The Global Web of National Water Security

Mark Zeitoun

University of East Anglia

Abstract

This paper explores the reasons why efforts to attain water security by states and the international water policy community often fall short of their goals, and suggests a conceptual tool as partial remedy. The main shortcomings of prevailing water security policy and thinking are found to stem from narrow and determinist analysis that is based on a separation of physical and social processes of water resources and use. Policy is found to place undue confidence in flawed methods and thresholds related to physical water scarcity, and to ignore the more influential social processes involved. Water resources are also found to be treated in isolation, as if independent of the food, climate or energy security of individuals, communities and states. The 'web' of water security introduced here emphasises combined readings of the social and physical processes that enable or prevent national water security. These processes are mediated by a socioeconomic and political context replete with power asymmetries such that water security for some rests on the water insecurity of others. Sustainable national water security in the long term, it is suggested, will be guided by principles of balance between related security areas, and equitability of distribution of resources between the actors involved.

Policy Implications

- Water security policy recommendations based on environmentally determinist analysis are often narrow, and should be evaluated as potentially interested and liable to lead only to short-term selective water security.
- Long-term national water security policy should seek a balance between natural 'security resources' (food, water, energy, climate) and equitability between the individuals, communities and states involved.
- The development of water security policy should expand beyond biophysical considerations to incorporate options stemming from related social processes, such as human agency, livelihoods and capacity for adaptation.
- Long-term national water security will be served through harmonisation of policy across sectors, for example between ministries of water resources, trade and foreign affairs.

1. Not water secure

This article addresses shortcomings of analysis and policy related to water security. It notes how such policy can lead to insecurity of related natural resources, and to short-term water security for some at the cost of water insecurity for others. A conceptual tool that may help guide both research and policy towards longer-term and more sustainable national water security is proposed – the 'web' of water security. The article does not offer a fully grounded analytical framework or prescriptions for the analytical pitfalls and incoherent policy identified. The approach taken to broaden and deepen the concept of water security does serve, however, as a basis to understand and tackle the complex and interconnected water security challenges we all face.

The approach to national water security taken here stresses that social and physical processes occur simultaneously across the many 'security areas' so intimately related to water. The breadth, complexity and immediacy of the Nile River conflict and UK consumption of Peruvian asparagus serve briefly to demonstrate.

For the want of a clause, the end of centuries of conflict over the Nile River was lost. The wording of Article 14b – titled *Water Security*, and hidden in the annex of the May 2010 Nile Cooperative Framework Agreement – has been interpreted by some to open up the possibility of discussion of reallocation of Nile flows. The opportunity was immediately endorsed by Ethiopia and other upstream governments,[1] and fiercely resisted by the downstream governments of Sudan and Egypt. These latter two had grown accustomed over half a century to use of the entire flow of the river, having 'secured' the distribution according to the 1959 bilateral agreement (with about one-quarter for Sudan, and three-quarters plus excess flows for Egypt, not including water lost to evaporation). Through its negotiations within the World Bank-facilitated Nile Basin Initiative (NBI) and the Cooperative Framework Agreement, the Egyptian government was eventually confronted with two options to maintain the water 'security' it had already achieved. It could either accommodate the expressed interests of the upstream states, which might lead to more equitable allocation of the flows, or it could maintain its lion's share of water use through other means, as it had done in earlier decades (Brunnée and Toope, 2002, Mekonnen 2010). It chose the latter, and inter-state tensions on the Nile are rising again.

The same sort of decisions may have to be made by governments of wetter climes, such as the United Kingdom. Nearly two-thirds of the water used in the UK comes through food imported from abroad (WWF, 2008, p. 13). Some of this 'virtual water' (Allan, 1997) comes

from environmental conflict zones, that is, in the form of oranges from Egypt (Nile Delta), potatoes from Israel (Jordan River) and asparagus from the desertic Ica Valley in Peru. Much of the water used to irrigate the Peruvian asparagus is abstracted at rates far beyond the sustainable capacity of the aquifers, and applied to green the desert on either side of the valley floor (Hepworth et al., 2010). With financial support from the World Bank, the agro-food industry employs thousands of local residents. It also perpetuates local inequities, particularly with established Ica Valley alpaca herders – who find themselves at once in competition for the water and in tension with the farm hands. The 'Carhuancho water conflict' (Hepworth et al., 2010, p. 56) has developed through a proposal to divert water away from communities living in the neighbouring Carhuancho basin. Both aggrieved groups (the Ica Valley herders and the Carhuancho communities) have turned to the Latin American Water Tribunal for justice, which has led to increased strain between locals and the national political and business elites. British demand for asparagus thus fuels the conflict – and its people are not fully independent of the unsustainable exploitation of the Peruvian people or the groundwater. Evidently not as pressed as the Egyptian government about its food and water policies, the UK government will be obliged at some point to question just how 'secure' these are – at least for its own citizens.

With such tensions rising from riverbeds all over the globe, it is at first reassuring to see the extensive policy and research effort devoted to 'water security'. Indeed, the hydrological cycle seems to be gaining part of the global attention devoted to the carbon cycle (Stern, 2009). But as the Nile and Ica Valley cases demonstrate, the largely uncoordinated approach taken to regional and global water security issues lags far behind the emerging global policy regime for climate change, and attempts to achieve water security fall well short of their mark. Where it is developed at all, water security policy is at best incoherent; at worst, it

creates situations of *in*security for other natural resources that people and states have come to depend upon, or for the communities and nations themselves.

The first step this article takes is to review critically the water security literature in academic and policy circles. The shortcomings of prevailing approaches to water security are found to: (a) overemphasise and place too much confidence in the physical aspects of water security; and (b) be environmentally determinist and narrow, as if environmental policy was driving politics, and water security was independent of the many other related security areas. The case of British consumption of Peruvian asparagus demonstrates that water security is actually coupled with food security (for the UK), human or community security (of the alpaca farmers) and state security (of Peru). Water security is also interdependent with energy and climate security, through the competition for water by crops destined for stomachs or petrol tanks, or the fossil fuel burned to get the vegetables from the desert floor on to a dinner plate in rural England.

The processes that drive such transactions are considered to be fundamentally socioeconomic and political, much as water *scarcity* in many cases is primarily 'social'. The complex networks of interrelated actors and resources involved in any case of water security drives the development of the water security 'web', which is the second step of this article.

The 'web' approach to water security reframes the term, recognising it as (very) broad, interdisciplinary in analysis and cross-sectoral in application. The suggested conceptual tool emphasises the inseparability of social and biophysical processes related to water, and an understanding of how these mediate and are mediated by the socioeconomic and political context within which they occur. Security is then discussed in relation to stability and the

interdependencies of associated security areas, where two guiding principles are proposed: (a) seeking a balance between water security and related natural 'security resources'; and (b) equitability in distribution of benefits and effects of any policy. The article concludes with a brief discussion of the implications the web has for policy and analysis.

2. Why narrow and deterministic is not good enough

This section critically reviews the academic and policy literature related to water security. Shortcomings of prevailing conceptions of water security are found to stem from an overreliance on the physical aspects of water, and on narrow and determinist analysis.

Water resources security, water links, water nexus

The researchers and policy makers who make up the international water community make liberal use of the term 'water security'. Cook and Bakker (forthcoming) review a wide variety of definitions to demonstrate how early definitions that were purely anthropocentric[2] have broadened to consider water quality and related environmental issues. Some of these less narrow definitions, the authors note, have been used in state-building and 'international development' efforts (e.g. GWP, 2000).

Application of the less narrow definitions of water security to poverty alleviation has attracted criticism, however. The association between water security, dams and national economic growth is a case in point. A select group of wealthy states and continents are found to have a high water storage capacity (dams and associated impoundments, chiefly), and a causal link between storage, flood protection and poverty is asserted (Brown and Lall, 2006;

Grey and Sadoff, 2007, Fig.3; Briscoe, 2009, Fig. 5). Working backwards, the variability in river flow that storage eliminates is cast as water security[3], and the construction of dams is recommended along with the development of related water institutions.The evidence base for such policy recommendations is shaky, however. The selection of presented cases is not justified, the reams of socio-economic analysis carried out on the multiple factors that contribute to national economic growth are ignored, and the quality of the relation between national water security and economic growth links remain untested. Indeed, direct causality between the two is cautioned against, at least in the case of Ethiopia (Grey and Sadoff, 2007, fn 22), while further analysis of the reliability of the method and data series employed (Conway and Schipper, 2011, p. 231) cast further doubt on the robustness of the evidence base. Despite these shortcomings, the 'increased storage = increased wealth' assertion is gaining currency in policy circles – in the name of water security (see, e.g., UNEP 2006; DFID, 2009; GWP, 2009, p. 9; World Bank, 2009)

Such less narrow definitions of water security, furthermore, cannot consider the interdependency of water and water use with related natural 'security resources', such as food, climate and energy. For their limited breadth and water resource-centric perspective, this body of work may be more accurately referred to as relating to 'water *resources* security'.[4]

Research conducted on the links between water security and a single other natural 'security resource' was perhaps the first step beyond simple water resources security. With agriculture accounting for over 80 per cent of global water use (Rogers, 2008), the water security–food security link has been explored at length, as in the *Ministerial Declaration on Water Security* at the 2000 World Economic Forum. The resulting virtual water and 'water footprint' work

(e.g. Aldaya et al., 2008) is increasingly taken up by water research institutes, think tanks and implementing agencies (e.g. IWMI, 2007; SIWI, 2005).

The link between water and *energy* security is relatively less developed. The competition between food and biofuels for water ('water for energy') is directly related to the demand (and cost) of fossil fuels (Berndes, 2002, Lundqvist et al., 2007, p. 56). The water footprint of biomass is 70 to 400 times larger than that of conventional fuels (Gerbens-Leenes et al., 2008, p. 5), raising concerns about competition for water, particularly in India and China. Concerns about energy used for the treatment, production and delivery of water ('energy for water') is also receiving attention (e.g. King et al., 2008).

Water and *human* (or *community*) security is most frequently discussed in relation to water and sanitation concerns, or individual access to water (Barlow, 2007). Vörösmarty et al. (2010) also reconcile a particular understanding of 'human water security' with the biophysical aspects of river flows. The 'bottom-up' approach has been explored in relation to armed conflict through water and climate issues (Smith and Vivekananda, 2007) while the emerging concept of *climate* security has developed in relation to national security (CNA, 2007; WBGU, 2008), as well as to human security (Adger et al., 2006). Fertilisation of the concept with water security remains relatively undeveloped, however.

Examination of the intersection of two water-related security areas has eventually given way to studies of water 'nexus', that is, the intersection of water processes with three or more related resources. Climate–water–national security links have been discussed in relation to the Middle East (Brown and Crawford, 2009), and more tangentially by water and agriculture think tanks concerned about impacts of climate change on food production (IWMI, 2009).

Houdret et al. (2010) connect water–human–state security while Magsig (2010, p. 62) refers to the 'security triad' of environment, energy and food. The water–food–climate nexus has also been explored in the Middle East and North Africa (FAO, 2008; Zeitoun et al., forthcoming).

Even more-encompassing water security work explores the links between water and human security, food security, economic security and health security (e.g. FAO, 2000; Grobicki, 2009, p. 14; Hellegers et al., 2008; McCornick et al., 2008). The international legal academic community is leading development of the legal perspective on multidimensional water security, which may form the platform from which a deeper understanding of the challenges involved may embark (Tarlock and Wouters, 2010). This article's approach of the 'web' of water security complements this latter body of work, but with a much less deterministic view of the links between water and national security, and a more critical interpretation both of politics and of natural resource science.

Overconfidence in the physical, and ignoring the social

Political ecological readings of science studies demonstrate how uncritical application of the scientific method can lead to the development of very deeply held and unquestioned explanations of environmental phenomena (e.g. Demeritt, 2006). Forsyth (2003, p. 38) documents a number of these 'environmental orthodoxies', including conventional wisdom on the positive relation between forests and river flow quantity and quality. The orthodox thinking determines policy, he demonstrates, despite physical scientific evidence of flaws associated with it.

The perpetuation of environmental orthodoxies in the face of evidence questioning them suggests blinkered science, or underlying agendas. Some of the views of water security appear to suffer from such constricted thinking, particularly in relation to water *scarcity*.[5] One is struck when reviewing the mounting literature on water security just how much the *physical* component of water scarcity alone has been used as a basis for policy. If physical scarcity were calculated with a reasonable degree of certainty, this would only be half bad. Despite roughly a century of effort devoted to the study of the hydrological cycle, there is no agreement on methods to calculate the basic quantities of water (in all of its forms) flowing in and out of a river basin. The established hydrological watershed models are just beginning to incorporate *ground*water into their water balance models. As Taylor (2009) points out, however, modellers do not yet incorporate the *soil water* that sits above the groundwater and sustains all non-irrigated plant matter, including the bulk of global food production. In the case of the Nile River, this means that half or more of the water in the basin is not even counted, much less deliberated over, in negotiations at the NBI.

Flawed understandings of water scarcity are perpetuated by simplistic but very popular classifications, such as the national 'water stress' thresholds. The classification asserts that countries with less than 1,000 m^3 of water available annually per person are 'chronically stressed' and those with less than 500 m^3/year are 'beyond the water barrier' (Perveen and James, 2010). The originator of the idea herself has proposed a more sophisticated approach to scarcity (Falkenmark et al., 2007), and has acknowledged that the original thresholds can mischaracterise national water issues for a number of reasons, including lack of consideration of soil water within a country and the pressure-reducing feature of food ('virtual water') imports. Despite their very significant conceptual shortcomings, the water stress thresholds are taken up or used as departure points by the Intergovernmental Panel on Climate Change

(see, e.g., Bates et al., 2008, p. 7) and many other high-profile water or climate change studies (e.g. Vörösmarty et al., 2010; Walker and King, 2008).

Such solely biophysical studies of water scarcity and security are limited most of all, perhaps, by their failure to consider how water is *distributed* within a country. Recognition that water scarcity for the masses does not necessarily mean water scarcity for the economic elite led to the development of the concept of 'social' (or 'economic') water scarcity (Ohlsson, 1999). The social side of scarcity considers politics, ethics, justice, economics and human water and food consumption in examination of distributional issues. As the concept is very well established (see, e.g., Mollinga, 2008; UNDP, 2006), avoidance of its use by the high-profile studies is disconcerting. Privileging research of the relatively neat biophysical aspects of water security over its messy social realities cannot be expected to form a cohesive policy basis.

Narrow and determinist views

The second shortcoming of the prevailing interpretations of water security which constrains policy options is the narrow and determinist approach relied upon. 'Environmental determinism' authors have struggled in interpreting complex sociopolitical phenomena such as water and security. Competition over scarce (or overabundant) natural resources will lead to peace, it is suggested, or to violent conflict – what Bakker (1999, p. 221) refers to as a 'seductive but problematic' neo-Malthusian message. The killing in Darfur has attracted media headlines as the world's first climate conflict (Borger, 2007), for example, with somewhat less deterministic reports drawing similar conclusions (e.g. Bromwich et al., 2008;

Burke et al., 2009; UNEP, 2007). ‘Dig more water wells’ is the typical policy recommendation, as water and human security are conflated.

Readers of *Global Policy* may have scant respect for advice arising from analysis that sees mono-causes of war (Cramer, 2006), and may consider that tensions between the Fur and the Zaghawa (or Khartoum and the Sudan Liberation Army) have more to do with the violence in Darfur than does the rainfall variability to which the residents have long adapted (see, e.g., Kevane and Gray, 2008). But the determinist and narrow ‘resource scarcity leads to war (or peace)’ message is heard and repeated in academic and policy circles around the world (e.g. CNA, 2007; Ki-Moon, 2007) to the point that it too may be considered an ‘environmental orthodoxy’. Meanwhile, the very important roles that food trade, energy security and human agency can play as opportunities for resolution of the conflict or community water security are passed up.

Water security policy based on a narrow and deterministic view of the issues involved can lead, furthermore, to water *in*security, as the UK Royal Association of Engineers has noted (RAE, 2010, p. 5). When selective water security policy is developed through power asymmetries, the effects can be far-reaching. Physically water-scarce Saudi Arabia, as just one example, has (sensibly) gone from being the world’s sixth largest exporter of cereal, to a net importer. The shift in water security policy from unbridled farming of the desert has not, however, led to resolution of the conflict over the Disi Aquifer with Jordan (Ferragina and Greco, 2008), or to concern for more equitable internal distribution of water and food within the country. The concern did lead – in the wake of the 2008 cereal price spike – to agricultural ‘land grabs’, for example in Sudan (Cotula et al., 2009). The same price spike called community and national security into question through the riots it led to in Egypt – the

direct result of an (unacknowledged) dependence on cereal imports,[6] and an incoherent (what Allan and Mirumachi (2010) call 'apparent') water security policy .

The tensions in the Ica Valley so distant from Lima may not be of the same geopolitical dimension, but are of the same character and importance locally. Policy makers would do well to consider the effects of the fact that water security for the powerful does not mean water security for the rest, and question how tenable and 'secure' their policies are in the long term.

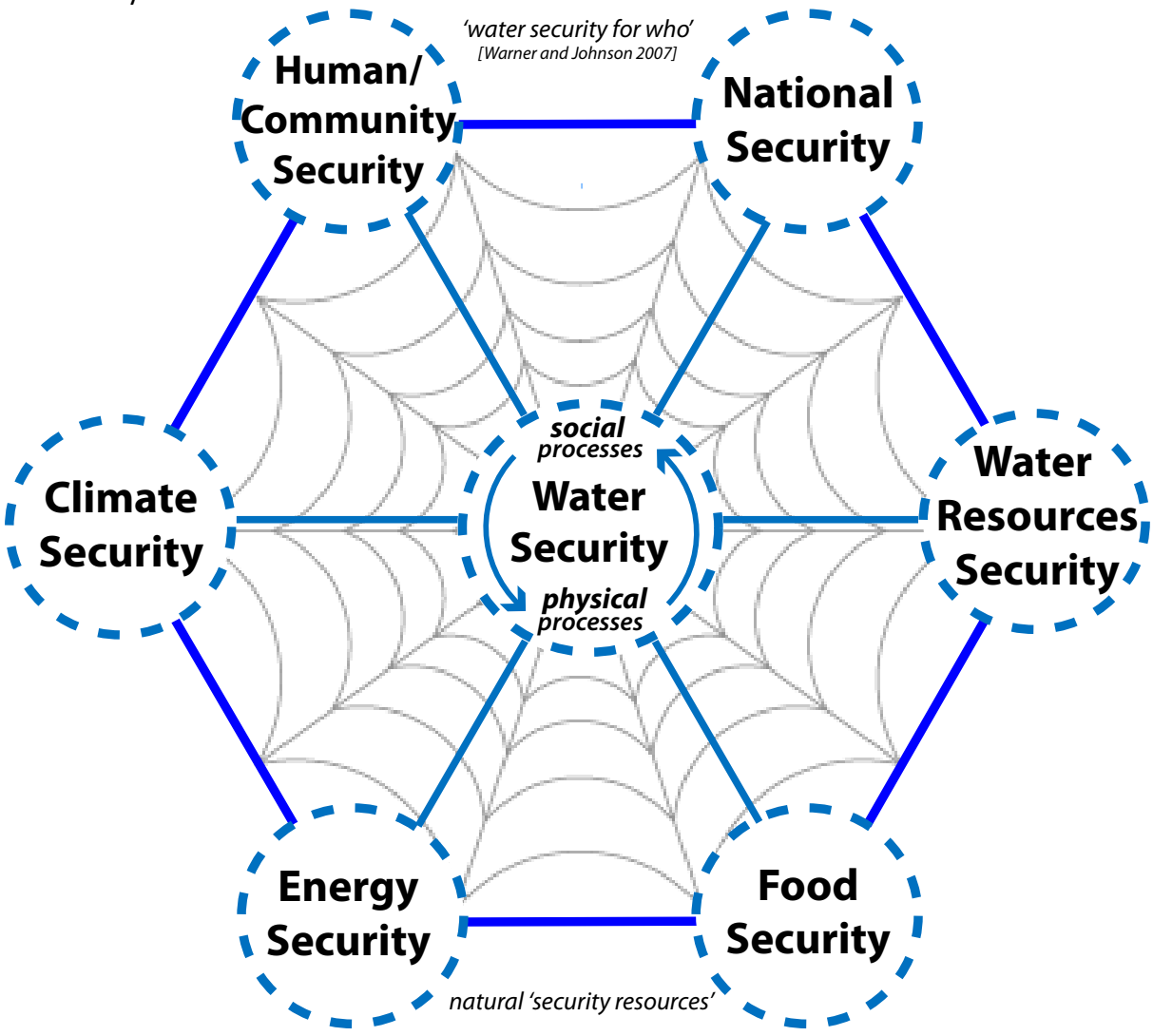
3. The 'web' of water security

This section proposes a 'web' as metaphor for a conceptual tool that can help guide water security research and policy formation through the shortcomings identified. It then discusses the important interdependencies between water and other security areas, seeing these as developing from within a context that can usefully be interpreted through political ecology and other disciplines.

A conceptual tool is preferred over the published definitions of water security, as these are either insufficiently narrow or all-encompassing to the point that they are not operationable (e.g. GWP, 2009, p. 6). The 'web' in Figure 1 centres on the interdependencies and a combined reading of how social and physical processes combine to create or deny water security.[7] Sustainable water security is interpreted as a function of the degree of equitability and balance between interdependencies of the related security areas, played out within a web of socioeconomic and political forces at multiple spatial levels. *Analytical* application of the

web is necessarily interdisciplinary; the development and implementation of *policy* deriving from the web is necessarily cross-sectoral.

Figure 1. The global 'web' of national water security.[8] Sustainable water security is interpreted as a function of the degree of equitability and balance between interdependencies of the related security areas, played out within a web of socio-economic and political forces at multiple spatial levels. *Analytical* application of the web is necessarily inter-disciplinary; the development and implementation of *policy* deriving from the web is necessarily cross-sectoral.



The 'web' of water security identifies the 'security areas' related to national water security. These include the intimately associated natural 'security resources' (water resources, energy, climate, food), as well as the social groups concerned (individual, community, nation). The

‘web’ recognises the interaction occurring at all spatial scales, from the individual through to river basin and global levels. In this sense, an individual’s water security may coexist with national water *in*security, as in the case of wealthy farmer-sheikhs with the deepest wells (who may be temporarily water secure) in the dry highlands of Yemen (which is not, on the whole, water secure) (Lichtenthaler, 2002).

While Figure 1 is symmetrical and clear, we can be certain that the shape, character and extent of each filament and the web in its entirety is anything but. The conceptual tool suggests consideration of the complex ‘simultaneously political, economic, and ecological processes’ (Bakker, 2003, p. 36), as indicated by the cyclical arrows at the centre of the figure. It follows on from political ecology work on environmental vulnerability and risk (Wisner et al., 2004), international political economy research on water (e.g. Allan, 2001) and the growing interest in socioecological systems (Agrawal and Chhatre, 2011). Like that work, the ‘web’ of water security eschews direct bi-valent causal relationships of water and socioeconomic and political processes for an understanding of the multi-valent underlying causes of water insecurity. This means, for example, less effort spent on prediction of the outbreak of a water war in the Ica Valley, and more spent on the (perhaps seemingly more bland) study of the effect of British vegetable consumption on the water resources and human and community security there. Similarly, the implications for UK national security of water leaving the Nile in the form of fruit destined for European supermarkets would be understood in the context of mounting tensions (and regional security) on the Nile, and would question if, how and for whom the NBI is generating national, food or water resources security.

At the risk of overextending a metaphor, analysis of the web in its entirety is not generally feasible, as tugging like a fly on the filaments will inevitably break some, or tie one up

methodologically. The approach suggests that if an analytical focus on any part of the web is necessary, the scope taken should be analytically nested within the web in its entirety. Interpretation of the physical and social components of interdependencies between two or more security areas may be assisted by the work that has been done by disciplines specialised in those areas. National security research concerned about climate security could apply the nondeterministic work done on the environment and security field (Hartmann, 2002; Mobjörk et al., 2010), for instance.

Interdependency and sustainable water security

As national water security is a function of the interdependencies between the related security areas at multiple levels, it is important to understand both the way and the context within which security and interdependencies relate to each other. In their discussion of 'water security for who', Warner and Johnson (2007, p. 71) point out that 'interdependence … means opportunity for some, but dependence and vulnerability for others. Virtual water trade delivers water-poor states from one type of dependency (on limited resources), but can usher in dependency of another type: on the unequal terms of world trade'. The remarks demonstrate that the trade-offs that occur in the pursuit of water security are made as much between groups as they are between natural 'security resources'.

It follows that the study of interdependencies should occur in two ways. One is to pursue the extent to which different natural security resources are interdependent. To what degree does the production of biofuels generate national energy security at the expense of national water resources insecurity (and hence national water security), for example? Here, 'balance' is the suggested operating principle, if a semblance of sustainability is sought.

The second research pursuit is to understand how the water security of different actors in the web is affected by interdependence. 'Equitability' is suggested as the operating principle towards sustainable water security here, with an understanding that instability and uncertainty are reduced by greater codependence (in ecosystems, as in the European Union) rather than independence (for discussion see, e.g., Buzan et al., 1998; Kaldor, 2007). Sustainable long-term water security may thus be assisted by thinking and action on human security in ways that are being tentatively explored (see, e.g., Pachova et al., 2008). The power asymmetries that enable short-term and 'selective' water security suggest that greater examination should be conducted of the mediating potential of international water law (McCaffrey, 2007; WWF-DFID, 2010), or injustices meted out through international food trade (e.g. Via Campesina, 2006).

The relationship between interdependencies and various relevant security areas requires considerable testing and theorisation, as brief testing of the upper and right side of Figure 1 shows. The interdependency created by transboundary waters flowing through or under state borders challenges the traditional view of national security assured through sovereignty and independence. Attempts to exert full sovereign territorial control over a 'fugitive resource' such as water (Frederick, 1996) clash with thinking on, and implementation of, natural resource management. These have evolved from seeing nature as static (which leads to attempts to 'conserve' it) to an appreciation of global biophysical processes being resilient and in 'non-equilibrium'. *Adaptive* natural resources and water management (see, e.g., Ostrom, 1990) developed as a result of the recognition that a sense of security is possible without stability and full control. Infrastructure built on the logic that variability in rainfall, river flow or aquifer recharge is a source only of *in*security goes against the grain of the

adaptive approach, and precludes alternative methods of dealing with the variability (e.g. Lankford, 2004).

Yet the sociopolitical and economic context in which transboundary water dynamics occur is just as fluid as the resource itself, and a firm understanding of the interdependencies for any country is difficult to pin down for long. A 'web' of water security reading of Egyptian water security would factor in the shifting political context between Nile Basin states, including the strengthening alliance between Ethiopia and the US, the expected 2011 secession of South Sudan, Sudan's newfound financial independence from the exploitation of oil and Chinese investment (including for new dams on the Nile River), and soil water, which makes up so much of the Nile Basin water balance. Seen in this light, the decision by Cairo (along with Khartoum) not to sign the Cooperative Framework Agreement in May 2010 selects security through independence over security through (more or less equitable) interdependence. The water security achieved through the position is tenable as long as the power asymmetry that sustains it is maintained.

The current political deadlock blocking any progress on cooperation along the Nile may also be seen in light of criticism the World Bank has drawn from NBI member states for driving its own agenda (see, e.g., Cascão, 2009, p. 59), or for taking a stand during the negotiations in support of the Egyptian position (Doya, 2009). The efforts to create a Nile Basin Commission were not perceived by all as an equitable process, and did not explicitly confront the inequitable allocation of Nile flows cemented in the 1959 Agreement. In that sense, the divisive impact of the *Water Security* Article 14b was entirely predictable (and was in fact predicted) (Cascão, 2008). Any water security ensured by Egypt through preservation of the

inequitable and contentious status quo is, on this reading, expected to survive only in the short term.

With the outcome of the latest round of the Nile conflict yet undecided, it is difficult to judge whether the NBI on its own has resulted in greater or less water security for all the Nile states, or for individuals and communities living within the basin. The attention drawn indirectly by the NBI to the core water-sharing issue and the extensive interaction between state representatives and epistemic communities may yet prove to generate a constructive distribution of resources and security. The notion that cooperation over transboundary rivers will lead eventually to stability between states (and eventually regional economic integration) marches on elsewhere, in any case. Experience from the Mekong and Nile basins initiatives is drawn upon for a similar World Bank-led initiative with Nepal, India and Bangladesh on the Ganges River (Rahaman, 2009). The same policy based on similar determinist analysis is thus applied to a completely different political, social and economic context. If the lessons learned on the other basins lead to a broader and less deterministic conception of water security, the expected selective and short-term water security may be avoided.

Analytical and policy implications of the 'web' of water security

The water security 'web' reading of transboundary waters and national security has highlighted the previously discussed shortcoming of water security policy. The narrow and deterministic approach blames water insecurity chiefly on physical phenomena, and reacts through infrastructure, institutions or treaties. When a relationship between a country's GDP (as seen in Ethiopia) is found to correspond with river flow variability, dams are proposed. When an opportunity to convert fossil water into cash is spotted (as in Peru), asparagus spears

are cultivated. When tensions are sensed between riparian states, a basin initiative that sets about to share collection of data (but not the water itself, as with the NBI) is deployed, under the assumption that environmental issues shape the broader political context, and not vice versa.

Such prescriptions are likely to lead to water security for some in the short term. They are unlikely, however, to lead to long-term national water security, for the reasons discussed. Yet the development of practical long-term national water security policy is no mean feat. The Coca Cola Corporate has identified the need to shift from IWRM to Integrated Water Energy and Food Management (Tickner and May, 2011), while the Global Water Partnership has identified the need for 'hard' (infrastructure) and 'soft' (policy, institutions) options for water security (GWP, 2010, p. 3).

A second useful step is to reconsider policy based on environmentally determinist analysis. This should be recognised as potentially interested and subjective, and as excluding solutions that may arise from the agency of local population to adapt and develop appropriate solutions. Between the 'pro-storage' and 'anti-dam' ideologues, for instance, there is space for 'good dams' (Gyawali, 2001; Skinner et al., 2009). It follows that researchers would do well to investigate the interests and agendas behind all recommendations put forward as attempts to achieve 'water security'.

The 'web' of water security further opens analytical eyes up to the political constraints on and less conventional opportunities for progress. The recognition of the influence of soil water on the water balance of the Nile Basin, for example, could lead to examination of the benefits to be gained from increased food trade within the basin (see, e.g., Phillips and Woodhouse, 2010). The impact of food exports or innovative water resource management

policies (e.g. water demand management) would be factored into externally imposed basin initiatives. Interpretation of the formation of international regimes dealing with the water, global food trade and energy nexus would consider the opportunities and constraints engendered from alliances developed in a world shifting in order to regional multilateralism. If analytical application of the 'web' is forcibly interdisciplinary, policy deriving from it is necessarily cross-sectoral. Making water security a core component of national security and putting water security at the centre of 'international development', as the RAE (2010) suggests, means harmonisation of policy across sectors and with foreign policy. Coherent national-level policy addressing water resources security, energy security, food security or national security will oblige transcending departmental borders. This would imply the training of experts in cross-sectoral policy, as well as increased cross-departmental policy committees, and the dispatch to rivers of lawyers and environmental diplomats along with hydrologists. These would interact with the relevant ministers and ministries of agriculture, trade and finance, and seek equitability of resource distribution between the actors involved as a matter of course, not exception.

Conclusions

This article has offered a critical review of academic and policy work on water security, arguing that prevailing conceptions both overemphasise the physical aspects of water, and are narrow and determinist. High-profile work on water security has been found to have built-in judgements and assumptions about watershed balances and scarcity thresholds that render them less solid than they first appear. Any hydrological, engineering or diplomatic initiative for water security should recognise the vast quantities of *soil* water therein, for instance. Just as importantly, it has been noted that the links between water and other related natural

‘security resources’ – food, energy, climate – are not routinely addressed or fully understood. Uncoordinated policy aimed at security in one area may result in less security in another: less water security as the cost of greater energy security through biofuel production, for example. The formulation of direct causal relationships between society and the environment (i.e. dams lead to water security, and this leads to state wealth) was found to yield correspondingly simple policy recommendations. The possibility that insufficiently broad working definitions of water security become unquestioned ‘environmental orthodoxies’ was identified, such that poor policy is expected to be perpetuated.

Policy downplaying the social aspects of water scarcity and security has been noted as leaving out half or more of any issue or options for policy. Ignoring inequitable distribution of water flows or associated resources will compromise the viability of efforts and lead to selective short-term rather than sustainable water security. The massive oversight comes at a cost – first, to those who suffer from the selective water ‘security’ policy, and second, to the budget lines of their financial backers.

A ‘web’ of water security has been offered as a conceptual tool to guide research and policy. ‘Sustainable’ water security is interpreted as a function of the degree of equitability and balance between interdependencies of the related security areas, played out within a web of socioeconomic and political forces at multiple spatial levels. Its understanding of combined social and physical processes leads to a number of implications for analysis and policy. The social, economic and political context that mediates the relationships between the related security areas must be considered, for instance. As that context is replete with trade-offs and asymmetries, equitability and balance are suggested as principles to counter the potential development of selective and short-term water security.

A significant amount of research and testing of the various filaments of the web is required, before the suggested approach can adequately support national water security policy. The nexus research already under way (e.g. water–food–climate) would thrive by considering the other interdependent water security-related security areas (e.g. 'water security for whom'), the governing principles of water allocation (Lankford, forthcoming) and ties with national economic security. Perhaps the most fertile gap to fill is the insight that may be garnered through incorporation of epistemological views on 'risk', as well as the philosophical foundations of uncertainty and 'security' itself. In the absence of this exploration, our collective ability to develop and implement long-term water security will remain compromised.

Notes

The author would like to thank T. Allan, D. Conway, T. Forsyth, E. Kistin, B. Lankford, N. Mirumachi, D. Phillips, J. Warner, colleagues at the UEA Water Security Research Centre, and three anonymous reviewers for the comments they have provided on this article.

References

Adger, W. N., Paavola, J., Huq, S. and Mace, M. J. (eds) (2006) *Fairness in Adaptation to Climate Change*. Cambridge, MA: MIT Press.

Agrawal, A. and Chhatre, A. (2011) 'Against Mono-consequentialism: Multiple Outcomes and Their Drivers in Social-Ecological Systems', *Global Environmental Change*, 21, pp. 1–3.

Aldaya, M. M., Hoekstra, A.Y. and Allan, J. A. (2008) *Strategic Importance of Green Water in International Crop Trade*. Value of Water Research Report Series No. 25. Delft: UNESCO-IHE Institute for Water Education.

Allan, J. A. (1997) 'Virtual Water: A Long Term Solution for Water Short Middle Eastern Economies?' SOAS Water Issues Study Group, School of Oriental and African Studies/King's College London, Occasional Paper 3.

Allan, J. A. (2001) *The Middle East Water Question: Hydropolitics and the Global Economy*. London: I. B. Tauris.

Allan, J. A. (Tony) and N. Mirumachi (2010). Why Negotiate? Asymmetric Endowments, Asymmetric Power and the Invisible Nexus of Water, Trade and Power that Brings Apparent Water Security. *Transboundary Water Management: Policy and Practice*. Earle, A., A. Jägerskog and J. Öjendal. London, Earthscan.

Bakker, K. (1999) 'The Politics of Hydropower: Developing the Mekong', *Political Geography*, 18 (2), pp. 209–232.

Bakker, K. J. (2003) 'A Political Ecologyof Water Privatization', *Studies in Political Economy*, 70, pp. 35–58.

Barlow, M. (2007) *Blue Covenant: The Global Water Crisis and the Coming Battle for the Right to Water*. Toronto: McClelland & Stewart Ltd.

Bates, B. C., Kundzewicz, Z. W., Wu, S. and Palutikof, J. P. (eds) (2008) *Climate Change and Water: Technical Paper of the Intergovernmental Panel on Climate Change*. Geneva: IPCC Secretariat.

Berndes, G. (2002) 'Bioenergy and Water: The Implications of Large-Scale Bioenergy Production for Water Use and Supply', *Global Environmental Change*, 12, pp. 253–271.

Borger, J. (2007) 'Darfur Conflict Heralds Era of Wars Triggered by Climate Change, UN Report Warns', *The Guardian*. [page 17 of Main section]

Briscoe, J. (2009) 'Water Security: Why It Matters and What to Do about It', *Innovations*, 4 (3), pp. 3–28.

Bromwich, B., Adam, A. A., Fadul, A. A., Chege, F., Sweet, J., Tanner, V. and Wright, G. (2008) *Darfur: Relief in a Vulnerable Environment*. Middlesex: Tearfund.

Brown, O. and Crawford, A. (2009) *Rising Temperatures, Rising Tensions: Climate Change and the Risk of Violent Conflict in the Middle East*. Winnipeg: International Institute for Sustainable Development.

Brunnée, J. and Toope, S. J. (2002) 'The Changing Nile Basin Regime: Does Law Matter?', *Harvard International Law Journal*, 43 (1), pp. 105–159.

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A. and Lobell, D. B. (2009) 'Warming Increases the Risk of Civil War in Africa', *Proceedings of the National Academy of Sciences of the United States of America*, 106 (49), pp. 20670–20674.

Brown, Casey and Upmanu Lall (2006). "Water and economic development: The role of variability and a framework for resilience." *Natural Resources Forum* 30: 306 - 317.

Buzan, B., Waever, O. and de Wilde, J. (1998) *Security: A New Framework for Analysis*. London: Lynne Rienner.

Cascão, A. E. (2008) 'Counter-Hegemony in the Nile River Basin', *Water Policy*, 10 (S2), pp. 13–28.

Cascão, A. E. (2009) *Institutional Analysis of the Nile Basin Intitative: What Worked, What did Not Work and What are the Emerging Options?* Report prepared for International Water Management Institute, the International Livestock Research Institute, the Nile Basin Initiative and the Eastern Nile Technical Organization.

CNA (2007) *National Security and the Threat of Climate Change*. Alexandria, VA: CNA Corporation. [refers to a report, so 'accessed at' or date should not be included. I have removed this]

Conway, D. and E.L.F. Schipper (2011). "Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia." *Global Environmental Change* 21: 227 - 237.

Cook, C. and K. Bakker (forthcoming). "Water Security: Debating an emerging paradigm." *submitted for publication to Global Environmental Change*.

Cotula, L., Vermeulen, S., Leonard, R. and Keeley, J. (2009) *Land Grab or Development Opportunity? Agricultural Investment and International Land Deals in Africa*. London/Rome: IIED/FAO/IFAD.

Cramer, C. (2006) *Civil War is Not a Stupid Thing*. London: Hurst & Co.

Dalby, S. (2006) 'Security and Environment Linkages Revisited', in H. Gunter Brauch, U. Oswald Spring, C. Mesjasz, J. Grin, P. Dunnay, N. Chadha Behera, B. Chourou, P. Kameri-Mbote and P. H. Liotta (eds), *Globalization and Environmental Challenges: Reconceptualizing Security in the 21st Century*. Heidelberg: Springer, pp. 165 – 172.

Demeritt, D. (2006) 'Science Studies, Climate Change and the Prospects for Constructivist Critique', *Economy and Society*, 35 (3), pp. 453–479.

DFID (2009) *Water Storage and Hydropower: Supporting Growth, Resilience and Low Carbon Development: A DFID Evidence-into-Action Paper*. Policy Booklet. London: Department for International Development.

Doya, M. (2009) 'Donors Back Egypt, Sudan on Nile Water Pact', *The East African*, Nairobi, 10 August 2009. [apologies page number not avail]

Falkenmark, M., Berntell, A., Jägerskog, A., Lundqvist, J., Matz, M. and Tropp, H. (2007) *On the Verge of a New Water Scarcity: A Call for Good Governance and Human Ingenuity*. Brief, S. P. Stockholm: Stockholm International Water Institute.

FAO (2000) *New Dimension in Water Security: Water, Society and Ecosystem Services in the 21st Century*. AGL/MISC/25/2000. Rome: Food and Agriculture Organization of the United Nations, Land and Water Division.

FAO (2008) *Climate Change, Water and Food Security*. Technical Background Document from the Expert Consultation, 26–28 February. Rome: Food and Agriculture Organization of the United Nations.

Ferragina, E. and F. Greco (2008) 'The Disi Project: An Internal/External Analysis', *Water International*, 33 (4), pp. 451–463.

Forsyth, T. (2003) *Critical Political Ecology: The Politics of Environmental Science*. London: Routledge.

Frederick, K. D. (1996) 'Water as a Source of International Conflict', *Resources*, 123, pp. 9–12.

Gerbens-Leenes, P. W., Hoekstra, A.Y. and van der Meer, T. H. (2008) *Water Footprint of Bio-energy and Other Primary Energy Carriers*. Value of Water Research Report Series No. 29. Delft, UNESCO-IHE Institute for Water Education.

Grey, D. (2006) 'Water, Poverty and Growth in Africa'. Paper presented at Department for International Development's 'Africa Growth Conference', London, 6 July, World Bank.

Grey, D. and Sadoff, C. W. (2007) 'Sink or Swim? Water Security for Growth and Development', *Water Policy*, 9, pp. 545–571.

Grobicki, A. (2009) 'Water Security: Time to Talk across Sectors', *SIWI Water Front*, pp. 14–15.

GWP (2000) *Towards Water Security: A Framework for Action*. Stockholm: Global Water Partnership.

GWP (2009) *GWP Strategy 2009–2013*. Stockholm: Global Water Partnership.

GWP (2010) *Water Security for Development: Insights from African Partnerships in Action*. Stockholm: Global Water Partnership.

Gyawali, D. (2001) *Rivers, Technology and Society: Learning the Lessons of Water Management in Nepal*. London: Zed Books.

Hajer, M. A. (1997) *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxford: Oxford University Press, Oxford Scholarship Online.

Hartmann, E. (2002) 'Strategic Scarcity: The Origins and Impact of Environmental Conflict Ideas'. Unpublished PhD thesis, Development Studies Institute, London School of Economics and Political Science.

Hellegers, P., Zilberman, D., Steduto, P. and McCornick, P. (2008) 'Interactions between Water, Energy, Food and Environment: Evoloving Perspectives and Policy Issues', *Water Policy*, 10 (S1), pp. 1–10.

Hepworth, N., Postigo, J. C. and Delgado, B. G. (2010) *Drop by Drop: A Case Study of Peruvian Asparagus and the Impacts of the UK's Water Footprint*, Progressio, in association with Centro Peruano De Estudios Sociales, and Water Witness International.

Houdret, A., Kramer, A. and Carius, A. (2010) 'The Water Security Nexus: Challenges and Opportunities for Development Cooperation'. GTZ International Water Policy and Infrastructure Concept Paper. GTZ/Adelphi, Eschborn, Germany.

IWMI (2007) *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*. International Water Management Institute. London: Earthscan.

IWMI (2009) *Flexible Water Storage Options and Adaptation to Climate Change*. Water Policy Brief Issue 31. Colombo: International Water Management Institute.

Kaldor, M. (2007) *New and Old Wars: Organized Violence in a Global Era*, second edition. London: Polity Press.

Kevane, M. and Gray, L. (2008) 'Darfur: Rainfall and Conflict', *Environmental Research Letters*, 3. DOI:10.1088/1748-9326/3/3/034006.

Ki-Moon, B. (2007) 'What I Saw in Darfur', *Washington Post*, 14 September, p. A13.

King, C. W., Holman, A. S. and Webber, M. E. (2008) 'Thirst for Energy', *Nature Geoscience*, 1 (55), pp. 283–286.

Lankford, B. (2004) 'Resource-Centred Thinking in River Basins: Should we Revoke the Crop Water Requirement Approach to Irrigation Planning?', *Agricultural Water Management*, 68, pp. 33–46.

Lankford, B.A. (2011) 'Responding to water scarcity – beyond the volumetric' in L. Mehta (ed.) *The Limits to Scarcity: Contesting the Politics of Allocation*. London: Earthscan.

Lichtenthaler, G. (2002) *Political Ecology and the Role of Water: Environment, Society and Economy in Northern Yemen*. Aldershot: Ashgate.

Lundqvist, J., Barron, J., Berndes, G., Berntell, A., Falkenmark, M., Karlberg, L. et al. (2007) *Water Pressure and Increases in Food & Bioenergy Demand: Implications of Economic Growth and Options for Decoupling*. Swedish Environmental Advisory Council Memorandum 2007:1, Chapter 3, Stockholm.

Magsig, B.-O. (2010) 'Introducing an Analytical Framework for Water Security: A Platform for the Refinement of International Water Law', *The Journal of Water Law*, 20 (2–3), pp. 61–69.

McCaffrey, S. (2007) *The Law of International Watercourses*. Oxford: Oxford University Press.

McCornick, P. G., Awulachew, S. B. and Abebe, M. (2008) 'Water–Food–Energy–Environment Synergies and Tradeoffs: Major Issues and Case Studies', *Water Policy*, 10 (S1), pp. 23–36.

Mekonnen, D.Z. (2010). "The Nile Basin Cooperative Framework Agreement Negotiations and the Adoption of a 'Water Security' Paradigm: Flight into

Obscurity or a Logical Cul-de-sac?" *European Journal of International Law* 21: 421 - 440.

Mobjörk, M., Eriksson, M. and Carlsen, H. (2010) *On Connecting Climate Change with Security and Armed Conflict: Investigating Knowledge from the Scientific Community*. Stockholm: Swedish Defence Research Agency Defence Analysis.

Molle, F. (2008) 'Nirvana Concepts, Narratives and Policy Models: Insights from the Water Sector', *Water Alternatives*, 1 (1), pp. 131–156.

Mollinga, P. P. (2008) 'Water, Politics and Development: Framing a Political Sociology of Water Resources Management', *Water Alternatives*, 1 (1), pp. 7–23.

Ohlsson, L. (1999) 'Water Conflicts and Social Resource Scarcity', *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmostphere*, 25 (3), pp. 213–220.

Ostrom, E. (1990) *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Pachova, N. I., Nakayama, M. and Jansky, L. (2008) 'National Sovereignty and Human Security: Changing Realities and Concepts in International Water Management', in N. I. Pachova, M. Nakayama and L. Jansky (eds), *International Water Security: Domestic Threats and Opportunities*. Tokyo: United Nations Press, pp. 289–295.

Perveen, S. and James, L. A. (2010) 'Scale Invariance of Water Stress and Scarcity Indicators: Facilitating Cross-Scale Comparisons of Water Resources Vulnerability', *Applied Geography*. DOI:10.1016/j.apgeog.2010.07.003.

Phillips, D. and Woodhouse, M. (2010) *Benefit Sharing in the Nile River Basin: Emerging Strategies for Fresh Water Use at the Country and Selected Sub-basin Levels, as Revealed by the Trans-boundary Waters Opportunity Analysis*. Windhoek, Nile Basin Initiative, Socioeconomic Development and Benefit Sharing component.

RAE (2010) *Global Water Security: An Engineering Perspective*. London: The Royal Academy of Engineering.

Rahaman, M. M. (2009) 'Integrated Ganges Basin Management: Conflict and Hope for Regional Development', *Water Policy*, 11 (2), pp. 168–190.

Rogers, P. (2008) 'Facing the Freshwater Crisis', *Scientific American*, July. pp 28 – 35.

SIWI (2005) *Let it Reign: The New Water Paradigm for Global Food Security*. Final Report to CSD-13. Stockholm: Stockholm International Water Institute, with IFRPI, IUCN and IWMI.

Skinner, J., Niasse, M. and Haas, L. (eds) (2009) *Sharing the Benefits of Large Dams in West Africa*. London: International Institute for Environment and Development.

Smith, D. and Vivekananda, J. (2007) *A Climate of Conflict: The Links between Climate Change, Peace and War*. London: International Alert.

Stern, N. (2009) *A Blueprint for a Safer Planet: How to Manage Climate Change and Create a New Era of Progress and Prosperity*. London: Random House.

Tarlock, D. and Wouters, P. (2010) 'Reframing the Water Security Dialogue', *The Journal of Water Law*, 20 (2), pp. 53–60.

Taylor, R. (2009) 'Rethinking Water Scarcity: The Role of Storage', *Transactions of the American Geophysical Union*, 90 (28), pp. 237–238.

Tickner, David and Rebecca May (2011). Thirsty Crops: social and environmental outcomes from a partnership approach to agriculture in Pakistan and India. Presentation given on behalf of the Worldwide Fund for Nature to the UEA Water Security Research Centre. University of East Anglia, Norwich, 13 March 2011.

UNDP (2006) *Beyond Scarcity: Power, Poverty and the Global Water Crisis*. Human Development Report 2006. New York: United Nations Development Programme.

UNEP (2006). Rainfall variability and economic growth in Zimbabwe, United Nations Environment Programme. http://maps.grida.no/go/graphic/rainfall-variability-and-economic-growth-in-zimbabwe *Accessed:* 20 November 2010.

UNEP (2007) *Sudan: Post-conflict Environmental Assessment*. Nairobi: United Nations Environment Programme.

Via Campesina (2006) *Rice and Food Sovereignty in Asia Pacific*. Jakarta: La Via Campensina.

Vörösmarty, C. J., McIntyre, P. B. Gessmer, M. O., Dudgeon, D. Prusevich, A., Green, P. et al. (2010) 'Global Threats to Human Water Security and River Biodiversity', *Nature*, 467, pp. 555–561.

Walker, G. and King, D. (2008) *The Hot Topic: How to Tackle Global Warming and Still Keep the Lights On*. London: Bloomsbury.

Warner, J. and Johnson C. L. (2007) '"Virtual Water" – Real People: Useful Concept or Prescriptive Tool?', *Water International*, 32 (1), pp. 63–77.

Warner, J. and Oré, M. T. (2006) 'El Niño Platforms: Participatory Disaster Response in Peru', *Disasters*, 20 (1), pp. 102–117.

WBGU (2008) *Climate Change as a Security Risk*. German Advisory Council on Global Change. London: Earthscan.

WEF (2009) *The Bubble is Close to Bursting: A Forecast of the Main Economic and Geopolitical Water Issues Likely to Arise in the World during the Next Two Decades (Draft for Discussion at the World Economic Forum Annual Meeting 2009)*. World Economic Forum Initiative: Managing Our Future Water Needs for Agriculture, Industry, Human Health and the Environment.

Wisner, B., Blaikie, P. M., Cannon, T. and Davis, I. (2004) *At Risk: Natural Hazards, People's Vulnerability and Disaster*s, second edition. London: Routledge.

World Bank (2009) *Directions in Hydropower*. Washington: Energy, Transport, Water – The World Bank Group.

WWF (2008) *UK Water Footprint: The Impact of the UK's Food and Fibre Consumption on Global Water Resources*. London: Worldwide Fund for Nature.

WWF-DFID (2010) *International Architecture for Transboundary Water Resources Management: Policy Analysis and Recommendations*. London: Worldwide Fund for Nature and the UK Department for International Development, with Pegasys Strategy and Development, and the UNESCO Centre for Water Law, Policy and Science.

Zeitoun, M., Allan, J. A. and Mohieldeen, Y. (2010) 'Virtual Water "Flows" of the Nile Basin, 1998–2004: A First Approximation and Implications for Water Security', *Global Environmental Change*, 20, pp. 229–242.

Zeitoun, M., Cascão, A., England, M. and Hodbod, J. (forthcoming) *Water Demand Management and the Water–Food–Climate Nexus in the MENA Region*. Ottawa: International Development Research Council.

Author Information

Mark Zeitoun, Water Security Research Centre, School of International Development, Water Security Research Centre, University of East Anglia.

---

1. These include Tanzania, Kenya, Uganda, Rwanda, Burundi and Democratic Republic of Congo. Eritrea was not part of the negotiations.
2. Cook and Bakker cite Clarke (1993), for example: water security means 'the ability to provide adequate and reliable water supplies for populations living in the world's drier areas so as to meet agricultural production needs'

[I have changed the quotation. Unpublished page number 4]

3. ‘Africa is deeply water insecure’ (Grey, 2006, p. 2).

4. Water resources security may be understood to comprise the same principles and ideas about environmental ‘quality’ as ‘environmental security’ (e.g. Dalby, 2006), and may be informed by the lessons drawn from the considerable effort spent globally on Integrated Water Resources Management (Molle, 2008).

5. Although the discussion focuses on water *scarcity*, an overabundance of water is equally relevant to water security, for instance in the Peruvian town of Ica (Warner and Oré, 2006).

6. Between 1998 and 2003, for instance, Egypt annually imported approximately 32 billion cubic metres of virtual water (mostly in the form of beef) from outside the Nile Basin – the equivalent of about one-third of the flow of the river itself (Zeitoun et al., 2010).

7. The ‘web’ metaphor comes from a draft WEF report by the Global Agenda Council on Water Security: ‘Water security is the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades’ (WEF, 2009, p. 5).

8 The ‘web’ metaphor comes from a draft WEF report by the Global Agenda Council on Water Security: “Water security is the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades.” (WEF, 2009: 5).