# CHAPTER 4
# ENVIRONMENTAL TRANSITIONS: MULTIPLE STRESSORS – MINIMAL SOLUTIONS?

Coleen Vogel

## Environmental transition – the global context

Several Southern African countries may be described as either going through, or emerging from, periods of transition. These transitions are the product of a number of factors including weak governance, civil strife and conflict, weakening economies, HIV/AIDS, and biophysical stress including droughts, floods, and degradation of natural resources. There are effectively two broad dimensions that underpin the transitions that are being experienced and may face Southern Africa in the future: a biophysical dimension driven at global and more local scales and the second, a socio-economic transition that is entwined with the biophysical aspects in very complex ways. Improving our understanding of these transitions and their implications is critical for both the functioning of the earth system and its inhabitants.

Cumulative evidence gleaned over the past few decades indicates that several planetary environmental changes are occurring.[1] These changes in turn can act as feedbacks that combine to drive the complex functioning of the earth as a system. With increased population, changes in governance, macro-economic changes and biophysical changes (to highlight a few) a number of impacts have occurred including: nearly half of the land surface has been transformed by direct human action, with significant environmental consequences, more than one-fifth of land ecosystems have been converted into permanent croplands and more than a quarter of the world's forest is estimated to have been cleared.[2] Our activities, global environmental change scientists argue, have thus begun significantly to alter the planet and how it functions.[3]

One of the most fundamental biophysical cycles of the planet, the carbon cycle, is linked to steady increases in atmospheric carbon dioxide measured at various sites. This increase in carbon dioxide has resulted in growing concern about the 'heat balance' of the global atmosphere.[4] Shifting or altering the heat balance "will force the global climate system in ways which are not well understood, given the complex interactions and feedbacks involved, but there is general consensus that global patterns of temperature and

precipitation will change, though the magnitude, distribution and timing of these changes are far from certain".[5]

From a global perspective these changes have caused many global environmental change scientists to conclude that we are currently living in a time that may be characterised by several 'transitions', several of which may be abrupt. Rates of change over the past few hundred years have been marked by rapid change. In 2001, several thousand scientists, comprising an expert panel (Intergovernmental Panel on Climate Change), indicated that globally average surface air temperatures would rise between 1.4 and 5.8 °C by 2100 relative to 1990.[6] The last half of the twentieth century experienced warming at various scales (hemispheric and other) unprecedented in the last millennium, with 1998 being noted as one of the warmest years for the past 1000 years.[7] These conditions have been identified as being part of a trend to warmer global temperatures.

A number of impacts may result from these changes in a transition to a warmer world including possible changes in vegetation, surface water, and rangeland condition. Not all of these impacts, however, will be negative and trying to identify the 'winners' and 'losers' in this changing environment at various scales is currently absorbing much scientific energy.[8]

Despite widespread debates around possible outcomes associated with global environmental change, there is a growing body of literature that indicates the earth system is 'fragile'. The notion that there is a single stable equilibrium characterising the natural state of Earth's environment is not supported by observations of past global changes. "The behaviour of the Earth System is typified not by stable equilibria, but by strong nonlineraities, where relatively small changes in a forcing function can push a system across a threshold and lead to abrupt changes in key system functions".[9] Research by world-leading scientists on global environmental change has "clearly shown that the Earth System has moved well outside the range of natural variability exhibited over the last half million years at least. The nature of changes now occurring simultaneously in the global environment, their magnitudes and rates, are unprecedented in human history …the Earth is now operating in a no-analogue state".[10] Such a state may result in various changes, transitions (possibly abrupt) bringing with them several surprises. What may such a global outlook mean for Southern Africa?

## Environmental transitions in Africa, including Southern Africa

Making predictions and trying to understand the cascading impacts that may be experienced at global and sub-global scales is clearly not simple.[11] In the IPCC assessment Africa is identified as being highly vulnerable to climate change. Water, for example, is a resource that is critically vulnerable to changes in both physical and socio-economic systems. Trends in regional per capita water availability for Africa over the past century show that water availability has diminished by 75 percent and that reductions in river flows have occurred in Sub-Saharan West Africa, mainly driven by increases in population.

What of the future? How can we get some glimpse of possible outcomes of an Earth system moving through transition? Global circulation models (GCMs) are examples of some 'tools' used to try and provide future scenarios of change that may accompany a 'warmer world'. These models have, and are, being used also to drive more applied environmental scenarios including agricultural assessments, water scenarios and vegetation assessments (e.g. US Country Studies Reports, essentially country studies for most countries in the region see www.gcrio.org/csp/Africa for reports relating to Malawi, Botswana, Zimbabwe and other areas). Although somewhat dated, they still give an indication of possible changes.

Some models, for example, show a general decrease in rainfall in several parts of Southern Africa, particularly in the south (South Africa). Others show a possible annual rainfall increase for Kenya, with smaller increases (up to 30 percent) over most of Tanzania, Uganda and north-eastern Zambia and very slight increases over smaller areas of western Zimbabwe, Botswana and Namibia.[12] This is in contrast to decreases in annual rainfall south of Tanzania.

**Table 1: Examples of possible indications of climate change derived from various models and sources[13] for the region and particularly for South Africa. [14]**

- The increase in temperature will be dependent on latitude.
- The increase in temperature will be greater in the winter rainfall area than in the summer rainfall area.
- The role of the escarpment is important in shaping expected rainfall and other dynamics of the climate system
- Rainfall (greater uncertainty surrounds estimates of future rainfall under a doubled carbon dioxide scenario, than estimates of temperature).
- Overall fewer rain-days are expected, rainfall intensity will increase (implying greater runoff).
- Increases in rainfall likely in summer rainfall, with more intense events
- More convective activity in winter rainfall areas.
- The seasonality of rainfall is unlikely to change and mean annual totals should only vary slightly.
- Rainfall is likely to increase slightly in the tropics (by <10 percent) and decrease somewhat in the east-central interior by about (10–20 percent).[15]
- For drought periods the model indicates increasing probabilities of dry spells or dry years in the tropics, to the south-west of the subcontinent and especially over western South Africa and over eastern Southern Africa including Mozambique.[16]
- Finally, Hulme analysing three regions of Africa suggests a wetting in East Africa, drying in southeast Africa and a poorly specified outcome for the Sahel.[17]

Coupled to these alterations in rainfall are a number of changes that may be induced in the hydrological regime. Decreases in annual runoff over much of South Africa, and over eastern Zimbabwe and most of Mozambique are indicated when using some models. Enhanced runoff, for example, may be anticipated over northern Zambia and Mozambique as well as over eastern Tanzania, with the most significant increases predicted for Kenya.[18]

Overlaid onto these scenarios of climate and related hydrological change is the view that these changes may also be exacerbated by 'shock' events such as drought and floods. Indications from several assessments, for example, show that the Southern African region may experience more extreme rainfall and drought periods. Additional assessments, undertaken by the International Institute for Applied Systems Analysis (IIASA), show that Africa and parts of

Southern Africa in particular may register negative impacts on cereal production.[19]

Having provided some indications of possible biophysical changes, one must always remember, however, that these are indications of change that have been obtained from a number of models, using different assumed emission scenarios, and therefore results can differ. Changes, for example, related to rainfall are difficult to quantify exactly and predicted changes in variability with warming are less certain.[20] Despite these limitations the available science thus far indicates that changes may occur and that this may, in some cases, aggravate current stresses on agricultural, fresh-water, land and human resources.

Residents in the region, particularly the poor, are usually those most exposed and negatively affected by periods of transition including 'vagaries' in the weather. At a macro level such periods of stress unleash a variety of 'knock-on' impacts that severely curtail livelihoods. The droughts of the early 1980s and 1990s, for example, seriously impacted the Southern African region, reducing cereal production and water supplies with resultant impacts on GDP and the loss of farm workers' jobs and the reduction of overall livelihoods.

## The human 'face' of transition in Africa and Southern Africa

Throughout much of the present decade (and while writing this paper) a food emergency 'crises' has gripped several countries in the SADC region. This emergency situation, however, is not solely due to drought. Rather climate stress events have arguably 'exposed' underlying chronic vulnerabilities in the region. Drinkwater[21] in a presentation on vulnerability in the light of an HIV/AIDS Pandemic bravely stated:

> At the onset of the emergency response to the crisis, I was struck by one comment made at a regional VAC meeting in June 2002, that defined the role of assessments as determining the deviation of food security from the 'normal'. This has been a constant refrain during the course of the 'emergency' interventions of the last year. Yet, having worked in Southern Africa for the past quarter century, and researched records of climate and peasant livelihoods over the century before that, one fact that is clear is that there is no such thing as a normal season, and no such phenomenon as a normal food security status.[22] (Emphasis added.)

In a similar voice, but with reference to a rather harsh account of governance in Africa[23] Glantz underscores the need for holistic assessments of transitions in Africa:

> I recently looked through a book on Africa[24] in which the author discussed various complex humanitarian crises in Zaire (Congo), Rwanda, Burundi, Liberia, and Angola. In each CHC (complex humanitarian crisis) there are food shortages, population movement, large numbers of refugees, ethnic conflict, brutality, death and destruction. Millions have died from causes, including climate-related problems but for the most part untimely deaths were due to other political, socioeconomic, and military factors.[25]

Mapping and trying to understand the combined (both biophysical and socioeconomic) impacts wrought by complex transitions requires that one understand the array of socioeconomic factors shaping vulnerability to such 'transitions' in Southern Africa. These include macro-economic alterations that are contributing to change (globalisation and structural adjustment), HIV/AIDS, civil conflict and poor governance. There are also a host of transitions that have occurred in the past that have resulted in differential allocations of ecological services, political rights, and access to resources that still have an impact on the region today. This paper cannot do justice to all these dimensions for they are varied and complex (several dimensions such as conflict however, are dealt with by others in this volume). Nonetheless one dimension, health, is briefly highlighted here.

HIV/AIDS and associated impacts are beginning to be increasingly visible in Africa, (although some would argue prediction is limited by accuracy and controversy around data). Estimates, at the time of writing, show that the Southern African region is one of the worst hit by the epidemic.[26] In South Africa, for example, HIV/AIDS prevalence is high with increasing workloads in the health sector. TB cases associated with HIV/AIDS continue to increase (estimated burden of disease for TB 90 747 in 1998 – 108 826 in 2001).[27]

Although difficult to project accurately, a number of impacts coupled to HIV/AIDS for Africa have been documented.[28] Using the farm-household system approach, Du Guerny, for example, traces the impacts on both the household and the farm system of HIV/AIDS, some of which include:

- Reduction in area of land under cultivation
- Declining yields

- Decline in crop variety and changes in cropping patterns
- Decline in livestock production
- Loss of agricultural skills
- Impact on food security
- Heightened vulnerability

The impact and tragedy of HIV/AIDS related deaths are borne, however, not only by the immediate families, but also have other knock-on effects: at a national level, through impacts on GDP in agriculture, for example, and at a local level by severely disrupting the functioning and daily lives of many including women and children. Impacts associated with AIDS include: reductions in labour time (funerals); loss of livestock management skills; decreased management of livestock resources; crop failures including fodder reductions for livestock; decreased livestock products; loss or transfer of livestock (and in cases of small stock such as chickens) from families; and associated overall loss of livelihoods.[29] All these impacts further exacerbate precarious livelihoods.

More recently additional, and yet critical, factors have also emerged that require more detailed investigation. The impacts that result from illness and death among urban residents in several areas raise additional issues of rights amongst orphans and women and an examination of society as we currently perceive it: the fraying and unraveling of 'society' through 'deagrarianisation' and depeasantisation of society.[30] Rural labour supply continues to grow, swelled by increased numbers of children and women and yet this is unmatched by diminishing demand as assets decline.[31] Of a cluster of households interviewed in Malawi, for example, 55 percent were dependent on piece labour work for more than four months of the year:

> Those looking for *ganyu* labour work take what opportunities they can, and since these are most commonly at the peak points of the agricultural cycle, their own crops are neglected and the yields shrink further.[32]

The 'transition' being unleashed by HIV/AIDS is clearly not fully understood but arguably several households currently find themselves or may find themselves in heightened periods of uncertainty.

## Interventions – Can we make a difference?

While it is acknowledged that 'something must be done' to manage transitions, with several international declarations documenting required goals (e.g. Millennium Development Goals), there is a realisation that we have to go beyond 'business as usual'. The call for 'better' science that may capture the complex interactions between the biophysical and social sciences is, for example, currently forming the focus of international discussion and action. Some even suggest that the nature of the problems requires 'new and innovative scientific' thinking around managing and adapting to such changes and transitions. A growing body of literature around what has been termed 'a transition to sustainability' and what may required from the scientific and technology community to achieve this is available.[33] A 'sustainability transition' has been described[34] as one in which a stabilising world population meets its needs, reduces hunger and poverty and maintains the planet's life support systems and living resources. Efforts are beginning to identify the types of scientific and political enquiry required, to understand the dynamic processes and relationships that may be required and a number of research areas have been identified. Briefly, suggested themes include better understanding the various user groups involved in such a transition; improved understanding of the governance of various systems required to manage such a transition and those already existing (how are they working, what makes for ineffective governance of complex systems?). Allied to such themes are the probing themes one uses to analyse these problems, including issues of scale, linkages between social and environmental systems and actors; adaptive management and learning - how are we doing, are we learning from the past in terms of how to 'effectively' manage the environment; knowledge – what knowledges are best to begin to address such issues – how does local knowledge fit in and how is this used? Of key interest by those scientists involved in understanding sustainability transitions is the 'framing of the problem – who frames the problem for investigation? "First and foremost, effective R&D systems for promoting sustainability will need to be structured so that they are driven by the most pressing problems of sustainable development as defined by stakeholders in those problems."[35]

## Conclusion

In this paper some of the transitions occurring in Africa and Southern Africa have been described. For some, these transitions are reflections of wider global transitions due to drivers of biophysical and socio-economic change.

Although one cannot say with certainty what the implications of such transitions are, there seems to be enough evidence that some may increase and become more visible in the future. Of concern are the indications that such changes may possibly be greatest in the Southern Africa, compounding problems for a region already undergoing dramatic changes.

Notwithstanding the uncertainty coupled to these outlooks, there is a need, however, to try and better manage risks associated with such transitions and to improve adaptive capacity to changes. Several efforts including those of a number of global environmental change programmes (e.g. IGBP, IHDP, WCRP and DIVERSITAS among others), are bringing scientists together to grapple with issues of transition. The focus of the discussions include debates around improved science, the most appropriate methods to use, best ways to integrate social, biophysical paradigms of enquiry and how to translate scientific knowledge to end-users.

From a Southern African perspective the requirements and calls for discussions around the most effective methods to effectively capture transitions and changes in the region have already begun. Drinkwater[36] for example, argues for a rethink around the most appropriate household unit that will effectively capture transitions coupled to HIV/AIDS and food security. The household unit, he argues, is 'mutating' and is at its most fragmented and fragile state in African history and therefore questions its current use as a means for analysis:

> These questions matter, since it is clear that in this situation, blind interventions, whilst in the short term saving life, can beyond the immediate food shortages of the past two years be hugely inhibiting of the search for the kind of pathways that will facilitate the rebuilding of human lives and dignity.[37]

The call for integrated and improved science is being made but the disconnection between better and more useful science translated into action still remains a pressing concern. How can we best convey the urgency of global environmental change and transition in **all** its forms to various policy makers and other 'stakeholders'? What forms should this communication take? What are the best means and methods of this engagement and whose interests are being served in such interactions? These are issues that will need attention if meaningful interventions are to be made to better manage 'negative' transitions. The central, however, may be more personal:

> As scientific researchers, we have a duty to care about the well-being of the people in the places we study. We are often in the awkward position of having to choose between sticking to science only, or embedding the science in its societal setting or telling the story as it is.[38]

## Endnotes

1 IGBP, International Geosphere-Biosphere Programme *Global change and the Earth system: A planet under pressure*, IGBP Science (4), Stockholm, 2001; W Steffen, J Jager, D Carson, C Bradshaw (eds), *Challenges of a changing Earth*, Proceedings of the Global Open Change Science Conference, Amsterdam, The Netherlands, 10–13 July, 2001, Springer, Berlin, 2002; W Steffen, A Sanderson, J Jager, P D Tyson, B Moore III, P.A. Matson, K Richardson, F Oldfield, H-J Schellbhuber, B L Turner II, R.J. Wasson, *Global change and the Earth system: A planet under pressure*, Springer Verlag, Heidelberg, Germany, 2004.

2 B Moore III, *Challenges of a changing Earth,* in W Steffen, et al, op cit, pp 7–17.

3 Steffen et al, op cit.

4 Moore, op cit.

5 Ibid p. 10.

6 IPCC, *Climate change 2001*: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J McCarthy et al., (eds), Cambridge University Press, Cambridge, 2001; UNEP, United Nations Environment Programme, Global Environment Outlook, 3, UNEP, Earthscan publications, London, 2002

7 M E Mann, R S Bradley, MK Hughes, *Northern Hemisphere temperatures during the past millennium: Inferences, uncertainties and limitations*. Geophy Res Lett (26), 1999, pp 759–762.

8 R M Leichenko, and K L O'Brien, *The dynamics of rural vulnerability to global climate change: The case of Southern Africa,* Mitigation and Adaptation Strategies for Global Change (7), 2002, pp 1–18; W H Adger, S Huq, K Brown, D Conway, and M Hulme, *Adaptation to climate change in the developing world,* Progress in Development Studies, 3, 2003, pp 179–195.

9 IGBP, op cit, p. 10.

10 Steffen, et al., 2002, op cit, p. 30; Steffen et al., 2004.

11 Moore, op cit; J Mitchell, Virtual realities of the past, present and future, (eds), *Challenges of a changing Earth*, Proceedings of the Global Open Change Science

Conference, Amsterdam, The Netherlands, 10–13 July, 2001, Springer, Berlin, pp 145–150.

12 R Schulze, J Meigh, and M Horan, Present and potential future vulnerability of eastern and Southern Africa's hydrology and water resources, South African Journal of Science, (97), 2001, pp 150–160.

13 L Y Shackelton, S J Lennon, and G R Tosen, *Global climate change and South Africa*, Environmental Scientific Association, Cleveland, 1996, p 160; A Joubert and B Hewitson, *Simulating present and future climates over Southern Africa using General Circulation Models,* Progress in Physical Geography (21), 1997, pp 41–78; A Joubert and P Tyson, *Equilibrium and fully coupled GCM simulations of future Southern African climates,* South African Journal of Science, (92), 1996, pp 471–484.

14 For more details see an SCF Report, 2002 by Vogel.

15 Joubert and Tyson, 1996, op cit.

16 Ibid.

17 IPCC, 2001, op cit. p. 494.

18 Schulze, Meigh and Horan, 2001, op cit.

19 IIASA, *Achieving sustainable development, The 21st century imperative*, Options, Vienna, 2002. G Fischer, M Shah, H van Velthuizen, *Climate change models predict huge impacts on global agricultural production patterns*, IIASA., 2002.

20 Mitchell, 2001, op cit.

21 Drinkwater, M., *HIV/AIDS and agrarian change in Southern Africa,* paper presented for the United Nations Regional Inter-Agency Coordination and Support Office Technical Consultation on Vulnerability in the light of an HIV/AIDS Pandemic, 9–11 September, 2003, Johannesburg, South Africa.

22 Ibid, 10.

23 B Berkeley, *The graves are not yet full: Race, tribe and power in the heart of Africa*, New York, Basic Books, 2001; M Glantz, *Editorial - Complex humanitarian crises (CHCs): Does climate matter?* Network Newsletter and ENSO Signal, 19 (1), Environmental and Societal Impacts Group, National Centre for Atmospheric Research, Boulder Colorado, <www.esig.ucar/newshp>, 2004, p.1.

24 Berkeley, op cit.

25 Glantz, op cit, p. 1.

26 R Lowenson and A Whiteside, *HIV/AIDS: Implications for poverty reduction*, Background paper prepared for the United Nations Development Programme for the UN General Assembly, Special session on HIV/AIDS, 25–27 June, 2001.

27 Republic of South Africa, National Treasury, Intergovernmental Fiscal Review, 2003.

28 Drinkwater, op cit; D Topouzis, *The implications of HIV/AIDS for rural development policy and programming: Focus sub-Saharan Africa*, FAO and UNDP, 1998; M K Shah, N Osborne, T Mbilizi, and G Vilili, *Impact of HIV/AIDS on agricultural productivity and rural livelihoods in the Central Region of Malawi*, Care International in Malawi, 2002.

29 Gillespie and Haddad, *Food security as a response to AIDS*, in IFPRI Annual Report Essay 2001/2002.

30 Drinkwater, op cit; Bryceson, D.F. (1996) *De-agrarianisation and rural employment in Sub-Saharan Africa: A sectoral perspective,* World Development, 24, 97–111.

31 Drinkwater, op cit.

32 Ibid p. 7

33 ICSU, op cit; Tokyo Summit; T Parris, *Toward a sustainability transition: The international consensus,* Environment, Jan–Feb, 2003.

34 Parris, op cit

35 W Clarke, *Research systems for a transition toward sustainability,* in W Steffen, J Jager, D Carson, C Bradshaw, (eds), *Challenges of a changing Earth*, 2002, Proceedings of the Global Open Change Science Conference, Amsterdam, The Netherlands, 10–13 July, 2001, Springer, Berlin, 197–200.

36 Drinkwater, op cit, p.11.

37 Ibid.

38 Glantz, op cit, p.1.