

# Adaptation to climate change in Southern Africa: New boundaries for sustainable development?

STEFFEN BAUER\* and IMME SCHOLZ

German Development Institute (DIE), Tulpenfeld 6, 53113 Bonn, Germany

The evident correlation of climate impacts and poverty poses a particular challenge for the Southern African region: climatically, the region is warming up faster than the rest of the world, and socio-economically it is one of the world's poorest and most vulnerable regions. With its land and water resources already under stress, the double bind of climatic change and structural poverty will create impenetrable boundaries for sustainable human development unless unprecedented adaptive capacities are developed. This introduction provides a conceptual and environmental background for empirically informed discussions of adaptation to climate change in Southern Africa. It first considers the notion of boundaries for human development and relates them to established concepts of vulnerability and adaptation. It then reviews expected climate impacts in the context of regional development and provides an outlook on the research presented in this special issue. It thus sets the stage for exploring the potential of Southern Africa to follow a sustainable human development path while responding to the impacts of climate change. In conclusion we argue that, uncertainty in regional climate scenarios notwithstanding, the reduction of people's vulnerability is imperative for development policies across the Southern African region.

Keywords: adaptation; boundaries; climate change; Southern Africa; sustainable development; vulnerability

There are few misfortunes in the world that you cannot turn into a triumph if you have the iron will and the necessary skill. (Nelson Mandela)

## 1. Introduction

Among the manifold studies and reports on anthropogenic climate change, the title-cum-slogan of the United Nations Foundation's report on how to confront climate change probably captures best the double-edged challenge that lies ahead: 'Avoiding the unmanageable and managing the unavoidable' (United Nations Foundation, 2007). In view of accumulating scientific insights and recent political developments, the latter half of the slogan is gaining ever more urgency for Southern Africa. How so?

Climatically, the Southern African region is warming up faster than the global average. Socio-

economically, Southern Africa represents one of the world's poorest and most vulnerable regions.<sup>1</sup> Between them, the countries of Southern Africa represent roughly one-tenth of the people that Paul Collier refers to as the world's 'bottom billion': the share of the global population that is effectively decoupled from overall global progress (Collier, 2007). It is them who will be hit first and hardest by climatically driven environmental change.

The resulting combination of environmental stress and structural poverty brings with it additional challenges for societies across the region. Thus, the overarching question that concerns this special issue of *Climate and Development* is whether and to what extent evident needs for adaptation represent boundaries to human development in Southern Africa: a region that includes some of the world's poorest countries (e.g. Zimbabwe, Mozambique, Zambia, Malawi) as well as

■ \*Corresponding author. **E-mail: [steffen.bauer@die-gdi.de](mailto:steffen.bauer@die-gdi.de)**

the regional engine of industrial development, the Republic of South Africa.

While the prospective boundaries resulting from adaptation – understood to both increase resilience to climatic change and reduce vulnerability regarding its impacts – will be the focus of our discussion, and indeed this special issue, we consider them as only one side of a coin. On its flip side are prospective boundaries resulting from mitigation, that is, the need to switch economic development to a low carbon path – not least in view of the coal-fuelled growth of South Africa's emerging economy.

We are not suggesting that Southern Africa has no role to play in global efforts to avoid the unmanageable. Indeed, adaptation must not be considered a substitute for mitigation: sustainable human development will require an approach that includes mitigation strategies as well as adaptation strategies. Yet, we argue that the challenges faced in terms of adaptation will be gigantic even if global mitigation efforts were to be more successful than is currently conceivable.<sup>2</sup> This pertains to sustainable development everywhere, but particularly so in Southern Africa: not only is there a very high correlation between climate impacts and poverty, but efforts to reduce poverty are undermined by ongoing climate change (Parry, 2009, p. 5).

Moreover, while even the poor economies of Southern Africa may contribute significantly to climate change mitigation, achieving the necessary emissions reductions to stabilize mean global warming within a 'manageable' margin is out of their hands. Indeed, 'the most important aspects of mitigation for Africa are the implications of the mitigation strategies chosen by the rest of the world' (Collier et al., 2008, p. 339).

In the wake of the truly disillusioning climate summit of Copenhagen, the choices of the rest of the world do not bode well for Africa. Global greenhouse gas emissions continue to increase at a dizzying rate. Meanwhile, evidence is mounting that even the daunting findings of the Intergovernmental Panel on Climate Change (IPCC)'s Fourth Assessment Report (IPCC, 2008) underestimate both the pace and the intensity

of climate change dynamics (Levin and Tirpak, 2009). In other words, it seems all but probable that the 'guardrail' of 2°C of global warming that promises manageable climate impacts will soon be out of reach, and that some of the tipping points in the Earth's climate system may be triggered within this century (Lenton et al., 2008; Rogelj et al., 2009; WBGU, 2009).

Hence, the focus of this special issue is on adaptation to climate change in Southern Africa in relation to the region's overall development prospects. Section 2 presents the key concepts that guide this special issue, and asks whether climate change and adaptation present 'boundaries' to sustainable human development in the context of socio-economic vulnerability to climate change impacts. Section 3 presents a brief overview of climate change dynamics and expected impacts in the regional development context of Southern Africa. Section 4 provides a concise summary of the specific contributions to this special issue, and Section 5 concludes with a brief discussion of key insights and further research needs.<sup>3</sup>

## 2. Concepts

### 2.1. Boundaries for development

Efforts to understand climate change and its impacts and to design and implement adequate adaptation strategies and programmes will inevitably face difficulties related to different dimensions of the coupled socio-ecological system that is our planet Earth. One of the most evident dimensions is the mismatch that often exists between territorial boundaries (e.g. at district or national level) and ecosystem boundaries (e.g. of a river basin). Further mismatches exist considering the delineation of competencies and responsibilities among different stakeholders, notably between ministries within a national government or even between departments of a given ministry. Similar mismatches prevail at all levels. Sound environmental management is thus hindered by inadequate spatial as well as administrative

boundaries, unless there are institutions that warrant effective coordination and cooperation.<sup>4</sup>

The deeper mismatch, however, is between the global economic use of ecosystem services and their capacity to reproduce themselves. Johan Rockström of the Stockholm Resilience Centre, together with a host of colleagues from the world's leading research centres on global environmental change, recently published an article in *Nature* on 'planetary boundaries'. The article demonstrated that there are nine distinct socio-ecological areas where planetary boundaries are being trespassed or where humankind is close to doing so (Rockström et al., 2009). Based on this rationale, boundaries are defined as 'the safe operating space for humanity with respect to the Earth System and are associated with the planet's biophysical subsystems or processes' (Rockström et al., 2009, p. 472).

Anthropogenic climate change – resulting from an intolerable accumulation of greenhouse gas emissions in the Earth's atmosphere – is but the best known example of these planetary boundaries. Yet, others are equally critical to the prospects of human civilization and development. They include the loss of biodiversity (more than 100 species per million species are becoming extinct per year, while the proposed threshold is 10), the nitrogen cycle (more than 121 million tons of nitrogen are taken out of the atmosphere every year for human use, while the proposed threshold is 35), global freshwater consumption (humankind already consumes more than half of what seems sustainable) and land-use changes (11.7% of global land cover has already been converted to cropland while agricultural demand is rapidly growing in view of a proposed maximum of 15%).

Transgression of these boundaries is linked to unsustainable patterns of modernization and economic growth over the last decades: 'largely because of a rapidly growing reliance on fossil fuels and industrialized forms of agriculture, human activities have reached a level that could damage the systems that keep Earth in the desirable Holocene state. The result could be irreversible and, in some cases, abrupt environmental

change, leading to a state less conducive to human development' (Rockström et al., 2009, p. 472). The underlying processes and the resulting dangers of irreversible environmental change unveil the fundamental crisis of the production and consumption patterns that dominate the global economy, and that persist as blueprint development strategies around the world.

Consequently, Rockström and colleagues urge collective global action in order to establish global caps for the use of these vital planetary systems (Rockström et al., 2009). On national and local levels, these ecological caps will need to translate into actual limits for socio-economic activity. Large disparities in social welfare, economic wealth and political power, however, call for this request to be qualified. Southern Africa as a region, and its countries, are especially marked by these disparities and overcoming them is at the top of the region's political agenda. Human development is low across the region and compounded by the highest coefficients of income generation in the world, a striking indicator of high poverty rates (UNDP, 2009). Still, in view of the non-negotiable ecological boundaries to development it seems paramount that societies as well as political, economic and scientific decision makers reconsider their entrenched notions of development or prosperity (e.g. Jackson, 2009). Otherwise, climate change will continue beyond the limits that allow for human adaptation or seemingly effective adaptation processes run the risk of being set off by other dynamics of global environmental change.

## **2.2. Vulnerability and adaptation**

By any means, the vulnerability of Southern African societies and ecosystems is extraordinary. The IPCC defines vulnerability to the impacts of climate change as 'the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate

of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity' (Baede et al., 2008, p. 89). Many social scientists, however, prefer a qualified definition that accounts for the social conditions that generate vulnerability and thereby reaches beyond the immediate impacts of climate change (e.g. Levina and Tirpak, 2006; O'Brien et al., 2007; Horstmann, 2008).

Vulnerability is thus understood as the result of the interactions between socio-economic conditions (e.g. poverty, income distribution, infrastructure) and their institutional context (e.g. quality of governance, rule of law, decentralization). Vulnerability is considerably influenced by poverty, particularly in developing countries, because the poor are typically more dependent on the direct use of natural resources and have less buffer capacity to cope with economic damage caused by natural disasters or incremental degradation.

From this perspective, adapting to climate change is primarily a responsibility of public authorities, at both national and international levels. Anticipatory measures for controlling risk and dangers require collective action and public expenditure in key areas such as adequate infrastructure and early warning systems, research technology development and deployment, information and advice for risk groups, and changes to decision-making procedures in the public realm.<sup>5</sup>

Take, for example, the risk of climatically induced natural disasters. In developed countries, local authorities, district administrations and the private sector typically organize capacity to facilitate planned as well as autonomous adaptation. In many developing countries, the weakness of both public and private institutions is particularly pronounced when they are confronted with future risks and dangers under conditions of increased uncertainty. They will therefore require strong support from those countries that have not only the capacity, resources and skills, but whose fossil-driven industrial development also bears the historic responsibility for the bulk of anthropogenic climate change.

The socio-economic dimension of vulnerability also relates to the adaptive capacity of the society in question. The IPCC defines adaptation as 'initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects' (Baede et al., 2008, p. 86). These initiatives and measures can take various forms: anticipatory and reactive, private and public, and autonomous and planned. Adaptive capacity, in turn, is defined as 'the whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures' (Baede et al., 2008). Most commonly cited examples for such measures include the raising of dikes and the introduction of drought-resistant crops.

With regard to adaptation in sub-Saharan Africa, there is a strong rationale for international assistance that builds on normative as well as practical reasoning (see also Collier et al., 2008). Normatively, the 'polluter pays principle'<sup>6</sup> suggests that the costs inflicted on Africa by anthropogenic climate change should be borne by those who have caused it (i.e. predominantly industrialized states). However, in practical terms many African states simply lack the adaptive capacity to cope with the challenges imposed by climate change in addition to their usual plight.

Consequently, the principle that large-scale external support is required for least developed countries to adapt to climate change has from the outset been part of the United Nations Framework Convention of Climate Change, and has since been repeatedly reaffirmed.<sup>7</sup> At the convention's 2006 conference of the parties, the Nairobi Work Programme specified that developing countries need assistance to improve their understanding and assessment of impacts, vulnerability and adaptation, and to make informed decisions on practical adaptation actions and measures to respond to both climate change and climate variability. At the 2007 conference of the parties in Bali, enhanced action on adaptation was reiterated as a major building block of a prospective post-2012 climate regime. This set the agenda for adaptation to be a central pillar of

international negotiations in the run-up to the Copenhagen conference of the parties.

As the next section elaborates, the indigence of Southern Africa can be established both on the grounds of an impact-centred understanding of vulnerability and on the grounds of a socio-economic approach to vulnerability. Not only will the region be severely affected by the impacts of global warming, but it is also plagued by low levels of human development with high poverty rates and little adaptive capacity.

### 3. Climate and development concerns in Southern Africa

Future sustainable development is contingent on the capacity to adapt to the impacts of climate change. Scientific research clearly shows that anthropogenic climate change is no longer avoidable (IPCC, 2008). The latest research even suggests that, remaining uncertainties notwithstanding, it appears to be occurring at a faster rate than hitherto assumed (Levin and Tirpak, 2009; WBGU, 2009). In other words, the climatically defined boundaries to development are determined by the limits to adaptation.<sup>8</sup>

As outlined above, warming in Africa occurs faster than the global average, while its greenhouse gas emissions represent only a minuscule fraction of the global total. Moreover, climate models and scenarios indicate that the impacts of regional warming across sub-Saharan Africa will be most severe in the Western Sahel and in Southern Africa, which will become both hotter and drier.<sup>9</sup>

Meaningful efforts to promote sustainable development in sub-Saharan Africa in general and in Southern Africa in particular will need to account for the probable impacts of global climate change. Its regional consequences are already observable and exacerbate the trends of desertification and biodiversity loss that are by themselves diluting vital ecosystem services and thereby adverse to sustainable human development (MA, 2005a, b; GTZ, 2009). It is foreseeable that Southern African states and societies will be

severely affected by climate change, even if global warming is successfully mitigated and stabilized at a global average of 2°C.

In general terms, this implies greater competition for scarce land and water resources, more humanitarian emergencies resulting from food insecurity, natural disasters and local conflicts, and frequently recurring extreme weather events, notably prolonged droughts and sudden flooding (see also Swatuk, 2007; WBGU, 2008). Against this background, opportunities to attract economic investment and improve production in the crucial agricultural sector are also likely to diminish.

More specifically, a global warming of 2°C is expected to lead to an increased risk of crop failure and subsequent malnutrition and hunger, particularly among rural subsistence farmers. Notwithstanding rapid urbanization (particularly in the Republic of South Africa), roughly half of the Southern African population continues to live in rural areas, many as small-scale farmers.<sup>10</sup> These are typically the most vulnerable to adverse climatic impacts on agricultural production (Boko et al., 2007). Even as food production systems vary considerably across the region, food security typically depends on local food production that is predominantly rain-fed and subsistence-based (see also WRI, 2005; Toulmin, 2009). The IPCC estimates that yields may decrease by up to 50% in rain-fed agriculture (Parry et al., 2007).<sup>11</sup>

By mid-century the length of the Southern Africa growing season may shorten by more than 20% (Thornton et al., 2006). Only a few high-lying regions in Lesotho, Zimbabwe and Mozambique can actually hope to benefit from prolonged growing seasons. Lesotho, for instance, may expect increasing yields of maize crops at altitudes that have so far been too cold (Lynas, 2007, p. 98). Overall, however, conditions for regional grain production seem bound to deteriorate. Maize and sorghum yields in Botswana could decrease by roughly one third as a result of declining rainfall in an already dry environment (Chipanshi et al., 2003; Hoerling et al., 2006). In Namibia, too, most climate

impacts will adversely affect the agricultural sector, even as rainfall conditions may improve over some areas (GTZ, 2009, p. 73). In effect, projected climatic trends will force much of rural agriculture out of production and make 'maize production in many parts of Zimbabwe and South Africa very difficult if not impossible' (Collier et al., 2008, p. 341). Indeed, if global warming were to rise to 3°C, drought is expected to turn into a perennial feature for much of Southern Africa (Lynas, 2007, p. 110). Ultimately, perennial drought would render concerns of spatial and temporal distribution of precipitation all but obsolete. The Kalahari Desert, large parts of which are actually savannah, would turn into a hyper-arid desert, 'complete with raging sandstorms and rapidly diminishing vegetation' (Lynas, 2007, p. 112).

This said, the climate scenarios behind such projections mostly depend on uncertain assumptions regarding future precipitation patterns, which are notoriously difficult to model.<sup>12</sup> However, the causal link between a warming Indian Ocean and a Southern African drought is by now sufficiently understood to support the assumption that the region will indeed become drier during the 21st century (Hoerling et al., 2006, p. 4002; see also Müller, 2009).

Obviously, this will also compound water scarcity in the region. This will in turn further inhibit efforts to ensure sustainable access to safe drinking water for the poor. This is already a huge challenge, given the over exploitation of existing freshwater resources and widespread institutional failure to govern equitable water management, especially in Southern Africa's dryland regions. For instance, even under current climate conditions Namibia's water-carrying capacity will be exceeded within the next ten years, as increasing demand – driven by population growth, increased irrigation and unsustainable economic development (especially mining) – rapidly surpasses local abstraction capacity (GTZ, 2009, p. 64). Projections of future climate change on water availability are marked by considerable uncertainty, but plausible assumptions can be made on, *inter alia*, deteriorating wetland

ecosystem services, increased evaporation and decreased run-off and drainage in perennial rivers. Such assumptions suggest that regional climate impacts will further exacerbate water stress throughout the region (GTZ, 2009; see also Pietersen and Beekman, 2006, pp. 144–145). In fact, uncertainty about the future flows of the region's major rivers – particularly the Okavango, the Orange, the Limpopo and the Zambezi – poses a formidable challenge in its own right, as 'even a uniform decrease in rainfall will hit the river flows disproportionately hard' (Collier et al., 2008, p. 339; see also de Wit and Stankiewicz, 2006).

Although climate change will place additional stresses on Southern African freshwater resources, some authors argue that there is considerable adaptive potential in, for example, water management reform, improved land-use regulation and better water storage, including from rainwater harvesting (e.g. Boko et al., 2007; Scheumann et al., 2008; Toulmin, 2009). Several contributions to this special issue testify to the particular relevance of this thriving segment of adaptation research (see below).

Not least, sea-level rise will affect Southern Africa's coastal states. This will not only affect fast-growing conurbations such as Maputo, Luanda or Cape Town, but also increase the exposure of coastal and riparian villages to recurring storm and flood disasters. Subsequent salination of groundwater and riverine systems will further compound freshwater scarcity and land degradation. Moreover, coastal erosion, loss of beaches and a climate-induced dieback of coral reefs are bound to adversely affect the further development of tourism, a promising sector for income generation, for instance in Mozambique and Madagascar (e.g. Arthurton and Korateng, 2006).

Focusing especially on the Zambesi river basin, the subject of adaptation to flood disasters is further discussed in Ifejika Speranza's contribution to this issue. While a comparison of the Mozambique flood events of the years 2000 and 2006 is encouraging in terms of the difference that adaptive prevention measures can make to

curb flood impacts, they are also a harbinger of what the region might expect, as storm events become more frequent and more intense linked to a warming Indian Ocean (see also WBGU, 2006; Toulmin, 2009, pp. 35–39). Much for the worse, this overview of regional climate impacts is by no means comprehensive.

In short, Southern Africa will be facing a steep uphill struggle in combining development aspirations with the imperative to adapt to climate change. Due to the combination of the region's particular geographical exposure with low levels of human development, high dependence on agriculture, weak institutions and exceptional levels of inequality, the peoples of Southern Africa are extremely vulnerable to the effects of climate change. Sustainable development will thus crucially depend on the timely development and implementation of comprehensive adaptation measures. For these to become effective, adaptation policies must not be annexed to conventional economic growth programmes, but will have to be part and parcel of modified development strategies that prioritize efficient use of resources, equitable distribution and improved governance structures over 'business as usual'.

#### 4. Contents

How do the overarching concerns outlined above match with empirical realities in Southern Africa? The contributions in this special issue shed light on different thematic and subregional aspects of this broad question.

Advancing from a review of analytical discourse regarding different 'framings' of adaptation and vulnerability, *Alexander Bisaro, Sarah Wolf and Jochen Hinkel* assess the influence of climate change discourse at international and national levels on actual adaptation responses at the local level. Their analysis of several wetlands and climate-related development projects in Lesotho concludes that there is indeed a significant influence emanating from higher governance levels. Moreover, they suggest that variation in observed influences depends on whether policies

responded to a more technocratic ('decision-analytic') or a more participatory ('institutional-analytic') framing of adaptation.

In their article on Malawi, *Lindsay Stringer, David Mkwambisi, Andrew Dougill and Jen Dyer* are also concerned with interlinkages between national-level policy processes and adaptation at local household levels. In doing so, they demonstrate how the dual challenge of adapting to climate change and desertification fails to further a comprehensive approach to national development in spite of strong connections between both agendas. Moreover, they find that Malawi's policies neglect the significance of rural–urban dynamics and conclude that accommodating the interlinkages between rural and urban areas will be key for facilitating effective adaptation at the household level.

*Chinwe Ifejika Speranza*, in her review article, examines the challenges that flood disasters in the Zambezi River Basin pose for adjacent countries Mozambique, Malawi, Zambia and Zimbabwe, as well as for international humanitarian agencies. She discusses how development policies, disaster risk reduction and humanitarian interventions may reduce vulnerability to flood events and thereby facilitate adaptation to regional climate impacts. The review shows how an incremental normalization of states of emergency may hinder long-term development strategies. It also highlights the potential of low-cost policy options that are not fully explored so far. Speranza also urges further empirical research on the local realities of humanitarian interventions in flood-prone developing countries.

Turning from the context of the region's least developed countries to its regional powerhouse, three contributions focus on the Republic of South Africa's capacity to adapt its water management to the challenges of climate change at a time when its freshwater resources are already under stress. Applying a broad institutional analysis framework, *Elke Herrfahrdt-Pähle* examines current water sector reforms. She discerns administrative and hydrological boundaries and identifies a couple of trade-offs that are inherent to the corresponding transformation of water

governance. *Sabine Stuart-Hill and Roland Schulze* in turn apply a domestic policy perspective to assess whether legislative framework conditions provide the flexibility that appears necessary to adapt South Africa's water management to the challenges implied by future climate change. Finally, *Gina Ziervogel, Moliehi Shale and Minlei Du* offer another angle by focusing on the urban level. As they scrutinize the particular challenge of adaptation in the urban water supply of Cape Town, they argue how general development challenges pertaining to water supply might benefit from forward-looking adaptation approaches to urban water management. All three case studies stress the importance of adequate institutions to deal with present and future challenges of water management and the necessity for efficient communication and coordination between institutions and across institutional levels. Each provides original insights on how South Africa might eventually brace its water sector for a drier future with increasing demands.

The special issue concludes with *Romy Chevalier's* scrutiny of the responsibilities of decision-makers in both developed countries and Southern Africa. Her article forcefully argues that the integration of climate change adaptation into socio-economic development strategies is not pursued with adequate urgency either by the international community or by Southern African states and societies. She proposes that Southern African leaders learn from and capitalize on the opportunities provided via policy initiatives such as the European Union's Green Paper on Adaptation, while emphasizing the need for industrialized countries to live up to mitigation imperatives. She highlights the costs of inaction and makes a strong case for inter-African cooperation and leadership to push a pro-poor adaptation agenda at local, national and regional levels.

## 5. Conclusion

This special issue of *Climate and Development* seeks to contribute to a better understanding of

adaptation to global warming on a regional scale. On the one hand, it aims to identify the socio-economic and political boundaries to sustainable human development in Southern Africa, which may be determined to a considerable extent by ongoing climate change and corresponding socio-ecological limits. On the other hand, it explores the region's potential for a transition to development strategies that combine meaningful socio-economic investment and promising adaptation measures: a sustainable transition that improves livelihoods and reduces vulnerability.

At this point, the picture of adaptation to climate change and the subsequent prospects for sustainable human development in Southern Africa necessarily remains patchy. Yet, the contributions to this special issue provide us with a number of valuable clues for further research and even policy advice.

An overarching concern is the need to build adaptive capacities and effective institutions at all sectors and levels as well as to brace existing institutions for the unprecedented challenges ahead. Moreover, we know that adaptation is hindered by the prevailing uncertainty over specific future impacts of climate change across Southern Africa. In particular, it remains impossible to make unambiguous predictions about subregional precipitation patterns. The magnitude as well as temporal and spatial distribution of rain, of course, is central to future developments in agricultural production, ecosystem services and water availability. Yet, the research presented in this special issue is not reduced to reading the proverbial tea leaves: climatic conditions will not remain the way they are today.

It seems therefore advisable to focus on 'no-regret' policies when pursuing sustainable human development under changing climatic conditions. In Southern Africa this implies at least two ways forward: reducing the immediate dependency of production systems on environmental conditions, and diversifying livelihood strategies and income sources at the household level. Measures to achieve these objectives promise to be beneficial for human development in any case, thereby strengthening the adaptive capacity of the

population as a whole. Some examples, in particular with a view to rural development in dryland environments, include the following:

- rainwater harvesting and construction of water storage and irrigation systems to reduce rainfall dependency and to secure water access over longer time periods;
- diversification of crop production (e.g. food and cash crops, annual and permanent crops) and the use of off-farm income sources (e.g. wildlife tourism); and
- micro-insurance schemes for extreme weather events to help poor households cope with droughts and floods.

In short, reducing people's vulnerability across Southern Africa should be an end in itself. It does not require precise climate forecasts. As climatic crisis looms ever more ominously over the region, one thing seems certain: it will require both iron will and unprecedented skills on behalf of states and societies to turn the misfortune of global warming into a triumph for sustainable development in all of Southern Africa.

## Notes

1. In this special issue the region of Southern Africa is considered as the geographical area to the south of the Democratic Republic of Congo and Tanzania (not including the adjacent small island developing states of Comoros, Seychelles and Mauritius). Thus defined, the Southern African region comprises Angola, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. It is home to some 154 million people, close to a third of which live in the Republic of South Africa. All 11 countries rank within the bottom 50 of the UNDP's Human Development Index (see UNDP, 2009, pp. 171–175).
2. For an argument in favour of 'adaptation now' see also Adger et al. (2009b). We fully subscribe to their notion that 'adaptation is not a simple and straightforward substitute for action to prevent climate change in the first place' (Adger et al., 2009b, p. 4).
3. The idea for this special issue and its conceptual focus goes back to a panel organized by the guest editors for the joint conference 'Frontiers and Passages' of the German African Studies Society (VAD) and the Swiss Society for African Studies (SGAS). The event took place in Freiburg im Breisgau in May 2008. We thank the panellists and authors for their contributions to this special issue. Moreover, we are grateful to Richard Klein, Lisa Schipper and Tom Gill for their guidance and support in the making of this special issue.
4. For a broader discussion of institutional 'fit' and interplay in the context of environmental change, see relevant contributions in the synthesis volume of the International Human Dimensions Programme on Global Environmental Change (Young et al., 2008).
5. For a discussion emphasizing the relevance of private actors to adaptation in Africa see Collier et al. (2008).
6. In international legal terms the so-called 'polluter pays principle' is defined as Internationalization of Environmental Costs in principle 16 of the Rio Declaration (UNCED, 1992). While its legal status remains contested, it serves as an important point of reference in international climate negotiations, especially with a view to burden-sharing.
7. Notably, under article 4.1 of the Convention, all parties agreed to include adaptation to climate change in domestic strategic planning and to cooperate in preparing to adapt to the impacts of climate change, particularly in Africa. Under article 4.4 developed country parties have committed to assist developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects (UNFCCC, 1992).
8. For an extensive discussion of the limits to adaptation see Adger et al. (2009a).
9. As a rule of thumb, dry subtropical regions – such as Southern Africa – will warm more than humid tropics. For an overview of relevant models and scenarios, see Müller (2009).
10. On urbanization trends in Africa see UN-HABITAT (2008); see also Toulmin (2009, pp. 87–108) for a discussion in the context of global warming.
11. But see also the recent models and scenarios provided by the International Food Policy Research Institute (Nelson et al., 2009) and the World Bank (Padgham, 2009).

12. The uncertainty of climate models and projections for Southern Africa is compounded by the coarse meteorological data on this region: there are hardly any complete historic data series, there are only few meteorological observation stations, and research on extreme weather events is limited (see also Müller, 2009).

## References

- Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J. and Wreford, A., 2009a. Are there social limits to adaptation to climate change? *Climatic Change*, 93(3–4). 335–354.
- Adger, W. N., Lorenzoni, I. and O'Brien, K. L., 2009b. Adaptation now. *Adapting to Climate Change: Thresholds, Values, Governance*, W. N. Adger, I. Lorenzoni and K. O'Brien (eds). Cambridge University Press, Cambridge, UK. 1–22.
- Arthurton, R. and Korateng, K., 2006. Coastal and marine environments. *Africa Environment Outlook 2: Our Environment, Our Wealth*, AMCEN & UNEP (eds). UNEP, Nairobi. 155–195.
- Baede, A. P. M., van der Linden, P. and Verbruggen, A., 2008. Annex II: Glossary. *Climate Change 2007: Synthesis Report*, Intergovernmental Panel on Climate Change (ed.). IPCC, Geneva.
- Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P., 2007. Africa. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. van der Linden and C. E. Hanson (eds). Cambridge University Press, Cambridge, UK. 433–467.
- Chipanshi, A. C., Chanda, R. and Totolo, O., 2003. Vulnerability assessment of the maize and sorghum crops to climate change in Botswana. *Climatic Change*, 61(3). 339–360.
- Collier, P., 2007. *The Bottom Billion. Why the Poorest Countries are Failing and What Can Be Done About It*. Oxford University Press, Oxford, UK.
- Collier, P., Conway, G. and Venables, T., 2008. Climate change and Africa. *Oxford Review of Economic Policy*, 24(2). 337–353.
- de Wit, M. and Stankiewicz, J., 2006. Changes in surface water supply across Africa with predicted climate change. *Science*, 311(5769). 1917–1921.
- GTZ, 2009. *Running Dry? Climate Change in Drylands and How to Cope With It*. Oekom, München.
- Hoerling, M., Hurrell, J., Eischeid, J. and Phillips, A., 2006. Detection and attribution of twentieth-century Northern and Southern African rainfall change. *Journal of Climate*, 19(16). 3989–4008.
- Horstmann, B., 2008. *Framing Adaption to Climate Change: A Challenge for Building Institutions*. Discussion Paper 23/2008. German Development Institute, Bonn.
- IPCC, 2008. *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel to Climate Change. IPCC, Geneva.
- Jackson, T., 2009. *Prosperity Without Growth. Economics for a Finite Planet*. Earthscan, London.
- Lenton, T. M., Held, H., Kriegler, E., Hall, J. W., Lucht, W., Rahmstorf, S. and Schellnhuber, H. J., 2008. Tipping elements in Earth's climate system. *Proceedings of the National Academy of Sciences*, 105(6). 1786–1793.
- Levin, K. and Tirpak, D., 2009. *Climate Science 2008: Major New Discoveries*. WRI Issue Brief July 2009. World Resources Institute, Washington, DC.
- Levina, E. and Tirpak, D., 2006. *Adaptation to Climate Change: Key Terms*. OECD, Paris.
- Lynas, M., 2007. *Six Degrees. Our Future on a Hotter Planet*. Fourth Estate, London.
- MA – Millennium Ecosystem Assessment, 2005a. *Ecosystems and Human Well-Being: Biodiversity Synthesis*. World Resources Institute, Washington, DC.
- MA – Millennium Ecosystem Assessment, 2005b. *Ecosystems and Human Well-Being: Desertification Synthesis*. World Resources Institute, Washington, DC.
- Müller, C., 2009. *Climate Change Impact on Sub-Saharan Africa: An Overview and Analysis of Scenarios and Models*. Discussion Paper 3/2009. DIE, Bonn.
- Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M. and Lee, D., 2009. *Climate Change: Impacts on Agriculture and Costs of Adaptation*. IFPRI, Washington, DC.
- O'Brien, K., Eriksen, S., Nygaard, L. P. and Schjolden, A., 2007. Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, 7(1). 73–88.
- Padgham, J., 2009. *Agricultural Development Under a Changing Climate: Opportunities and Challenges for Adaptation*. World Bank, Washington, DC.
- Parry, M., 2009. Climate change is a development issue, and only sustainable development can confront the challenge. *Climate and Development*, 1(1). 5–9.
- Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. and Hanson, C. E. (eds), 2007. *Climate*

- Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, UK.
- Pietersen, K. and Beekman, H., 2006. Freshwater. *Africa Environment Outlook 2: Our Environment, Our Wealth*, AMCEN & UNEP (eds). UNEP, Nairobi. 119–154.
- Rockström, J., Steffen, W., Noone, K. and 26 others, 2009, 24 September. A safe operating space for humanity. *Nature*, 461. 472–475.
- Rogelj, J., Hare, B., Nabel, J., Macey, K., Schaeffer, M., Markmann, K. and Meinshausen, M., 2009. Halfway to Copenhagen, no way to 2°C. *Nature Reports Climate Change Online*, www.nature.com/climate/2009/0907/full/climate.2009.2057.html. (last accessed 27 July 2009).
- Scheumann, W., Neubert, S. and Kipping, M. (eds), 2008. *Water Politics and Development Cooperation: Local Power Plays and Global Governance*. Springer, Berlin.
- Swatuk, L. A., 2007. *Southern Africa, Environmental Change and Regional Security: An assessment. Externe Expertise für das WBGU-Hauptgutachten 'Welt im Wandel: Sicherheitsrisiko Klimawandel'*. WBGU, Berlin.
- Thornton, P. K., Jones, P. G., Owiyo, T. M., Kruska, R. L., Herero, M., Kristjanson, P., Notenbaert, A. and Bekele, N., 2006. *Mapping Climate Vulnerability and Poverty in Africa. Report to the Department for International Development*. ILRI, Nairobi.
- Toulmin, C., 2009. *Climate Change in Africa*. Zed Books, London.
- UN-HABITAT, 2008. *The State of African Cities*. UN-HABITAT, Nairobi.
- UNCED, 1992. *Rio Declaration on Environment and Development*. Report of the United Nations Conference on Environment and Development, Annex I, 12 August. Doc. UN A/CONF.151/26 (vol.1) (available at www.unep.org/Documents/Default.asp?DocumentID=78, last accessed 28 April 2004). United Nations, New York.
- UNDP, 2009. *Overcoming Barriers: Human Mobility and Development*. Human Development Report 2009. Palgrave Macmillan, New York.
- UNFCCC, 1992. *United Nations Framework Convention on Climate Change*. UN Doc. FCCC/INFORMAL/84. United Nations, Bonn.
- United Nations Foundation, 2007. *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable*. United Nations Foundation, Washington, DC.
- WBGU – German Advisory Council on Global Change, 2006. *The Future Oceans: Warming Up, Rising High, Turning Sour*. WBGU, Berlin.
- WBGU – German Advisory Council on Global Change, 2008. *Climate Change as a Security Risk*. Earthscan, London.
- WBGU – German Advisory Council on Global Change, 2009. *Solving the Climate Dilemma: The Budget Approach. Special Report*. WBGU, Berlin.
- WRI – World Resources Institute, 2005. *World Resources 2005: The Wealth of the Poor – Managing Ecosystems to Fight Poverty*. WRI, Washington, DC.
- Young, O. R., King, L. A. and Schroeder, H. (eds), 2008. *Institutions and Environmental Change. Principal Findings, Applications, and Research Frontiers*. MIT Press, Cambridge, MA.