

THE HYPOTHESISED WATER-CONFLICT-MIGRATION LINK: A REVIEW OF EMPIRICAL EVIDENCE

IN SUPPORT OF “FORESIGHT GLOBAL ENVIRONMENTAL MIGRATION PROJECT”

ABSTRACT

This document was submitted in contribution to Sir John Beddington’s Foresight Global Migration Project. It represents a literature review of evidence concerning the relationship between water, conflict and migration and a suggested conceptual framework for analytical work. Outcomes of the research were presented at the Institution of Civil Engineers on the 11th of February 2011, as a component of the University of East Anglia and International Commission on Irrigation and Drainage’s “Water and UK foreign policy” seminar. The authors would like to acknowledge the role of all anonymous interviewees, their generosity with their time, and their useful input into the project. However, the document represents the views of the authors and as such any inaccuracies or errors rest with them.

Principle Author: Gareth Walker, School of Geography and Environment, University of Oxford

Additional Author: Teresa Sprague, School of Geography and Environment, University of Oxford

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School of Geography and Environment
University of Oxford
South Parks Road
Oxford
OX1 3QY
United Kingdom.

Contact: gareth.walker@keble.ox.ac.uk

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SECTION 1: REVIEW OF EVIDENCE BASE

WATER AND SOCIETY

The following section offers a review of evidence concerning long term interactions of human society with water resources. While contemporary challenges in water resource management may be distinct, the examples serve to highlight the role of climate and water resource management in shaping the technological, social, and cultural functions of society which relate to a steady growth in demand and the resulting need to manage and distribute water under relative scarcity and protect against climate and weather variability (**Wittfogel 1972**). This need for management widens the role of water resources as both a potential source of conflict and a possible forum for cooperative behaviour (**Priscoi 2000**).

Most research examining the relationship between climate and pre-industrial societies with predominantly agriculturally based economies have tended to emphasise Malthusian models. It is argued that climatic influence on agricultural production, and consequentially per capita food availability, significantly affects the socio-political stability and population dynamics of a society. For instance, archaeological studies have used such models to explain correlations between intense drought periods and the decline of Akkadian, Maya, Mochica and Tiwanaku civilisations, each broadly characterised as a “shift to lower subsistence levels by reducing social complexity, abandoning urban centres, and reorganizing systems of supply and production” (**DeMenocal 2001**).

In addition to short term shocks of drought, research has also investigated the impacts of broader shifts in climate on agricultural production, population shifts, and socio-political stability at the century scale. These studies depend heavily on contentious estimates of past population trends, written and oral accounts of socio-political change, and reconstructed agricultural patterns, resulting in high margins of error. However, correlations within error ranges between climate shifts, agricultural yield, population, and socio-political stability have been claimed for China and Western Europe from 1000 A.D to 1800 A.D (**Galloway 1986**), in eastern Africa from 900 A.D to 2000 A.D (**Verschuren et al 2000**), and China and Europe from 1400 A.D to 1800 A.D (**Zhang et al 2007**).

Similar efforts have been made to investigate the effect of climate shifts on patterns of mass migration. **Fang and Lui (1992)** detect a correlation between reconstructed shifts in climate patterns and shifts in the migration patterns of nomadic peoples of southern Mongolia as outlined in ancient Chinese chronicles. Similarly, **Gupta et al (2006)** observe trends of a weakening Monsoon intensity from the early Holocene onwards correlate with estimated shifts in population distributions, as well as accounts of the construction of storage dams, suggesting an impact mediated through agricultural production. **Tyson et al (2002)** suggest a correlation between long term climate shifts in Southern sub-tropical and Eastern Africa over the past millennium and oral accounts of migration patterns, suggesting shifting opportunities for agro pastoralist populations as a causal mechanism.

It should be noted that in almost all accounts of paleoclimatic trends and their influence on human systems, the emphasis is on climate as a *factor* rather than a determinant; causal explanations of war, population movement, and agricultural production can be found in entirely political and social accounts of ancient history. It is interesting to note that studies with sufficient longitudinal scope emphasise a weakening of the correlation between climate signals and societal impacts, suggesting that post-industrial societies represent a distinct system with higher resilience and adaptive capacity to water scarcity and shocks. In this sense, one can consider climate as an input potentially contributing to social disruption at varying intensity while the capability of a society’s coping mechanisms determine the outcome of the disruption.

THE PROPOSED RESOURCE - CONFLICT LINK

The case for linking conflict with environmental degradation and scarcity stems from the role of renewable resources in economic productivity and hence social and political stability. Those arguing the scarcity-conflict link emphasise that environmental degradation leads to a reduction in the quality and quantity of available per capita renewable resources, as well as an uneven distributions of access (**Homer-Dixon 1994**). In contrast, the work of Paul Collier and his associates has emphasised the risk of resource *abundance*, arguing that the presence of significant wealth of natural resources, in particular sub-soil assets, serve as an economic incentive for violence as a form of rent seeking (**Collier and Hoeffler 1998**).

The subsequent link to the onset of violence in each case is often discussed in terms of either “greed” or “grievance”. The “greed” mechanism interprets violence as a as an extreme case of non-cooperative economic behaviour aimed to maximise utility (**Grossman 1991, Hirshliefer 1995**). Put simply, conflict will arise where the opportunity cost of abandoning a livelihood is smaller than the perceived benefit of engaging in violence (**Collier and Hofler 1998**). The “grievance” mechanism emphasises the role of uneven distributions of wealth (derived from renewable resources) in aggravating grounds for grievance based on ethnic tensions, political marginalisation, and economic inequality. In practice most scholars do not interpret these as competing theories, but rather elements of a complex causal relationship between violence and resources.

Empirical studies of this relationship are limited, but tend to emphasise the dominance of socio-political factors in mediating the effects of resource scarcity and abundance. In later work, Homer-Dixon emphasises socio-political elements which contribute to an “ingenuity gap”, whereby weaker nation states may be more vulnerable to the effects of scarcity and abundance due to their limited ability to provide the financial and structural buffering necessary to adapt and mitigate these effects (**Homer-Dixon 1999**). Ingenuity in this part of the literature is categorized as both social, such as stable market systems and education, as well as technical, such as access to drought resistant technologies. Reinforcing this important notion, the role of wider social and political factors as an independent explanatory factor, rather than a mediating mechanism, must also not be overlooked.

Tir and Diehl (1998) take social factors such as population density and growth to be indicators of resource scarcity and in a study of international conflict from 1930 to 1989 detect a statistically significant correlation between population density and likelihood of conflict. The study, however, also indicated that population density does not predict the likelihood of a state to initiate or escalate war. An earlier study by **Hauge and Ellingsen (1998)** sampled all states from 1980 to 1992 to test for a correlation between internal civil violence and the degradation of resources such as land, forests, and freshwater; the outcome suggested a weak but significant relationship, but one secondary to factors such as economic development and political regime type. A similar result was found by **Urdal (2005)** who examines incidences of conflict in all sovereign national states from 1900-2000 and finds that resource scarcity indicators of land availability and population growth provide a weak statistical explanation when compared with other socio-political variables of levels of development, regime type, and geographical location. However, in a subsequent study of 27 Indian states from 1956 to 2002, the same author detects a correlation between increasing land scarcity and productivity, population density and civil conflict and concludes that analysis at a sub-national scale is better able to capture the influence of resource scarcity on the onset of violence (**Urdal 2008**). In contrast to theories of resource scarcity, **De Soysa (2002)** samples all post-Cold War (1989 to 2000) incidences of violent conflict leading to deaths of over 25 individuals and finds little evidence for the influence of resource scarcity as a factor, but a significant correlation with resource abundance, supporting the “resource curse” theory.

WATER SCARCITY, VARIABILITY, ECONOMIC PRODUCTIVITY AND CONFLICT

In applying the above discussion to the specific case of water resources, it is important to note the dynamic relationship between water security and economic performance in many nations. GDP is often cited as stronger indicator of violence, yet studies at a global scale have highlighted the significant negative correlation between inter-annual and seasonal variability of rainfall and GDP (**Brown and Lall 2006**). This correlation is in turn difficult to deconstruct; seasonal variability not only restricts the success of energy and agricultural systems originally developed in temperate climates, but also requires greater investment in seasonal storage infrastructure, placing economies in developing countries at a disadvantage (**Brown and Lall 2006, Sachs 2001, Grey and Saddoff 2006, Washington et al 2004**). In the specific case of water resources, there is therefore a case to be made that the “ingenuity gap” may be a product as well as a determinant of a society’s ability to cope with seasonal variability.

Examining the role of seasonal variability and sudden shocks in more detail, the impact of short term shocks on economic productivity and hence the hypothesised increase in probabilities of civil conflict has shown some evidence for a correlation. A study of 41 African countries from 1981 to 99 shows rainfall shocks to trigger drops in GDP which in turn significantly increase the likelihood of violence the following year (**Miguel 2004**). Analysis of global data sets of internal conflict and rainfall patterns at the sub-national scale from 1980-2002 has shown a significant correlation between deviations of rainfall patterns and the onset of high intensity internal conflict, whereas mean annual rainfall shows no such impact, suggesting that variability and unexpected shocks play a greater role than absolute scarcity (**Levy et al 2005**). This conclusion is in agreement with similar research which finds inter-annual variability to be a more significant predictor of conflict (**Hendrix and Glaser 2007**).

However, as an example of necessary caution in attributing environmental conditions to the onset of conflict, a paper by **Burke et al (2009)** is instrumental; citing **Miguel’s (2004)** earlier work, Burke et al claim to detect a statistically significant correlation between long term temperature fluctuations and the onset of civil violence in sub-Saharan Africa from 1400 to 2002 A.D. Using the economic arguments outlined above, the paper cites climate as a key predictor of conflict. Soon after a paper by **Buhaug et al (2010)** re-examined the data used with a more comprehensive sample criteria for incidence of violence, as well as an extended time period to more recent years. The results show little or no significant correlation, a result which the authors then build upon to suggest that ultimately “the primary causes of war are political, not environmental”.

A review of evidence suggests that to draw direct casual lines between water resources, economic performance, and conditions for the outbreak of violence is to overlook the potentially more significant explanatory variables of wider political, social and economic process. As such resource scarcity must be interpreted as factor whose effects are determined by wider technological and institutional conditions.

WATER SCARCITY AND MIGRATION

A simplistic interpretation of the interaction between water scarcity and shocks and migration would build upon the economic theory used to discuss resource scarcity and conflict. Such an approach emphasises the economic incentives to migrate borne out of discontinuities in access to factors such as wage rates, capital,

credit and insurance, which in turn may be altered by the impact of environmental change. It should be noted however, that even within the economic paradigm, environmental factors are not taken as salient in determining migration (**Massey et al 2007**). This is backed somewhat by empirical economic studies; **Naude (2010)** assesses the determinants of international migration in 45 sub-Saharan countries over the period of 1965 to 2005 and finds environmental and demographic factors to be weak in comparison to GDP and armed conflict. In addition, migration is misinterpreted when cast as an opportunistic or reactionary response; in reviewing the role of environmental factors on mobility in Africa, **Jónsson (2010)** emphasises that migration requires a specific set of resources including financial capital, supporting social networks, and a knowledge of migration routes, all of which take time and planning to develop.

Reuveny (2008) provides a review of all identified cases of migration triggered in part by environmental change. Of the 36 cases identified, 15 occur in Africa, 12 in Asia, 8 in Latin America, 2 in North America, and 1 in Russia. In addition, land degradation is associated with 27 cases, droughts with 19, deforestation with 17, water scarcity with 15, floods with 9, storms with 7, and famine with 5. These preliminary results, as well as a more in-depth analysis of the case studies shows less developed countries to be more vulnerable to environmental degradation which in turn places stress upon livelihoods. While water scarcity, availability, and shocks are shown to play a role, their impact is in part mediated through the wider social and physical systems which surround land management and influence vulnerability to environmental degradation at a local scale (**Meze-Hausken 2000**).

Migration as a response to such pressures is equally complex and localised. **Findley's (1994)** study of the response of Mali families to the 1983 – 1985 drought provides a discussion of migration which usefully outlines the complexity of the interaction between water resources and migration. Firstly, it emphasises that migration, or perhaps more accurately mobility, is a normal part of livelihood strategies for many of the families sampled and not the last resort which it may conventionally be interpreted as. Secondly, the research notes that net migration patterns were relatively unaffected by the drought, however there was a significant shift in migratory patterns in which short range migration to neighbouring cities increased while long range out migration decreased. The emphasis on the distinction between long and short distance migration, as well as permanent and cyclical, recurs in most of the literature reviewed. **Henry et al (2004)** study migratory patterns and shifts in rainfall patterns in Burkina Faso 1970 to 1998 and arrive at a similar conclusion on the importance of local migration as an important indicator rather than net migration. **Massey et al (2007)** also observe the dominance of local level migration in response to changes in agricultural productivity. As well as distance, literature makes a distinction between permanent and temporary patterns of migration. Both **Brown (2008)** and **Nielsen et al (2008)** stress that where forced migration occurs in response to sudden shocks, it is usual for the population to re-settle areas after the event. Finally **Meze-Hausken (2000)** reviews responses to drought by northern Ethiopian subsistence farmers and argues that vulnerability to shifts in rainfall does not necessarily indicate a decision to migrate, as this is one of many adaptive options which may be open to a household.

The risk of violence as a result of mobility is emphasised by **Obioha (2008)** who notes that trends in reduced rainfall in northeast Nigeria have resulted in significant effects on animal husbandry which in turn has led to population drifts and resulting conflicts over rights to access of land and water resources. This reiterates the relation between land management and current social structures at the local level in their capacity to adapt and mitigate change.

THE SPECIAL CASE OF INTERNATIONAL RIVER BASINS

Given the literature thus far cited places emphasis on the sub-national scale, it is perhaps not surprising that the evidence for the relationship between international conflict and trans-boundary river basins is limited. **Wolfe (1998)** provides an early attempt to empirically examine the proposed causal link between disputed international water basins and argues that under a strict definition of conflict as acute violence between two sovereign states, historic records covering a period of approximately 800 A.D to the 1990s show little or no evidence of rights to water resources being a primary cause of international conflict. The paper emphasises that conversely, 145 treaties may be identified which relate to cooperation in the management of shared freshwater bodies. A later study by **Wolfe et al (2003)** concerning the Basins at Risk (BAR) project further concludes that cooperation is more common in multilateral management of transboundary freshwaters than that of bilateral or two-state management. The study indicates conflict occurs bilaterally involving particularly issues pertaining to quantity of water allocated and development of infrastructural assets.

Large N sample studies have shown further reason to question the “water wars” theory in its most severe case of armed international conflict; **Gleditsch and Hamner (2001)** review evidence of shared river basins from 1948 -92 and find a greater probability of both conflicts and cooperative measures in the presence of shared river basins and water scarcity. This is mirrored by **Brochman and Gleditsch (2006)** who review data on international river basins from 1820 to 2001 and show treaties on water management tend to correlate with and follow disputes, suggesting a mitigating role. **Toset et al (2000)** review databases of armed disputes between states from 1816 to 1992 and find that being neighbours is the most significant factor in predicting conflict, while sharing a shiver basin offers a similar statistical magnitude in predicting conflict to other factors such as regime type, economic status, and alliances. This study was further refined by **Gleditsch et al (2004)** and **Gleditsch et al (2006)** who test against the role of rivers as contested borders and conclude that river basins and their associated resources are potential sources of conflict and tensions particularly in cases of upstream and downstream user interactions, lending support to neo-Malthusian interpretations. Finally, **Wolfe et al (2003)** emphasise the role of institutional capacity in determining the likelihood of conflict over share water resources, identifying the presence of management bodies and international treaties as similar if not more significant than physical parameters traditionally associated with the likelihood of conflict; water stress, population, reliance on hydropower etc. In addition, they emphasise the role of rapid institutional and infrastructural change and the capacity of management systems to absorb that change as a key indicator of conflict risk.

LOOKING FORWARDS: PROJECTIONS, PREDICTIONS, AND PERCEPTIONS

A recurring theme throughout both the literature review and interviews conducted for this review has been the recognition that projections of future trends in migration and violence in connection to water resources tend to be based primarily on perceived threats rather than outcomes of comprehensive and more scientifically based models, which as the above review has outlined are lacking. Given this lack of transparent science backing claims concerning future trends, there is a risk that approaches to mitigating future impacts of water scarcity and shocks follow a misplaced discussion rooted in national sovereignty and military strategy. The pressing need therefore is a means of integrating water into discussions of security and foreign policy while avoiding militarisation of the issue.

The connection between national security and resource conflicts is argued to have its sources in the cold war onwards, where access to natural resources was seen as strategically significant. **Deudney (1990)** argues that such rhetoric has been appropriated by those emphasising the need to act on global environmental decline, characterising such decline as a threat to national security. Certainly when looking at past reports to national governments, this seems to be the case. **Nordas and Gleditsch (2007)** observe that a

2003 report to the US department of defence emphasising the national security risk of climate change was widely reported by the press and further emphasised by a subsequent report from 11 retired US generals emphasising climate change as “threat multiplier”. Similar language and logic has been employed by the German Advisory Council on Global Change. Similarly in the U.K, a report by the Oxford Research Group chose to use the analogy of terrorism to emphasise the role of natural resource depletion and climate change as the “root causes of conflict and insecurity in today’s world and likely determinants of future conflict” (**Abbott et al 2006**).

As **Trombetta (2008)** and **Deudney (1990)** argue, while characterising environmental decline as a security threat may have served to galvanise support for action on issues such as climate change and emphasise a sense of urgency, it has also served to introduce the logic of national sovereignty, national security, and the possible militarisation of the environment. Such, an approach is at risk of being conceptually at odds with the mechanisms of governance and institutional cooperation which the above case studies emphasise as means to mitigate conflict and risk.

A case in point has been the role of projections of environmental migrants in media, politics and research. The temptation to endow a sense of urgency and employ a tone of national security resulted in the term “environmental refugee” rising to prominence in the past decade¹. These claims were partially supported by the projections made by **Myers (1993)** of 150 million environmental refugees, or in more recent times 200 million **Myers (2000)**. Such projections are by the authors’ own admission based on “heroic extrapolation” and others have suggested a highly contentious initial dataset based on third party references (**Brown 2008**). Beyond projections making little allowance for the distinct patterns of mobility in terms of permanent, temporary, long and short distance, they offer little insight into the agency of society and its possible adaptive measures. In addition, the use of the term “refugees” in keeping with the security discourse and has been criticised as legally inaccurate (**Brown 2008**). It is noted that under the UN 1951 Convention and 1967 Protocol, the term refugee is strictly reserved for those fleeing persecution², and as such its appropriation by those emphasising environmentally displaced peoples has been criticised by human rights lawyers. This is not to say that the issue of conflict and migration isn’t present, but to warn that using the language of national security and refugees carries a high risk of inappropriate political responses.

¹ A full review of the claims made concerning Environmental Refugees can be found in **Boano et al (2008)**, the most alarmist being a Christian Aid report in 2007 which postulated a billion people permanently displaced by 2050.

² “A refugee is a person who owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion, is outside the country of his nationality, and is unable to or, owing to such fear, is unwilling to avail himself of the protection of that country.”

SECTION 2: PROPOSED CONCEPTUAL MODEL

OUTLINING A PRELIMINARY CONCEPTUAL MODEL AND CLARIFYING TERMS

Beyond a summary of evidence, the review has also served to emphasise the lack of clarity in the assumed underlying causal mechanisms at play when discussing society's interaction with water resources and the vague and inter-changeable use of terms. The following section therefore aims to provide some structure and clarity of terms when discussing issue of water, conflict and migration (Table 1.).

Table 1. Definition of Terms

Hazard Variables	
Climate	A statistical description of meteorological data in a given region over a long (multi decadal) period of time. Climate can be contrasted to weather, being a description of current, day to day, and intra-annual conditions.
Seasonal variability	A statistical description of meteorological data on an intra-annual scale.
Short term shocks	Weather phenomena which occur over a short (intra-seasonal) scale which represent outliers on an average distribution of seasonal weather patterns. May potentially lead to droughts and floods.
Social system variables	
Population distribution	The geographic and demographic characteristics of a population which affect local water resources.
Infrastructure and treaties	Determines the ability of a society to extract, store, treat and distribute freshwater resources. International treaties in turn place an additional limitation on society's ability to abstract water.
Water institutions and governance	The formal and informal rules which govern collective action on water resource management.
Community / Household strategies	A combination of assets and activities which make up the primary occupation of the household.
Wider political economy	All social factors, be they investment in infrastructure or the successful governance of water resources, are situated within a wider political economy which is a system of exchanges at increasingly wider levels of society. This becomes particularly important when discussing the adaptive measures taken to changes in water availability and security and their relation to the risk of violence and the dynamics of mobility.
Vulnerability indicators	
Exposure	The probability of a society being subjected to environmental stresses. Exposure is linked to risk through a societies ability to resist and adapt to environmental stress.
Water security	Reflects society's ability to provide an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies. Security is achieved through the physical and institutional mechanisms used to resist and adapt to environmental stresses.
Water entitlements	Reflects society's ability to distribute water resources efficiently and equitably. Social influences in such cases are the institutions and governance mechanisms which surround water management and rights within a river basin.
Household capabilities	Reflects the role of water resources in community and household livelihood strategies, and therefore to some degree their sensitivity to long and short term shifts.

PROPOSED CONCEPTUAL MODEL

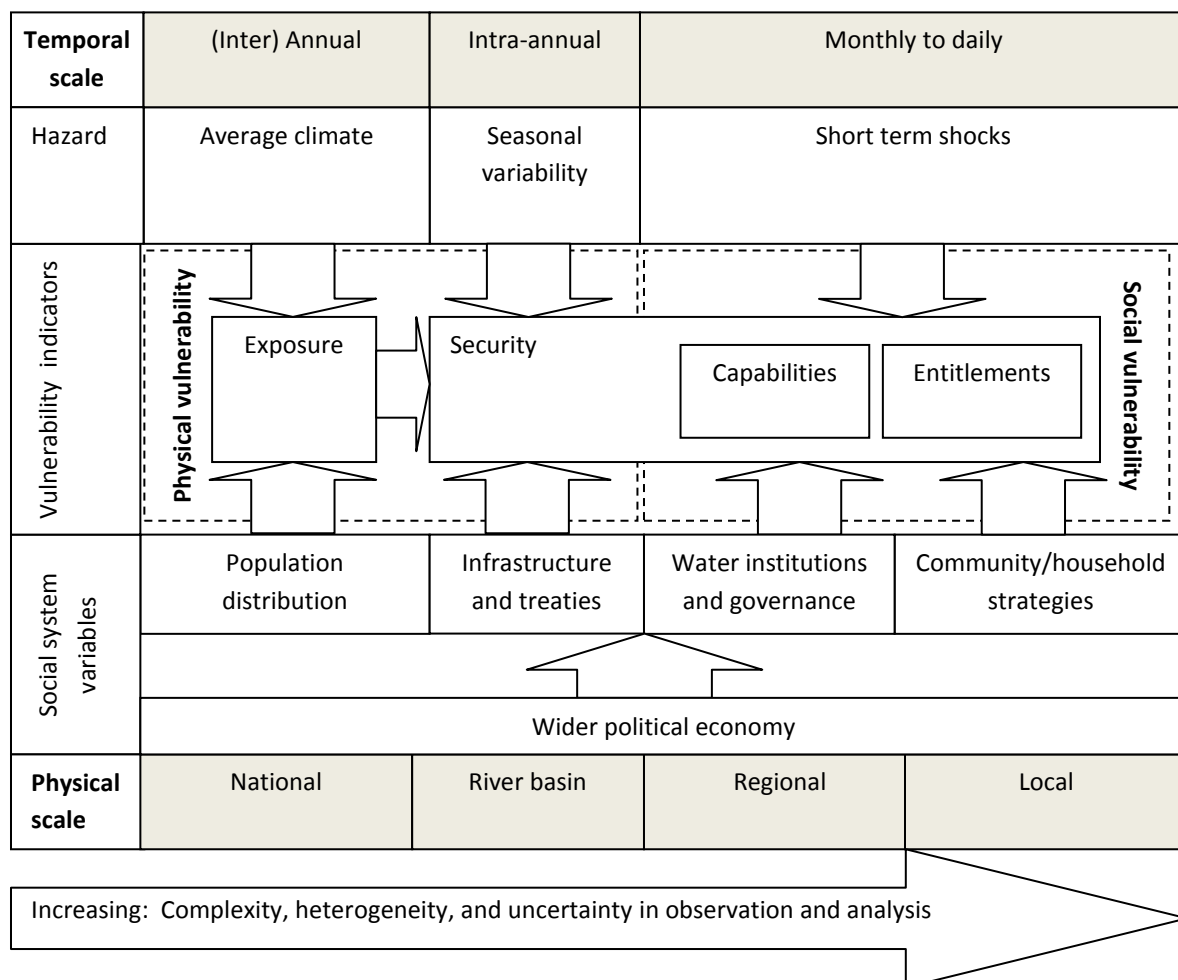
The impacts of water resource scarcity, seasonal variability, and short term shocks have been shown in literature to be mediated by complex collection of physical and social factors. While simplistic Malthusian and

neo-Malthusian models attempt to hold all other factors constant, a discussion of impacts in practice must make allowances for this complexity. The proposed model is based on a Political Economy / Political Ecology interpretation of resource scarcity and shocks (Figure 1.). The impacts of primary climate variables (temperature and climate) are understood to be mediated across spatial and institutional scales by both physical infrastructure and wider political economic arrangements. The impact on a particular household at a particular time is expressed through an adaptation of Amartya Sen's concept of entitlements which aims to capture how social and institutional arrangements surrounding a household shape the access of that household to resources in support of their livelihoods. This allows for a discussion of vulnerability to distinct forms of water resource hazards (trends, variability and shocks) across distinct scales of analysis (macro top-down studies, micro household analysis).

EXPLAINING THE MODEL

The conceptual model works in a similar way to a flow diagram and attempts to capture some of the interactions across spatial and temporal scales. Thus if we wish to discuss the impact of seasonal variability on households, we may trace this through the ability of infrastructure and treaties to mitigate variability (water security), how local water governance and institutions shape a household's rights to access water (water entitlements), and finally the characteristics of the household itself (household capabilities). It should also be noted that as each step in the flow diagram is taken, the discussion becomes increasingly localised, complex and uncertain reflecting the difficulty in tracing direct causal mechanisms.

Figure 1. Conceptual Model



SECTION 3: POLICY OPTIONS DISCUSSED

ADDRESSING DECISION MAKERS CONCEPTUAL UNDERSTANDING

The trend in securitizing the debate over climate change, water resources, tensions between users, and migration, is at odds with the governance mechanisms which will ultimately be needed to mitigate the effects of water scarcity, variability, and shocks. Models which emphasise national boundaries over natural units of river basins, characterise shared water basins as non-cooperative stand-offs, and view shifts in mobility and livelihood structures as threats to national sovereignty will most likely reduce the chances of international cooperation which is needed to address these issues.

INFRASTRUCTURE, INVESTMENT, AND GOVERNANCE

The recent backlash in the international community to dams and reservoirs³ has cast doubt over the legitimacy and effectiveness of large scale water infrastructure investment, yet as the literature review has shown, in some cases investment in such storage, whether large or small scale assets, may be key in protecting against heightened seasonal scarcity. Unfortunately, it is often the case that national infrastructure serves as a platform for corruption and mismanagement, and so from a national and sub-national perspective, there is pressing need to establish sufficiently transparent and accountable governance systems to support effective investment in, and management of, infrastructure.

MECHANISMS TO MANAGE AND PROTECT INTERNAL MOBILITY AND INTERNAL DISPLACEMENT

Research has also shown that water scarcity, variability and shocks tend to trigger migration at a sub-national scale which may or may not be part of an already established livelihood strategy. Future patterns of internal mobility may follow established routes in a more intensified manner or may reach a threshold where new patterns are established. Rather than characterising mobility as an indication of failed livelihood strategies or a “last resort”, governments should seek to understand how mobility currently contributes to the resilience of livelihoods to water scarcity and shocks, and how best to support and protect that resilience.

Related to this is the perceived “protection gap” identified by the UNHCR concerning internally displaced people. As previously observed, UN conventions and treaties relating to the protection of refugees do not apply to those displaced by environmental factors, nor those who haven’t crossed international borders. In such cases the only existing multilateral mechanism is the 1998 Guiding Principles on Internal Displacement. A key challenge for states with limited financial and institutional capacity will therefore be how to build upon the existing platform of human rights and guiding principles in order to protect those forced into mobility, support those who employ mobility as a strategy, and those who do not have the resources to be mobile. In each case future changes in water resource patterns will serve to emphasise an already pressing issue; however, climate change may serve as a platform for fostering global north-south cooperation in supporting and protecting internally displace peoples.

FOSTERING COOPERATION ON INTERNATIONAL RIVER BASINS

The evidence reviewed indicates that the only certainty of a shared river basin is that users have a significant impact on each other’s economic social and environmental systems. How these impacts are managed is heavily dependent on the institutions used to govern the river basin in question. It should be emphasised that the collaborative management of a river basin is not a “zero sum” game, and that while there may be tensions concerning conflicting interests, there are also significant mutual benefits in managing a river basin in cooperation particularly in the need for adaptive and mitigative management.

³ partly a result of the World Commission on Dams report of 2000, and a shift in the world bank’s policies in investment

THE ROLE OF SCIENCE

While future projections of climate and water available for use by society are extremely uncertain, there is a more fundamental role to be played by scientists in supporting negotiations between users. For example, one interview subject pointed to the Colorado River as an example of flawed policy based on flawed science where water abstraction rights were negotiated in terms of percentages of absolute flow rates and therefore did not accounting for periods of low flow and the resulting disputes. This case is not held in isolation. In general, where decision makers seek to make clear the rights and obligations of water users in river basins, agreements should be robust to the current and projected changes in water scarcity and variability, using clear physical indicators and robust analysis, with an aim to reduce future disputes.

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APPENDIX 1: PROJECT OUTLINE AND TERMS

APPENDIX 2: CUREC APPROVAL AND INTERVIEW CONSENT FORM

APPENDIX 3: UEA ICID SEMINAR DETAILS AND PRESENTATION

