WORLD DEVELOPMENT REPORT 2011

BACKGROUND PAPER

Resource Scarcity, Climate Change and the Risk of Violent Conflict

Alex Evans[1]
Center on International Cooperation
New York University

September 9, 2010

The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Development Report 2011 team, the World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

[1] Head of Program, Resource Scarcity, Climate Change and Multilateralism, Center on International Cooperation, New York University. Contact: alex.evans@nyu.edu. For more information on CIC's research in this area, see http://www.cic.nyu.edu/internationalsecurity/scarcity.html. The author would like to thank Cynthia Brady, Sarah Cliffe, Geoff Dabelko, Bruce Jones, Gary Milante and Martin Parry for their valuable advice and comments on earlier drafts.

Abstract
This paper provides a brief assessment of how natural resource scarcity and global climate change may change the risk of violent conflict in the future. The resource scarcity element of the paper is primarily focused on resources required to meet basic needs such as food, land and water, as opposed to high-value commodities associated with the 'resource curse', such as diamonds, coltan or hardwood (although oil is touched on in the paper, primarily because of the linkages between oil and other scarcity issues). The paper begins with an overview of projected trends in resource scarcity and climate change. It emphasises that problems of resource availability may be as much the result of poor governance as physical constraints, and that the risk posed by climate change or resource scarcity depends as much on the vulnerability of populations, ecosystems, economies and institutions as on the magnitude of climate or scarcity impacts themselves. Resource availability must be seen not as a stand-alone issue, but rather in the context of the overall political economy landscape. The paper then discusses ways in which these trends may affect conflict risk, including already-established links and ways in which such links may evolve in the future, including under abrupt change scenarios. The paper concludes with some brief remarks on possible avenues of exploration for conflict prevention and building resilience in the light of scarcity and climate change.

1: The natural resource scarcity and climate change outlook

Recent years have seen an increase in concern over whether rising demand for natural resources such as food, water, land and oil will increasingly begin to hit limits to supply growth, and thus trigger intensifying zero-sum competition or increased violent conflict over scarce resources – particularly, but not exclusively, because of the projected impacts of climate change.[2] The section below discusses why concern over these issues has increased, before turning to whether they do in fact increase the risk of violent conflict.

Changes in the supply / demand balance for key resources

On the **demand** side of the natural resource outlook, median projections of global population growth suggest a rise from 6.9 billion today to around 9.1 billion in 2050, an increase of 32%.[3] While the global rate of growth has slowed significantly since its peak in 1963, much of the growth projected between now and 2050 will be in low income countries, including many – such as Pakistan, Nigeria, Bangladesh, the Democratic Republic of the Congo, Ethiopia and Kenya – that are politically fragile, regionally significant, or both.[4]

Increasing demand for resources also derives from more affluent consumers, primarily in OECD countries, but increasingly also in emerging economies such as China, Brazil and India.[5] Particularly important in the natural resource scarcity context is rising demand in developed and emerging economies for energy (including biofuels – which effectively create an arbitrage relationship between food and fuel), and diets rich in meat and dairy products (which tend to be proportionately more resource-intensive than other diets).[6]

As a result of these drivers, significantly increased demand for key resources is projected to emerge between now and 2030. For example:

[2] For example Wolf (2007); Sachs (2008); Brown (2006); International Peace Bureau (2007).
[3] UN Department of Economic and Social Affairs (2008).
[4] *Ibid.* Global population growth reached 2.19% a year in 1963 and currently stands at 1.15% a year; under median UN-DESA scenarios, the rate is projected to fall below 1% by 2020 and to less than 0.5% by 2050.
[5] Goldman Sachs (2007) find that the four 'BRIC' economies alone could outweigh the combined GDP of the G7 economies by 2035.
[6] Currie (2007); Evans A. (2009).

- The World Bank has projected that demand for food will rise by 50% by 2030, and for meat by 85% by the same year;[7]

- The reference scenario in the International Energy Agency's 2009 World Energy Outlook projects a rise in oil demand of 1% a year between now and 2030 (from 85 million barrels a day now to 105 mb/d in 2030, with *all* of the growth in demand from non-OECD sources);[8] and

- UNESCO projects that total global water use will rise by 32% between 2000 and 2025, while UNDP notes that global water use has been growing nearly twice as fast as population for over a century, and will continue to do so.[9]

In practice, however, a range of drivers on the **supply** side pose questions as to whether these demand projections will in fact be met.

- On *food*, the yield increases of the 20th century 'Green Revolution' have shown diminishing returns in recent years: average productivity growth rates of 2.0% between 1970 and 1990 fell to 1.1% between 1990 and 2007 and are projected to continue to decline, and global food consumption outstripped production in seven of the eight years between 2000 and 2008.[10]

- The food outlook is further complicated by potential constraints on the availability of *land*. While the Food and Agricultural Organization and the UN Environment Programme have suggested that 12% more arable land is available globally, they also estimate that 16% of the arable land used now is degraded.[11] Intensifying competition between different land uses is likely to emerge in future, including food crops; livestock (both pastureland for grazing and arable land to produce feedstock); biofuels; fibre (such as paper and timber); conservation; carbon sequestration; and the world's expanding cities.[12]

- Current rates of *water* extraction from rivers, groundwater and other sources are already unsustainable in many parts of the world. 1.2 billion people live in water basins in which the physical scarcity of water is absolute; by 2025, the figure is projected to rise 50% to 1.8 billion, with up to two thirds of the world's population living in water-stressed conditions (mainly in non-OECD countries).[13] While water scarcity will more often be a regional than a global issue, the concept of 'embedded' or 'virtual' water in crops that are then traded internationally means that water is in effect also traded (1kg of wheat effectively 'contains' the 900 litres of water required to produce it, for example).[14]

- On *oil*, finally, the International Energy Agency has warned consistently that with investment in new oil production having fallen sharply as a result of the financial crisis and subsequent downturn, there is a significant risk of a new "supply crunch" as the global economy recovers.[15] There is also an unresolved public debate over when global oil production is likely to peak: while

[7] World Development Report (2008).
[8] International Energy Agency (2009).
[9] UNESCO (1999); UNDP (2006).
[10] Trostle (2008).
[11] FAO / UNEP (1997).
[12] World Bank (2008); Evans A. (2009).
[13] Comprehensive Assessment of Water Management in Agriculture (2007).
[14] UNESCO (2003).
[15] Ebrahimi (2009). The 2009 World Energy Outlook finds that global upstream investment budgets for 2009 were cut by around 19% compared with 2008, a reduction of more than $90 billion.

some commentators insist that proven reserves are adequate to meet projected demand for decades, others (including the IEA's chief economist) suggest that peak production could take place by 2020.[16]

In all of these cases, institutional, political or economic factors can be as important as physical or material factors in limiting to supply growth. Governments can make scarcity worse (for example through perverse subsidies or price controls); similarly, *perceptions* of scarcity can be as damaging as absolute limits (as for example when over 30 countries implemented food export restrictions during the food price spike that peaked in 2008, even as many import-dependent countries sought to rebuild stock levels).[17]

Climate change and its effects on resource scarcity

All of these potential limitations to supply growth are before **climate change** is considered, which is likely to be the most important long-term driver of change on all of the above sectors.

Since pre-industrial times, global average temperatures have increase by 0.7° Celsius, and emissions already in the atmosphere mean that the world is committed to a further increase of 0.6° Celsius.[18] Overall, even stringent global mitigation action may not be enough to avoid a 2.0° Celsius increase on pre-industrial temperatures. Even if the 2009 Copenhagen summit had agreed that global emissions would peak in 2015 and decline by 3% a year thereafter, this would still have left the world with an even chance of exceeding a 2° Celsius temperature increase.[19] As it is, the summit's outcome appears insufficient to prevent warming of 3° Celsius or more.[20]

Most of the key near-term impacts of climate change will result from reduced freshwater availability, which will expose hundreds of millions of people to additional water stress.[21] Decreased crop yields (in all areas except mid and high latitudes, and in *all* areas above 2.0° Celsius), will also be particularly important, and will expose tens to hundreds of millions more people to the risk of hunger.[22]

The IPCC also highlights a number of regions that will be particularly exposed to climate change, including the Arctic, Africa, small islands, and densely populated coastal "megadeltas" in Asia and Africa such as the Nile, Ganges-Brahmaputra and Mekong, where tens of millions will be at increased risk of acute flood and storm damage, chronic coastal flooding and loss of coastal wetlands.[23] Significantly, these regions' high exposure is in some cases as much the result of their high vulnerability as of the scale of climate impacts they are projected to experience; Africa, for example, is likely to be especially affected by climate change because of its "low adaptive capacity", whilst the high population densities of Asian and African megadeltas are also factors in determining their exposure.[24]

[16] Yergin (2009); Connor (2009)
[17] Evans (2009).
[18] Parry (2008).
[19] *Ibid.*; Evans and Steven (2010 forthcoming); Parry et al.(2009a).
[20] Parry (2010).
[21] *Ibid.*
[22] IPCC (2007).
[23] IPCC (2007); Parry (2008); Parry et al. (2009b).
[24] IPCC (2007).

However, assessments of the climate and scarcity outlook are complicated by a number of methodological issues, particularly in the area of climate change. New science findings continue to emerge rapidly, with the effect that overall estimates quickly become dated: the IPCC's 2007 Fourth Assessment Report is already out of date in some key respects, for example, whilst the next assessment is not due to be published until 2014.[25] Although climate models are improving all the time, their findings remain subject to a substantial degree of uncertainty, a problem that increases at more specific levels of geographical focus.

A further challenge for policymakers arises from the fact that while some estimates of future climate impacts may seem to imply steady, gradual changes that can be adapted to over time, in fact past changes in the earth's climate have been the opposite: highly non-linear and unpredictable, and hallmarked by sudden shifts as key thresholds are passed. Accordingly, an increasing concern for policymakers in recent years has been the risk of abrupt climate change that could result from positive feedback effects, such as:

- rapid die-back of tropical forests or melting of Arctic tundra (both of which would release large amounts of methane into the atmosphere);[26]
- rapid melting of polar ice sheets or glaciers (which would result in higher sea levels);[27] or
- reduction in the capacity of atmospheric sinks such as the world's oceans to absorb carbon dioxide (which would magnify the impact of current emissions).[28]

While these kinds of risk are largely omitted from IPCC assessments, due to the high degree of uncertainty associated with them, they nonetheless remain a real consideration for policymakers wanting to take a risk management approach based on feasible worst case scenarios.[29] Some best-guess estimates suggest that global average warming of around 2.0° Celsius may be a key threshold for some of these effects, while the IPCC concluded in its Third Assessment Report that "there is low to medium confidence that a rapid warming of over 3° Celsius would trigger large-scale singularities in the climate system", but such assessments are highly uncertain.[30]

2: Do climate change and resource scarcity increase the risk of violent conflict?

As concern over both climate change and resource scarcity has increased in recent years, so speculation has grown that they will lead to increased risk or incidence of violent conflict. UN Secretary-General Ban Ki-moon, for example, said in 2007 that "changes in our environment and the resulting upheavals - from droughts to inundated coastal areas to loss of arable lands - are likely to become a major driver of war and conflict".[31]

However, while climate change and resource scarcity do pose risks – especially for poor people and fragile states, which as discussed below are most vulnerable to their effects – caution is needed in forecasting their effects, particularly in the area of violent conflict.

[25] Allison et al. (2009).
[26] Lenton (2009).
[27] *Ibid.*
[28] Le Quere et al. (2009).
[29] Mabey (2009); Schwartz and Randall (2004).
[30] Mabey (2009); IPCC (2007).
[31] Ban (2007).

In part, this is because the impacts of resource scarcity or climate change will in practice almost always blur with those of other risk drivers, with the effect that it becomes extremely difficult to attribute particular impacts solely to climate change or resource scarcity. The rise in the number of undernourished people from 854 million people in 2007 to over 1 billion in late 2009, for example, is only partly attributable to the effects of the food price spike: also critical were the subsequent effects of the global downturn, which further eroded the purchasing power of many poor people.[32] Similarly, while poor people are undoubtedly vulnerable to the direct impacts of climate change, the most far-reaching effects of global warming may be the indirect "consequences of consequences" – such as political instability, economic weakness, food insecurity or large-scale migration (see below).[33]

Secondly, it is important to remember that the actual risk of violent conflict posed by climate change or resource scarcity depends as much on the *vulnerability* of populations, ecosystems, economies and institutions as on the strength of climate or scarcity impacts. The fact that poor people are more exposed to price spikes, resource scarcity and climate impacts is well-established, for example – as is the fact that environmental risks are among the most frequent, costly and impactful causes of the kinds of shock that can cause people to become poor in the first place, and that make escape from poverty so difficult.[34]

Similarly, the institutional and political weaknesses of fragile states have been argued to make them more susceptible to conflict risk arising from climate change and resource scarcity. A 2007 report from International Alert, for example, found that 46 countries, home to 2.7 billion people, would experience a "high risk of violent conflict" as a result of climate change interacting with economic, social and political problems, while in a further 56 countries with 1.2 billion inhabitants "the institutions of government will have great difficulty taking the strain of climate change on top of all their other current challenges".[35]

Climate change and resource scarcity are rarely, if ever, the sole cause of violent conflict, then: instead, they are better understood as 'threat multipliers' that will in practice interact both with other risk drivers, and with diverse sources of vulnerability.[36] However, this is not to say that climate and scarcity do not increase the risk of violent conflict. On the contrary, as a United Nations Environment Programme report recently argued: "the exploitation of natural resources and related environmental stresses can be implicated in all phases of the conflict cycle, from contributing to the outbreak and perpetuation of violence to undermining prospects for peace".[37]

Kahl (2006) cites a range of evidence for the argument that scarcity can increase the risk of violent conflict, including quantitative studies that suggest population size and density are significant conflict risk factors, and statistical work indicating that countries highly dependent on natural resources, as well as those experiencing high rates of deforestation and soil degradation or low per capita availability of arable land and freshwater, have higher than average risks of conflict.

A particularly noted study in this area was undertaken by Miguel et al. (2004), who examined rainfall variation in Africa as an instrumental variable for economic growth in order to estimate the impact

[32] High Level Task Force on the Global Food Crisis (2008); FAO (2009).
[33] Smith and Vivekananda (2007).
[34] For example Evans (2009); Heltberg and Siegel (2008); Dercon (2004).
[35] Smith and Vivekananda (2007).
[36] CNA (2007); Evans G. (2008).
[37] UNEP (2009).

of economic growth on civil conflict.[38] Their research found a strong causal relationship between lower economic growth (measured via rainfall) and increased conflict risk: a five per cent decline in annual economic growth increased the risk of civil conflict the following year by more than one half.[39] The authors found that their results applied across a wide variety of different contexts in Africa, with similar findings in richer, more democratic, more ethnically diverse or more mountainous countries, and noted that their findings resonated with previous studies that found economic variables to be more important determinants of civil war than political "grievances".[40]

More recently, Burke et al. (2009) found strong historical linkages between civil war and temperature in Africa, with warmer years significantly increasing the likelihood of war (a 1°C rise in temperature leads to a 4.5 per cent increase in civil war in the same year). When combined with projections of future temperature trends as a result of climate change, they found, historical data suggest a roughly 54% increase in armed conflict incidence by 2030, or "an additional 393,000 battle deaths if future wars are as deadly as recent wars".[41]

Overall, however, the data on the links between resource scarcity and conflict risk remain limited.[42] Relatively few quantitative studies have so far been undertaken in this area, and those that have (including both of the studies cited immediately above) rely on state-based data that excludes conflicts that do not directly involve the state, such as clashes among pastoralist groups in Northern Kenya.[43] In particular, much of the utility of the quantitative data that does exist rests on an implicit assumption that the future will be like the past – which may well be open to question, given the unpredictable and non-linear nature of future impacts of climate change, as discussed earlier.

An alternative, non-quantitative approach rests on identifying examples of specific cases of recent conflicts in which scarcity of basic natural resources played a significant role, and exploring how resource availability interacted in such instances with other factors, such as governance and its role in defining perceptions and fostering grievance or supporting resilience. For example, competition for land was identified as a significant part of the backdrop to the post-election violence in Kenya in early 2008, and to the 1994 genocide in Rwanda; water and land have both been identified as conflict drivers in Ethiopia and in Darfur.[44]

Above all, while it is possible to use both quantitative and qualitative approaches to identify particular instances in which scarcity and conflict may be correlated, the deeper question is *how* they are linked, and what are the specific transmission mechanisms through which scarcity can lead to conflict – or vice versa. This question is explored in the next section of the paper.

3: The relationship between scarcity and the risk of violent conflict

Homer-Dixon (1994) distinguishes between three kinds of environmental scarcity that can increase the risk of violent conflict:

[38] The authors note that their approach would not apply to other regions of the world, where agriculture accounts for a smaller proportion of overall economic growth.
[39] *Ibid.*
[40] *Ibid.;* Collier and Hoeffler (1998, 2001, 2002); Fearon and Laitin (2003).
[41] Burke et al. (2009).
[42] See in particular Gleditsch (1997), Gleditsch (1998), Raleigh and Urdal (2008) and Kahl (2006).
[43] Miguel et al. (2004).
[44] International Crisis Group (2008); Prunier (1997); International Crisis Group (2009a); UNEP (2007).

- *Environmental change*, which refers to "a human-induced decline in the quantity or quality of a renewable resource that occurs faster than it is renewed by natural processes";

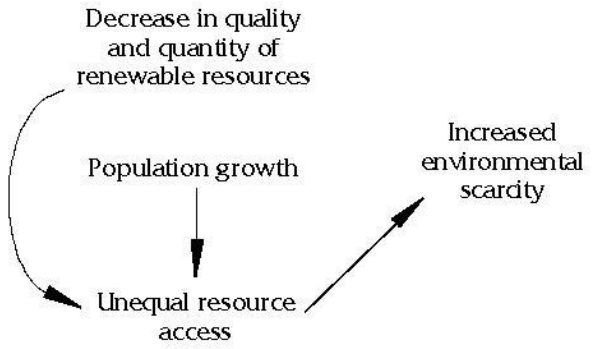
- *Population growth*, which "reduces a resource's per-capita availability by dividing it among more and more people"; and

- *Unequal resource distributions*, which "concentrates resource in the hands of a few people and subjects the rest to greater scarcity", and which often results when "property rights that govern resource distribution ... change as a result of large-scale development projects or new technologies that alter the relative values of resources". [45]

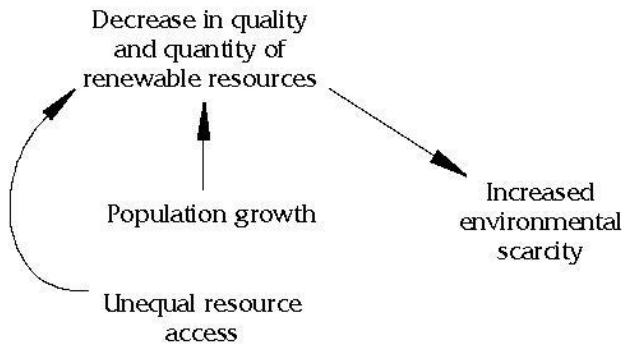
Homer-Dixon also highlights two distinct kinds of interaction between these dimensions of environmental scarcity, which he terms "resource capture" and "ecological marginalization". In the former, decreased quality and/or quantity of renewable resources combines with population growth to create unequal resource access, which then leads to increased environmental scarcity (and risk of conflict). In the latter, by contrast, unequal resource access is a cause rather than an effect; combined with population growth, it leads to decreased quality and/or quantity of renewable resources, and hence once again to increased environmental scarcity and risk of violent conflict (see Figure 1 below).

As an example of resource capture, Homer-Dixon cites events in the Senegal River valley in 1989.[46] In this case, he argues, population pressure and land degradation led to agricultural shortfalls, which the Mauritanian government decided to tackle through constructing a new dam, which would provide hydropower and expanded irrigation. However, anticipation of the dam led to a sharp increase in land values along the riverbank. According to Homer-Dixon, "the elite in Mauritania, which consists mainly of white Moors, then rewrote legislation governing land ownership, effectively abrogating the rights of black Africans to continue farming, herding, and fishing along the Mauritanian riverbank"; this in turn triggered ethnic conflict in both Mauritania and neighbouring Senegal.

[45] Homer-Dixon (1994).
[46] *Ibid.*



Resource Capture: Resource depletion and population growth cause unequal resource access.



Ecological Marginalization: Unequal resource access and population growth cause resource degredation and depletion.

Figure 1: Resource Capture vs. Ecological Marginalization[47]

As an example of ecological marginalization, by contrast, Homer-Dixon offers the case of the Philippines, where "inequalities in access to rich agricultural lowlands combine with population growth to cause migration to easily degraded upland areas; erosion and deforestation contribute to economic hardship that spurs insurgency and rebellion".[48] (Similar observations could be made today of Haiti, where widespread deforestation stemming in large part from the lack of sustainable energy systems has led to both serious topsoil loss – and hence reduced food production capacity – and high exposure to flooding, prompting the International Crisis Group to observe that "reversing a decades-long trend of environmental destruction is essential to Haiti's development, social and economic stability and, ultimately, security".)[49]

Homer-Dixon's work, and indeed the broader literature on environment and armed conflict, has been critiqued by a number of researchers, notably Nils Petter Gleditsch (1998), who has argued that much of the work in this field is methodologically unsound. Among the specific charges levelled by Gleditsch are that there is a lack of clarity over what is meant by "environmental conflict", that researchers engage in polemics rather than analysis, and that important variables – especially

[47] Reproduced from Homer-Dixon (1994)
[48] *Ibid*.
[49] International Crisis Group (2009b)

political and economic factors – are neglected.[50] Levy (1995) echoes the last of these arguments, arguing that it is poverty *per se*, rather than environmental scarcity, that creates the risk of conflict:

> "It is difficult to imagine how conflict in any developing country could not involve renewable resources. Developing country elites fight over renewable resources for the same reason that Willy Sutton robbed banks – that's where the money is."[51]

Gleditsch and Levy are undoubtedly correct to emphasise the need to see environmental scarcity not as a stand-alone issue, but rather as an integral part of the overall political economy landscape of a country or region.[52] Ruckstuhl (2009) agrees with the need to see scarcity issues in a political economy context, identifying four discrete categories in which "renewable natural resources define systems of power and access":

- *Ownership* – who possesses a resource, and what rights that brings;
- *Consumption* – how the resource should be used;
- *Distribution* – who has access to the resource, and who does not; and
- *Governance* – Who has the power to make decisions about the resource with regard to ownership, consumption and distribution.

A political economy-based approach to understanding scarcity also underscores the importance of the point that scarcity should not be viewed in isolation from the contextual factors that make an individual, community or society vulnerable – or resilient – to its effects. While disputes over the ownership, consumption, distribution or governance of scarce resources can increase the risk of violent conflict, the key to reducing the risk of such conflicts may have less to do with access to the resources *per se* than to the livelihoods that they enable. Creating alternative livelihoods not reliant on these resources, or improving access to social protection systems and safety nets, may therefore be equally viable approaches to achieving the same end. Nor are economic considerations the only potential source of grievance or conflict risk associated with natural resources: social and cultural attachments to land can be an equally important consideration for some communities, for example.

A sense of caution is also needed before making deterministic assumptions that violent conflict and/or environmental collapse will always result when populations exceed the 'carrying capacity' of their environments. As an ecological concept, the idea of carrying capacity does not take account of the human variable of how good or bad are the systems of governance that manage people's access to renewable resources – or, just as importantly, the question of whether people perceive natural resource governance systems as effective and legitimate.

These variables matter a great deal, particularly when ineffective governance systems lead to behaviours that themselves worsen environmental scarcity. At worst, the contribution of environmental degradation to conflict risk can become cyclical if conflict itself becomes a significant source of environmental degradation. In Afghanistan, for example, violent conflict has led to coping strategies that have directly eroded the country's resource base: a 2003 post-conflict environmental

[50] Gleditsch (1998). See Schwartz et al. (2000) for a detailed response to Gleditsch by Homer-Dixon and his colleagues.
[51] Levy (1995). See also Gleditsch (1997).
[52] See also Kahl (2006).

assessment conducted by UNEP, for example, found that over 50% of natural pistachio woodlands had been destroyed in order to sell wood for income, or to stockpile it for fear that access to the forests would be lost; in consequence, the livelihoods that these forests sustained were also destroyed.[53] Some humanitarian interventions to provide emergency water supplies in Afghanistan have also had the effect of exacerbating water scarcity by failing to understand groundwater dynamics, co-ordinate activities or monitor extraction levels.[54] Similarly, it is important to note that policy responses to climate change or scarcity issues could potentially increase the risk of conflict if they are badly designed or fail to take all parties' interests into account – for example if new rules to reduce emissions from deforestation or forest degradation (REDD) fail to take account of wider social and political considerations beyond the climate mitigation context.

Trans-boundary dimensions

Another important nuance that needs to be taken into account in applying the concept of carrying capacity to human activity is the question of what is the most appropriate spatial lens through which to analyse different scarcity issues. In many cases, the boundaries between ecosystems (such as forests) or other natural resources (such as river basins) will be radically different to those that exist between countries or other political units.

From a conflict risk perspective, trans-boundary water resources are especially important in this regard. At present, there are 263 rivers that either cross, or demarcate, international boundaries (the total number changes when countries' borders change, as for example with the break-up of the Soviet Union or the former Yugoslavia).[55]

To date, shared water resources have more often been the stimulus for co-operation than for conflict. Giordano and Wolf (2002) observe that,

> "...cooperative interactions between riparian states over the past fifty years have outnumbered conflictive interactions by more than two-to-one. Since 1948, the historical record documents only 37 incidents of acute conflicts (i.e., those involving violence) over water (30 of *these* events were between Israel and one or another of its neighbors, the last of which occurred in 1970), while during that same period, approximately 295 international water agreements were negotiated and signed."[56]

However, there are important qualifiers to this apparently hopeful finding. They go on to observe that **"**158 of the world's 263 international basins lack any type of cooperative management framework", and that "of the 106 basins with water institutions, approximately two-thirds have three or more riparian states, yet less than 20 percent of the accompanying agreements are multilateral".[57] Even where trans-boundary management frameworks do exist, cooperation may still take place on an unequal basis, reflecting existing power and political economy dynamics.[58] In addition, there is also the future effect of climate change to consider, which as noted earlier is likely to have particularly significant near-term impacts on water availability.

[53] Giordano and Wolf (2002).
[54] *Ibid.*
[55] UNEP (2002).
[56] Giordano and Wolf (2002).See also Wolf et al. (2003) and Sadoff et al. (2003).
[57] *Ibid.*
[58] Zeitoun and Allan (2008).

A further concern in this context is the risk of glacial retreat in the Himalayas, Hindu Kush and Tibetan Plateau, where existing glaciers provide water resources to 1.3 billion living in river basins including the Mekong, Irrawaddy, Indus, Ganges, Brahmaputra, Yangtze and Yellow River, particularly during the dry season. The effects of climate change on these flows could be far-reaching: to take the Ganges as an example, 80-85% of the river's dry season flow is from glacial meltwater, and over the last 30 years dry season flows have fallen by 11%.[59] With snowlines retreating as average temperatures rise, some projections estimate future reductions in dry season flow on the river to be substantially steeper (one study places the potential decline as high as 60-70%).[60] Projections of this kind for the region as a whole have led to an increase in concern about the potential risk of capture of water resources by particular countries.[61]

Other resources – such as oil and many food commodities – need to be assessed at the *global* level, which introduces further dimensions to the idea of a country or area's carrying capacity. One of these, of course, is that international trade can enable a country to consume particular goods at higher levels than its own resource endowment would otherwise allow. Another, conversely, is that consumption of a good elsewhere in the world may affect the ability of a country or community to access that good – a dynamic seen in the 2008 food price spike, when diversion of crops to biofuels in the United States contributed to rising food prices elsewhere in the world.[62]

Consideration of global supply chains also introduces the question of whether inter-state conflict over access to scarce resources is becoming more likely. While estimates in this area remain highly speculative, there are already signs of friction in inter-state competition for access to some key commodities. Recent years have seen intensifying competition between major economies for access to energy resources in a range of regions, notably the west African seaboard, the Caspian Basin and the South China Sea, for example.[63]

More recently, concern has increased about third country land or food access deals that have seen a reported 690,000 hectares of Sudanese land leased to South Korea, 2.8 million hectares of land in the DRC leased to China, and 2 million hectares of Zambian land requested for lease by China.[64] In some cases, such deals may be less about the land itself than the water resources that come with it, given the potential for export of 'embedded water' (discussed above) in the crops produced.[65]

In addition, a related risk associated with such investment deals is that they could provoke violent unrest if the benefits of investment are perceived to be unequally shared. The March 2009 coup d'etat in Madagascar, for example, followed international media reports that the government had leased one half of the country's arable land to a South Korean company; the new President's first act was to cancel the contract.[66] Similar concerns have been expressed over the impact of energy access deals on governance standards in low income countries.[67]

Most fundamentally, the growth of global supply chains introduces the need to consider the concept of carrying capacity at global level too – a point not considered in this paper, but that is nonetheless of fundamental importance to security, as to all other areas of policy-making.

[59] Boulton, G. (2009).
[60] *Ibid*.
[61] For example TNN (2009).
[62] IMF (2008); World Bank (2008b); Currie (2008).
[63] Klare (2008).
[64] Von Braun and Meinzen Dick (2009).
[65] Brabeck-Lemanthe (2009).
[66] Burgis, T. and Blas, J. (2009).
[67] Discussed in separate WDR background paper on the resource curse

Indirect conflict risks from climate change and resource scarcity

A further range of conflict risks arises from indirect consequences of resource scarcity and climate change – the "consequences of consequences" referred to earlier.

One such set of linkages centres on the risk of **acute shocks** driven by climate change (such as extreme weather events) or resource scarcity (such as price spikes), that then create knock-on social, economic or security impacts. During the food and fuel price spike that peaked in 2008, for example, at least 61 countries experienced unrest as a result of price inflation; in 38 countries, these protests were violent.[68] Countries with no social protection provision were particularly hard hit, and often turned instead to policy measures with unintended negative consequences, such as economy-wide subsidies (which were fiscally damaging and encouraged further price inflation), price controls (which reduced the incentives for producers to increase output) or export restrictions (which created ripple effect problems for many other countries).[69]

A second set of indirect linkages between climate change and resource scarcity on one hand and conflict risk on the other centres on the risk of **large-scale unplanned migration** as the result of increasing environmental degradation. The first Assessment Report of the IPCC in 1990 noted that the greatest single impact of climate change could be to displace millions of people, particularly through shoreline erosion, coastal erosion and agricultural disruption.[70]

Since then, however, projections of increased numbers of "climate refugees" have been challenged by some analyses. Black (2001) argues that while environmental degradation or catastrophe may be important factors in decisions to migrate, "their conceptualisation as a primary cause of forced displacement is unhelpful and unsound intellectually, and unnecessary in practical terms".[71] Kolmannskog (2008) also questions the term 'climate refugees', arguing that while "it is very likely that climate change impacts will contribute to an increase in forced migration", the idea of 'climate refugees' is unhelpful in that it "implies a mono-causality that one rarely finds in human reality ... no one factor, event or process, inevitably results in forced migration or conflict".

As contentious as the term 'climate refugees' has been the question of how many such refugees can be expected in future. Many analysts have focused on a figure of 200 million 'climate refugees' by 2050.[72] This figure has been challenged, however, for example by an International Organization for Migration (2008) study which noted that the figure exceeds the current global total of 192 million people who have migrated, and that "the consequences of climate change for human population distribution are unclear and unpredictable" – particularly in view of the non-linear and frequently abrupt nature of past climate changes, as discussed earlier.[73]

However, the IOM study also notes that whatever the total proves to be in 2050, "it is likely that the burden of providing for climate migrants will be borne by the poorest countries", and that increased conflict risk is one of the four key ways in which forced migration hinders development.[74] Raleigh

[68] Von Braun (2008).
[69] UN High Level Task Force on the Global Food Crisis (2008).
[70] Intergovernmental Panel on Climate Change (1990).
[71] Black (2001).
[72] Cited in International Organization for Migration (2008).
[73] *Ibid.*
[74] *Ibid.* The other three ways in which forced migration is argued to hinder development are increased pressure on urban infrastructure and services, undermining economic growth and worse health, educational and social indicators among migrants themselves.

and Urdal (2008) add that while abrupt displacements of people may happen, the more significant trend may be "climate change causing a gradual migration by people searching for more fertile land – or for other economic opportunities to replace lost livelihoods".

A third potential area of indirect conflict risk that could arise from climate change and increased resource scarcity is the potential for **existing international legal structures to be rendered outdated or irrelevant** by changing environmental circumstances, thus paving the way for novel disputes that existing law may struggle to manage. Trans-boundary water sharing agreements may become sources of conflict rather than co-operation as flows and water levels change, particularly where agreements are based on a set volume of water rather than a percentage of what is available (and above all when the rate of change in access outpaces institutions' capacity to adapt); agreements on sharing access to fisheries may be undermined if fish shift to other regions due to climate change; hydropower-sharing agreements also risk being undermined by changing water flows, particularly in regions affected by glacial melting with the risk of above-average flows as glaciers melt being followed by droughts once they have disappeared.[75]

The prospect of sea level rise (and hence changing national coastlines) is particularly important in the legal context. At present, the UN Convention on the Law of the Sea (UNCLOS) provides coastal countries with Exclusive Economic Zones (EEZs) that extend 200 nautical miles out to sea from the coastline.[76] A number of significant border disputes include, or have included, reference to EEZs, including claims over the South China Sea (involving China, Taiwan, the Philippines and Vietnam among others) and the Gulf of Mexico (including the maritime border between the US and Cuba). As coastlines change because of climate change, so the context for these disputes will also shift, with unpredictable consequences.[77] Such border claims can also have knock-on impacts for other potential dispute areas, including ownership of undersea energy resources, and newly navigable waterways such as the North-West Passage.[78] Rising sea levels will also introduce the question of what happens to the sovereignty rights, resource claims, and indeed populations of low-lying island states that disappear altogether.

4: Summary and conclusion

Even before climate change is taken into account, scarcity of land, food, water and oil is likely to be an increasing driver of change between now and 2030, and beyond. Climate change will exacerbate the challenge in all of these areas, and the combined effect of these changes is likely to put tens to hundreds of millions more people at risk of impacts including hunger, disease, displacement, injury, poverty or other forms of hardship.

Although the conflict risk posed by climate change and resource scarcity will almost always be better understood as a 'threat multiplier' than as a sole cause of violent conflict, a range of potential linkages between climate, scarcity and conflict risk can nonetheless be identified, whether through intensifying existing problems, or through creating new environmental problems that lead to instability.[79]

[75] Paskal (2009); Wolf et al. (2003).
[76] UN Convention on the Law of the Sea (1982).
[77] Paskal (2007)
[78] *Ibid.*
[79] USAID (2009).

The most obvious such linkage is the risk of direct conflict over access to or control of scarce resources such as land or water. Most current examples of such conflicts take place *within* countries, but intensifying resource scarcity and climate change could see an increase in strategic resource competition *between* states, both at the regional level (particularly if abrupt climate effects, such as rapid glacial melting, manifest themselves and thus impact trans-boundary water resources) and internationally (with some countries already pursuing third country access rights to oil, land, food and potentially water).

However, a range of other conflict risks arising from climate change and resource scarcity also have the potential to make themselves felt in the future. Among them are cases where livelihoods or economies are undermined by resource scarcity, potentially increasing state fragility in the process; cases where violent conflict itself has the effect of contributing to environmental degradation, thus potentially creating a cyclical relationship between scarcity and conflict; large-scale unplanned migration as a result of climate impacts or resource scarcity; and the risk that changing geographical circumstances, such as rising sea levels or changing water flows in trans-boundary watercourses, render existing legal agreements out of date.

Making specific projections about the extent or location of future conflict risks driven by climate change and resource scarcity is highly complex and resistant to specificity. In part this is because, as just noted, climate and scarcity effects will rarely if ever be felt in isolation from the impacts of other risks. The extent of the impacts caused by climate and scarcity will also depend as much on social, institutional, economic and ecological vulnerability as on the magnitude of the threats themselves. Above all, projections of the future effects of climate and scarcity issues are highly uncertain and unpredictable, given not only limitations in the current scientific outlook (particularly at more granular levels of geographical focus), but also the non-linear nature of many of the changes involved and the complex feedback loops between different scarcity issues.

For all these reasons, policymakers will often face an uphill struggle in deciding on priorities for measures to invest in preparedness and reduce vulnerability to increasing climate change and resource scarcity. However, some general observations may still be made about some key areas for action.

Surveillance, early warning and risk anticipation

First, the extent of unpredictability and the lack of region-specific data on scarcity and climate change will create a premium on improved systems for risk surveillance and early warning. Higher resolution climate change models that are able to provide more locally specific projections are gradually becoming available, but policymakers will still need to integrate these and other scientific surveillance systems with monitoring of more human factors such as existing conflict risks and data on vulnerability and political economy variables.

The non-linear nature of many of the shifts that climate change and resource scarcity may drive also implies a need for policymakers to accept that while prediction will not always be possible, much can still be done to improve *anticipation* of potential risks. Horizon scanning methodologies to assist policymakers in identifying and planning for worse case scenarios arising from scarcity and climate change are also improving, and policymakers can do much to accelerate this process by using the systems that are available and investing in improving them.[80]

[80] Mabey (2009).

Building resilience to scarcity

A focus on anticipation of potential climate and scarcity risks leads on naturally to a focus on ways of reducing vulnerability (to violent conflict as to other consequences) and building resilience.

Already, a wide range of work on this front is beginning to get underway in developing countries and among international donors. Recent years have for example seen greatly increased attention being paid to climate change adaptation, disaster risk reduction, social protection and other risk-focused dimensions of the broad development agenda. The effect that these measures could have on the scale of the challenge is significant: the most recent science findings available for the effects of climate change on hunger, for example, show that while the increase in the risk of hunger as a result of climate change could be between 10% and 60%, effective adaptation policies could reduce the number to 5%.[81]

However, much remains to be done to mainstream these resilience-focused areas of work through national development strategies. For fragile states, in particular, a key paradox will be the fact that successful resilience-building will often depend on the resources that by definition they lack: either institutional capacity, or legitimacy, or both. As with other risk factors explored in this World Development Report, the kinds of capacity required will range across state, informal, private sector and civil society institutions.

For international donors, a key challenge is likely to be the need to recognise that while they can provide valuable assistance to partner countries on institutional capacity building, they will also frequently find themselves having to navigate acutely political disputes about winners and losers in natural resource governance. As section 3 discussed, scarcity needs to be seen and understood within the larger political economy context; by extension, decisions over sequencing reforms should take scarcity issues into account, particularly in post-conflict contexts.

International action

Perhaps the most novel challenge that climate change and resource scarcity will pose for international actors, however, is the extent to which managing the conflict risk that these issues pose for fragile states will depend on action taken internationally as well as in fragile states themselves – a point that reflects the broader theme of exogenous conflict risks in this World Development Report.

One part of this challenge relates to the need to improve identification and avoidance of unintended international consequences of national policy actions. During the food / fuel price spike that peaked in 2008, for example, diversion of crops to biofuels (particularly corn-based ethanol in the US) was, as noted earlier, one of the most significant drivers of rising food prices: a policy measure designed to improve national energy security proved to have the accidental impact of undermining food security for millions of people.[82] Numerous other linkages exist that could drive similar effects: for

[81] Parry et al. (2009b).
[82] IMF (2008); World Bank (2008b); Currie (2008).

instance, while desalination technologies could improve water security for some countries, this will typically entail high knock-on costs in terms of both energy use and greenhouse gas emissions.[83]

Another important area of work is likely to be making international systems more resilient to climate- or scarcity-driven impacts. As noted earlier, discussions of individual countries' environmental carrying capacity overlook the extent to which international trade can alleviate national resource limits; but if international markets prove unreliable (as many low income, food import dependent countries found during the summer of 2008, for example), then interdependence can become a source of vulnerability rather than resilience.

A key area for action is hence the need to improve the resilience of international trade markets (for example through multilateral rules against sudden export restrictions, or by building up stocks of key commodities), at the same time as assessing their own vulnerability to scarcity (for example, if future oil scarcity sharply increases the costs of maritime trade).

In sum: scarcity issues are likely to present a significant challenge to poor people, to fragile states, and to the international community as it attempts to support them. As the case of trans-boundary water system governance shows, scarcity issues have to date often provided a stimulus for cooperation rather than competition – although climate change, in particular, implies a need to ask whether the future will look like the past.

At all levels from local to global, climate change and scarcity issues will force decision-makers – and, ultimately, individual citizens – to make choices between intensifying zero-sum competition and increasing co-operation in rules-based orders. The quality of governance, and levels of trust in it, will be fundamental in shaping these choices.

[83] Western Australia Water Corporation (2006).

References

Alden, C. And Alves, C. (2009). *China and Africa's Natural Resources: The Challenges and Implications for Development and Governance*. Occasional Paper 41. Johannesburg: South African Institute of International Affairs.

I. Allison, N. L. Bindoff, R.A. Bindoff, R.A. Bindschadler, P.M. Cox, N. de Noblet, M.H. England, J.E. Francis, N. Gruber, A.M. Haywood, D.J. Karoly, G. Kaser, C. Le Quéré, T.M. Lenton, M.E. Mann, B.I. McNeil, A.J. Pitman, S. Rahmstorf, E. Rignot, H.J. Schellnhuber, S.H. Schneider, S.C. Sherwood, R.C.J. Somerville, K.Steffen, E.J. Steig, M. Visbeck, A.J. Weaver. *The Copenhagen Diagnosis, 2009: Updating the world on the Latest Climate Science*. Sydney: University of New South Wales Climate Change Research Centre (CCRC).

Ban Ki-moon (2007). *Address to the United Nations International School – UN Conference on "Global Warming: Confronting the Crisis*. Available to download at: http://www.un.org/apps/news/infocus/sgspeeches/search_full.asp?statID=70.

Black, R. (2001). *Environmental Refugees: myth or reality?* UNHCR New Issues working paper no. 34. Available to download at: http://www.humansecuritygateway.com/documents/UNHCR_EnvironmentalRefugees_MythOrReality.pdf

Blumenthal, G. (2009). "Investors' Perspectives on Farmland". In Kugelman and Levenstein (2009).

Boulton, G. (2009). *Adapting to climate change: the space between science and politics*. Presentation to the Royal Society of Edinburgh, 2009. Available to download at: http://www.rse.org.uk/enquiries/climate_change/talks_slides/boulton_slides.pdf

Brabeck-Letmathe, P. (2009). "The Next Big Thing: H20". *Foreign Policy*, May/June 2009.

Brautigam, D. (2009). *The Dragon's Gift: The Real Story of China In Africa*. Oxford: Oxford University Press.

Brautigam, D. (2010). "Africa's Eastern Promise". *Foreign Affairs*, January 2010. Available at: http://www.foreignaffairs.com/articles/65916/deborah-brautigam/africa%E2%80%99s-eastern-promise

Broadman, H. (2007). *Africa's Silk Road: China and India's New Economic Frontier*. Washington DC: World Bank.

Broadman, H. (2008). "China and India go to Africa". *Foreign Affairs*, March / April 2008.

Brown, L. (2006). *Plan B 2.0: Rescuing a Planet Under Stress and a Civilisation in Trouble*. New York: Norton.

Burgis, T. and Blas, J. (2009). "Madagascar scraps Daewoo farm deal", *Financial Times*, 18 March 2009.

Burke, M., Miguel, E., Satyanath, S., Dykema, J. and Lobell, D. (2009). "Warming increases the risk of civil war in Africa", *Proceedings of the National Academy of Sciences of the United States of America*, vol. 106 no. 49, 8 December 2009

CNA Corporation (2007). *National Security and the Threat of Climate Change*. Alexandria, VA: CNA. Available to download at: http://securityandclimate.cna.org/report/National%20Security%20and%20the%20Threat%20of%20Climate%20Change.pdf

Collier, P. and Hoeffler, A. (1998). "On Economic Causes of Civil War." Oxford Econ. Papers 50 (October): 563–73.

Collier, P. and Hoeffler, A. (2001). "Greed and Grievance in Civil War." Policy Research Paper no. 2355 (May). Washington, D.C.: World Bank.

Collier, P. and Hoeffler, A. (2002). "On the Incidence of Civil War in Africa." J. Conflict Resolution 46(February): 13–28.

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

Conca, K. and Dabelko, G., *eds*. (2002). *Environmental Peacemaking*. Washington DC: Woodrow Wilson Center.

Connor, S. (2009). "Warning: Oil supplies are running out fast", *The Independent*, 3 August 2009.

Copenhagen Diagnosis (2009).

Cotula, L., Vermeulen, S., Leonard, R. and Keeley, J. (2009). *Land grab or development opportunity? Agricultural investment and international land deals in Africa*. Joint report, IIED, FAO and IFAD. London: International Institute for Environment and Development.

Currie, J. (2007). "Food, Feed and Fuels: an outlook on the agriculture, livestock and biofuels market". Presentation, Goldman Sachs, March 2007.

Dercon, S. (2004). *Insurance against Poverty*. Oxford: Oxford University Press. Quoted in Heltberg and Siegel (2008).

DFID (2005). *Partnerships for Poverty Reduction: rethinking conditionality*. London: UK Department for International Development. Available at: http://www.dfid.gov.uk/Documents/publications/conditionality.pdf.

Diouf, J. (2008). Address by Mr Jacques Diouf, Director-General of the Food and Agriculture Organization, on the Occasion of the High-Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy, 3 June 2008.

Ebrahimi, H. (2009). "IEA warns of oil 'supply crunch'", *Daily Telegraph*, 16 February 2009.

Evans, A. (2009). *The Feeding of the Nine Billion: Global food security in the 21st century.* London: Chatham House. Available to download at: http://www.chathamhouse.org.uk/publications/papers/download/-/id/694/file/13179_r0109food.pdf

Evans, A. and Steven, D. (2010 forthcoming). *The World After Copenhagen: What can we learn from the geopolitical dynamics of climate negotiations?* Washington DC: National Intelligence Council.

Evans, G. (2008). "Conflict Potential in a World of Climate Change". Speech given at Bucerius Summer School on Global Governance, 29 August 2008. Available to download at: http://www.crisisgroup.org/home/index.cfm?id=5648&l=1

Fearon, J. D., and Laitin, D.D. (2003). "Ethnicity, Insurgency, and Civil War." *American Political Science Review* 97 (March).

Food and Agriculture Organization (2009). "1.02 billion people hungry". FAO news release, 19 June 2009. Available to download at: http://www.fao.org/news/story/en/item/20568/icode/

Food and Agriculture Organization / UN Environment Programme, 1997. *Negotiating a Sustainable Future for Land. Structural and Institutional Guidelines for Land Resources Management in the 21st Century*. Rome: FAO / Nairobi: UNEP. Quoted in Warburton (2008).

Freemantle, S. and Stevens, J. (2010). *Brazil weds itself to Africa's latent agricultural potential*. Standard Bank economics brief, 1 February 2010.

French, H. W. and Polgreen, L. (2007). "China, seeking resources, brings deep pockets to Africa". *New York Times*, 12 August 2007.

Gill, B. and Reilly, J. (2007). "The Tenuous Hold of China Inc. in Africa". In *The Washington Quarterly*, Summer 2007, 30:3 pps. 37-52. Available at: http://www.twq.com/07summer/docs/07summer_gill_reilly.pdf

Giordano, M. and Wolf, A. (2002). "The World's International Freshwater Agreements". In UNEP (2002).

Gleditsch, N.P. (1997). "Environmental Conflict and the Democratic Peace". In Gleditsch, N.P. (ed.) (1997). *Conflict and the Environment*. NATO ASI series, 2 (vol. 33). Dordrecht: Kluwers Academic.

Gleditsch, N.P. (1998). "Armed Conflict and the Environment: A Critique of the Literature". *Journal of Peace Research* vol. 35 no. 3 pps. 381-400, May 1998.

Goldman Sachs (2007). *BRICs and Beyond*. London: Goldman Sachs. Available to download at: http://www2.goldmansachs.com/ideas/brics/BRICs-and-Beyond.html

Hallam, D. (2009). "International Investments in Agricultural Production". In Kugelman and Levenstein (2009).

Hanson, S. (2008). *China, Africa and Oil*. CFR Background Paper. Washington DC: Council on Foreign Relations. Available at: http://www.cfr.org/publication/9557/

Heltberg, R., and Siegel, P.B. (2008). *Climate Change: Challenges for Social Protection in Africa*. Paper prepared for conference on *Social Protection for the Poorest in Africa*. Washington DC: World Bank.

Hendrix, C.S. and Glaser, S. M. (2005). *Trends and Triggers: Climate Change and Civil Conflict in Sub-Saharan Africa*. Paper presented at workshop on 'Human Security and Climate Change', Oslo, 21-23 June 2005.

Homer-Dixon, T. (1994). *Environmental Scarcities and Violent Conflict: Evidence from Cases*. Toronto: University of Toronto. Available to download at: http://www.library.utoronto.ca/pcs/evidence/evid1.htm

Homer-Dixon, T. (1999). *Environment, Scarcity and Violence*. Princeton: Princeton University Press.

Hughes Butts, K. and Bankus, B. (2009). *China's Pursuit of Africa's Natural Resources*. Collins Center Study, Volume 1-09. Carlisle: US Army War College Center for Strategic Leadership.

International Crisis Group (2008). *Kenya in Crisis*. Brussels: ICG.

International Crisis Group (2009a). *Ethiopia: Ethnic Federalism and Its Discontents*. Brussels: ICG.

International Crisis Group (2009b). *Haiti: Saving the Environment, Preventing Instability and Conflict*. Brussels: ICG.

International Energy Agency (2008). *World Energy Outlook 2008*. Paris: International Energy Agency.

International Energy Agency (2009). *World Energy Outlook 2009*. Paris: International Energy Agency.

International Organization for Migration (2008). *Migration and Climate Change*. Geneva: IOM. Available to download at http://www.iisd.org/pdf/2008/migration_climate.pdf

International Peace Bureau (2007). A Climate of War: The Links Between Climate Change and Conflict. Available to download at: http://www.ipb.org/environment.html.

Intergovernmental Panel on Climate Change (1990). *Climate Change 1990 (First Assessment Report): Synthesis Report Summary for Policymakers.* Geneva: IPCC.

Intergovernmental Panel on Climate Change (2007). *Climate Change 2007 (Fourth Assessment Report): Synthesis Report Summary for Policymakers.* Geneva: IPCC.

Kahl, C. (2006). *States, Scarcity and Civil Strife in the Developing World*. Princeton: Princeton University Press.

Klare, M. (2008). *Rising Powers, Shrinking Planet: The New Geopolitics of Energy*. New York: Metropolitan Books.

Kleine-Ahlbrandt, S. and Small, A. (2008). "China's new dictatorship diplomacy", in *Foreign Affairs*, January / February 2008.

Kolmannskog, V. O. (2008). *Future Floods of Refugees: A comment on climate change, conflict and forced migration*. Norwegian Refugee Council. Available to download at: http://www.nrc.no/arch/_img/9268480.pdf.

Kugelman, M. and Levenstein, S., eds. (2009). *Land Grab? The Race for the World's Farmland*. Washington DC: Woodrow Wilson Center.

Lapper, R. (2010). "Brazil accelerates investment in Africa". *Financial Times*, 9 February 2010.

Le Quere, C., Raupach, MR; Canadell, JG; Marland, G; Bopp, L; Ciais, P; Conway, TJ; Doney, SC; Feely, RA; Foster, P; Friedlingstein, P; Gurney, K; Houghton, RA; House, JI; Huntingford, C; Levy, PE; Lomas, MR; Majkut, J; Metzl, N; Ometto, JP; Peters, GP; Prentice, IC; Randerson, JT; Running, SW; Sarmiento, JL; Schuster, U; Sitch, S; Takahashi, T; Viovy, N; van der Werf, GR; Woodward, FI. *Trends in the Sources and Sinks of Carbon Dioxide*. Nature Geoscience 2 (12), December 2009.

Lenton, T. (2009). *Tipping Points in the Earth System*. UEA Earth System Modelling Group, 2009. Available to download at: http://researchpages.net/ESMG/people/tim-lenton/tipping-points/

Levy, M. (1995). "Is the environment a national security issue?" *International Security*, Vol. 20, No. 2 (Fall 1995).

Mabey, N. (2009). "Tackling Worst Case Scenarios: Developing a risk management approach to delivering climate security". Presentation at Royal Institute of International Affairs, 10 November 2009.

Miguel, E., Satyanath, S. and Sergenti, E. (2004). "Economic Shocks and Conflict: An Instrumental Variable Approach", *Journal of Political Economy*, vol. 112 no. 4, 2004.

Parry, M. (2008). *Humanitarian Implications of Climate Change*. Presentation to Inter-Agency Standing Committee Principals meeting, Geneva, 20 April 2008.

Parry, M. (2010). "Copenhagen number crunch". *Nature*, published online, 14 January 2010.

Parry, M., Lowe, J. and Hanson, C. (2009a). "Overshoot, adapt and recover". *Nature* Vol. 458 No. 30, April 2009.

Parry, M., Evans , A., Rosegrant, M., and Wheeler, T. (2009b). *Climate Change and Hunger: Responding to the Challenge*. Rome: World Food Programme.

Paskal, C. (2007). *How climate change is pushing the boundaries of security and foreign policy*, Chatham House briefing paper 07/01. London: Royal Institute of International Affairs.

Paskal, C. (2009). *UK National Security and Environmental Change*, Policy brief for IPPR Commission on National Security for the 21st Century. London: Institute for Public Policy Research.

Prunier, G. (1997). *The Geopolitical Situation in the Great Lakes Area in Light of the Kivu Crisis*. Geneva: UNHCR. Available to download at: http://www.unhcr.org/refworld/docid/3ae6a6be0.html

Raleigh, C. and Urdal, H. (2008). "Climate Change, Demography, Environmental Degradation, and Armed Conflict", *New Directions in Demographic Security* series, Woodrow Wilson International Center for Scholars Environmental Change and Security Program. Available to download at: http://www.wilsoncenter.org/topics/pubs/ECSPReport13_RaleighUrdal.pdf.

Ruckstuhl, S. (2009). *Renewable Natural Resources: Practical Lessons for Conflict-Sensitive Development*. Washington DC: World Bank.

Sachs, J. (2008). *Common Wealth: Economics for a Crowded Planet*. New York: Penguin Books.

Sadoff, C., Whittington, D. and Grey, D. (2003). *Africa's International Rivers: An Economic Perspective*. Washington DC: World Bank.

Schwartz, D., Deligiannis, T. And Homer-Dixon, T. (2000). "The Environment and Violent Conflict: A Response to Gleditsch's Critique and Some Suggestions for Future Research", *Environmental Change and Security Report*, Issue 6 (Summer 2000).

Schwartz, P. and Randall, D. (2004). *An Abrupt Climate Change Scenario and Its Implications for United States National Securit*y. Emeryville: Global Business Network. Available to download at: http://www.gbn.com/articles/pdfs/Abrupt%20Climate%20Change%20February%202004.pdf

Smith, D. and Vivekananda, J. (2007). *A Climate of Conflict: The links between climate change, peace and war*. London: International Alert.

Spieldoch, A. and Murphy, S. (2009). "Agricultural Land Acquisitions: Implications for Food Security and Poverty Alleviation". In Kugelman and Levenstein (2009).

Taylor, I. (2006). *Unpacking China's Resource Diplomacy in Africa*. CTR Working Paper no. 19. Hong Kong: Center on China's Transnational Relations, Hong Kong University of Science and Technology.

TNN (2009). "India to check if China is building Brahmaputra dam". *Times of India*, 16 October 2009.

Trostle, Ronald (2008). *Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices.* Washington DC: US Department of Agriculture (USDA) Economic Research Service.

United Nations Convention on the Law of the Sea (1982). Available to download at: http://www.un.org/Depts/los/index.htm.

United Nations Department of Economic and Social Affairs (2006). *World Population Prospects: the 2008 Revision*. New York: United Nations. Available to download at: http://esa.un.org/unpp/p2k0data.asp.

UN High Level Task Force on the Global Food Crisis (2008). *Comprehensive Framework for Action*. New York: United Nations.

UNDP (2006). *Human Development Report 2006: Beyond Scarcity – Power, poverty and the global water crisis.* New York: UNDP.

UNEP (2002). *Atlas of International Freshwater Agreements*. Geneva: UNEP.

UNEP (2003). *Afghanistan post-conflict environmental assessment*. Geneva: UNEP.

UNEP (2007). *Sudan post-conflict* environmental assessment. Geneva: UNEP.

UNEP (2009). *From Conflict to Peacebuilding: the Role of Natural Resources and the Environment*. Geneva: UNEP. Available to download at: http://www.unep.org/publications/search/pub_details_s.asp?ID=3998.

UNESCO (1999). *World Water Resources at the Beginning of the 21st Century*. Paris: UNESCO. Data source available to download at: http://webworld.unesco.org/water/ihp/db/shiklomanov/summary/html/sum_tab7.html.

UNESCO (2003). World Water Assessment Programme, *Water for People, Water for Life*. UNESCO and Berghahn Books

USAID (2009). *Climate Change, Adaptation and Conflict: A preliminary review of the issues*. CMD Discussion Paper no. 1, October 2009.

US National Security Council (2006). *The National Security Strategy of the United States of America*. Washington DC: NSC. Available to download at: http://www.strategicstudiesinstitute.army.mil/pdffiles/nss.pdf

Von Braun, J. (2008). *Food and Financial Crises: Implications for Agriculture and the Poor*. IFPRI Food Policy Report. Washington DC: International Food Policy Research Institute.

Von Braun, J. and Meinzen Dick, R. (2009). "*Land Grabbing" by Foreign Investors in Developing Countries: Risks and Opportunities*. Washington DC: International Food Policy Research Institute.

Warburton, R. (2008). *The 'bull run' in soft commodities: commodity cycle or structural shift in food and farming?* Research paper. Cambridge: Bidwells Agribusiness.

Western Australia Water Corporation (2006). 'Desalinisation' paper prepared for the 2006 Australian State of the Environment Committee, Department of the Environment and Heritage, Canberra. Available to download at: http://www.deh.gov.au/soe/2006/emerging/desal/index.html

Wolf, M. (2007). "The dangers of living in a zero sum world economy", *Financial Times*, 18 December 2007.

Wolf, A., Yoffe, S. and Giordano, M. (2003). "International waters: identifying basins at risk", *Water Policy* 5, Number 1 (2003) pps. 29-60

World Bank (2008). *World Development Report 2008*. Washington: World Bank.

Yergin, D. (2009). "It's still the one", *Foreign Policy*, September / October 2009

Zeitoun, M. and Allan, J. (2008)."Applying hegemony and power theory to transboundary water analysis", *Water Policy* Vol. 10 No. S2, pp. 3-12.