralists, fishers, women farmers etc.)

The CFS should:

- Initiate an inclusive and participatory multi-stakeholder process to formulate International Guidelines on Water Management that can be agreed upon by governments in order to address the challenges raised in this report, including existing policy gaps and incoherence, such as those pertaining to the exclusion of the poor from formal water rights systems, large-scale land deals and their impacts on water use, access, and allocation. This is particularly due to the lack of global governance arrangements for water.

11. Trade as an option to ensure water and food and nutrition security

As water variability continues to increase under climate change and extreme events are increasing in intensity and number, it will be important to ensure open and fair trading systems so that those countries affected by droughts and floods and those that have run out of freshwater resources can meet their national food demands without further degrading their natural resource base.

States and the international community should:

- Integrate food imports as a viable strategy to ensure national food and nutrition security when natural resources are insufficient to meet national demands or would suffer levels of exploitation or degradation that are not acceptable under stable trading systems.
- Ensure that trading systems are stable, fair and open, especially for countries affected by droughts, floods, and long-term natural resource degradation or scarcity that renders meeting national food and nutrition security goals unviable.

The CFS should:

- Bring in its voice to ensure that trading systems remains open and fair in times of water and food crises.

12. Rights to water and food

A key focus of this report has been the relationship between water and the FSN of the world's poor, whether they are located in developing or in developed countries. The report addressed the framing of water and FSN within current inequities in the distribution and allocation of food and water, and suggests that aligning the right to water and the right to food, and giving clear priority to the rights of the poor, might inform a different framing of the issue and therefore the solutions.

Of primary importance is a possible expansion of the right to water to incorporate the right to water for meeting individual and household food and nutrition requirements, with a focus on meeting the rights of the poor as a priority. This would fundamentally shift the current global discourse on water allocation in which water for economic purposes is given greater weight and priority than water for the self-provision of food for the poor. The current definitions of the right to water are clearest on the need for potable water and water for sanitation, but there are emerging discussions on expanding the scope to address the importance of adequate water for ecosystem sustenance and subsistence agriculture, as a right. This raises the issue of how much water is sufficient to meet the rights to water and food. The alignment of the rights to food and water would prioritize the right to water for food production over water use for other uses, at whatever scale.

State and international donors should

- Revise their water allocation systems to recognize the rights of the poor to sufficient water to meet their FSN requirements.

The CFS should:

- Request the Human Rights Council to explore the opportunities for and the implications of expanding the scope of the right to water so that it advances the right to the food and nutrition security of the most vulnerable. This entails expanding the scope of the right to water to include water for ecosystems reserves and water for subsistence production, consistent with the more developed jurisprudence around the right to food.
- Request the UN special rapporteurs on the Right to Food and the Right to Water, in consultation with human rights organizations, experts in international law and other stakeholders, to develop the most accurate framing of the issue to achieve synergies between the rights to water and food in order to promote food security and nutrition for the most vulnerable groups.
- Support the development of voluntary guidelines on implementing the right to water in a manner that supports food security.
- Support the expansion of the mandate of the Special Rapporteur on the Right to Water to track violations of the right to water in the same way as that done by the Special Rapporteur on the Right to Food.

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APPENDICES

A1 National policies that impact on the water/FSN interface (adapted from FAO FAPDA Policy Classification)

<i>Orientation and nature of the policy decisions</i>	<i>Policy decisions</i>	<i>Examples</i>
Consumer-oriented policies		
Social	Unspecified social policy, Unspecified or targeted food assistance including food for work targeted and untargeted subsidies	Social policy that aims to improve human welfare and meet human needs for food, safe drinking water and sanitation; General subsidies that apply to the entire population such as on water; Specific subsidies that apply for a targeted part of the population expecting specific results (e.g. free or low-cost water supplies to the poor; subsidised public distribution system for essential food supply)
Market	Unspecified food stock policy Setting up a strategic stockpile Promotion of local products Legal framework for consumer protection	Incentivise the cultivation of a specific food commodity Creation of a food reserve strategically, as a safety net Encouraging the consumption of local/indigenous food products may have beneficial impacts where such products are less water intensive or more drought resistant than non-local products. Regulatory frameworks that allow reformed institutions develop and operate effectively towards consumer protection purposes.
Nutritional health assistance	Water supply and sewage facilities	Introduction or improvement of drinking water quality; Water storage, distribution and treatment works, sewerage and sanitation facilities, waste water treatment plants.
Producer-oriented policy decisions		
Production support	Agricultural inputs measures such as access to • subsidy for fuel resources, • fertilizer subsidies, • targeted seed subsidies Promotion of use of locally produced fertilizer including biofertilizer Seed distribution/ Seed legislation	Any measure to facilitate access of smallholder farmers to fuel. It should be noted that inappropriate fuel pricing policies may lead to over-pumping of groundwater, as in India. Use domestic inputs, especially home-made fertilizers and inputs which can impact agricultural run-off water quality Provision of pre-packaged kits of seed, import of seeds, that can at time undermine resilient local food systems Develop seed production system of local

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<i>Orientation and nature of the policy decisions</i>	<i>Policy decisions</i>		<i>Examples</i>
	Seed multiplication		drought resistant seeds for sustainability
	Conservation and management of natural resources:	Water policies and regulations	Policies and regulations governing the management, administration, and procedures by which water rights, water uses, and water diversions are evaluated, ranked, and allocated (eg water resource development, transport, water treatment, allocation among various competing uses, conservation, waste-water treatment etc.)
		Fisheries and aquaculture policies and regulations	Policies on the management of natural or farmed freshwater fisheries
		Unspecified national biodiversity policies and regulations	Policies and regulations promoting the protection, conservation, and sustainable use of biologically diverse ecosystems and habitats, including aquatic habitats, such as the protection of wetland or river ecosystems.
		Forest policies and regulations	Policies and regulations concerning forest management. In dry areas, commercial afforestation can impact negatively on water availability for other purposes, such as agriculture. In naturally forested areas, protection of such areas can be an important element of managing the watershed to improve water availability and reduce water pollution and soil erosion.
		Climate change mitigation and adaptation measures	Climate change adaptation policies are particularly important in relation to ensuring sufficient water of an appropriate quality for food production, processing and consumption.
	Finance and credit facilities	Facilitate farmer access to credit	Access to credit enable farmers to invest in on-farm water-related infrastructure to improve farming productivity, e.g dams, groundwater pumps, irrigation systems etc
		Agri-oriented financial instruments for risk management	Disasters that threaten farming, such as crop failure, drought, flood, fire and hail storm, can be managed by insurance policies or government disaster funds. This enables farmers to recover more easily from disasters and improved agricultural productivity over time, particularly in areas vulnerable to climatic extremes.
	Genetic resources measures	Financial support through public banks	Public institutions that manage public resources bank-wise for agriculture
		Crop genetic improvement programme	Genetic improvements can lead to crops that required less water or are more drought resistant.
		Animal genetic resource	

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<i>Orientation and nature of the policy decisions</i>	<i>Policy decisions</i>		<i>Examples</i>
		policies and regulations	
	Institutional measures	Public institutions	Policy decisions that affect the public institutional framework, such as decentralisation of water management, or combination of water and agriculture into one ministry.
		Privatization	Transfer of public sector activities and functions to the private sector can impact small holder producers negatively
		Support to the development of producers organisations	Water user associations can be useful structures for farmers to manage their shared water resources optimally.
	Knowledge generation and dissemination	Agriculture and livestock research and technology Technical assistance, extension and training	Participatory research and technology in Agricultural, aquaculture and pastoral livestock development to improve water productivity and reduce water pollution Measures aiming to foster farmers' participation in and access to private and/or public technical assistance services, including around improved water management
	Land policy	Rural land-use planning	Land use planning measures affect the location of farming and food processing activities, and their location in relation to water and impact on water resources
		Land governance and land administration	Secure land tenure arrangements are an important factor in encouraging farmers to invest in conservation efforts including improved water productivity measures.
		Land management	Land management supports the productive use of land, and the prevention of land degradation, which has important spin-offs in relation to retaining soil moisture and preventing siltation of water bodies through erosion.
		Land reform / Facilitate access to land	Land reform also impacts on issues of access to water for farming because of the common link between land and water.
	Livestock, fisheries and aquaculture	Livestock policies and regulations	policies and regulations covering all aspects of the livestock subsector (excluding trade related food safety animal oriented norms and standards)
	Smallholders farming and food	Smallholder farmer food production-consumption	Promotion of/support to self-consumed production within smallholders' farms, for example by promoting crop diversification.
		Urban and periurban	Agriculture in urban and peri-urban areas can be an important source of food particularly for

<i>Orientation and nature of the policy decisions</i>	<i>Policy decisions</i>		<i>Examples</i>
	security	agriculture (UPA)	poor communities. The challenge comes in ensuring water for such food production, and whether treated municipal water should be used for such purposes or whether there are other means of providing water for urban and peri-urban agriculture.
	Production Subsidies	Unspecified production subsidies	Any kind of direct government subsidy aiming to maintain agricultural production, support farmers' income, ensure food security, promote modernization/re-orientation of farms systems or other purposes such as protection of biodiversity or wetlands
	Productive assets and infrastructure	Financing water infrastructure	The financing of new or rehabilitation of water infrastructure (irrigation channels, water pumps, rice fields development).
Market Management	Government market intervention	Minimum price on key staple food commodities	When the government establishes a minimum price for key staple commodities (e.g. wheat), when producers are not able to sell.
		Increase of strategic crops prices (price support)	Government intervention on the price of a specific crop, to support the producer.
		Government procurement to replenish stock	This refers to food grains bought by the government in order to maintain a certain level of reserve stock
	Unspecified market management policy	Unspecified market management policy	Any intervention from the government in the market in favor of the producers (including smallholder farmer food producers)
	Value chain developments	Unspecified value chain development measure	Any measure aimed to develop value chains, and specially the inclusion of smallholder farmers in them, has the potential for diverting water from food crops to crops required by valuechains, and can impact water for FSN
Trade-oriented and Macroeconomic Policies			
Imports	Import restrictions and bans		Import prohibitions and restrictions can result in the need to use water in a specific location to produce food that cannot be imported from an area that might have more water or better conditions for producing the same food. On the other hand these could help protect domestic, smallholder producers.
	Import subsidies		Government subsidies on imports, usually for specific products, for example in order to lower the domestic price of food to consumers during food shortages or price

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<i>Orientation and nature of the policy decisions</i>	<i>Policy decisions</i>	<i>Examples</i>
		spikes.
Trade defense measures	Anti-dumping	A tariff levied on dumped imports, i.e. imports that entered with prices that are "unfairly low," defined as either below the home market price (normal value) or below cost. It can protect local producers from the effects of agricultural dumping, including long term food insecurity/ loss of livelihoods.
Exports	Export prohibition, quota, other restrictions	Restrictions on export of certain products may result in countries with high water productivity in food production being unable to export this to other countries with lower productivity or poor growing conditions
	Export-Subsidy	A subsidy to exports; that is, a payment to exporters of a good per unit of the good exported or any other payments to producers that leads to an increase in exports, from an area that may or may not have enough water.
Other trade and trade-related measures	Government procurement	Imports of goods and services by government and by state-owned enterprises, including imports of grains to replenish stocks,.
	Entry into force of a free (or preferential) trade agreement	Entry into force of a free (or preferential) trade agreement that can impact agricultural, food and water policies.
Macroeconomic policy decisions	Share of agricultural and water expenditure in the National Budget (increased or decreased)	The proportion of the budget dedicated to water and agricultural issues is an important policy indicator in relation to the water/FSN interface.
	Growth-led agricultural policies and development encouraging foreign direct and commercial agricultural investment	While large-scale commercial agriculture can promote growth and local employment, it can affect the quality and quantity of water for all users. Small-scale users who lack official titles to land and water may not be able to compete with large-scale commercial users.

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