Climate Change – a critical emerging issue

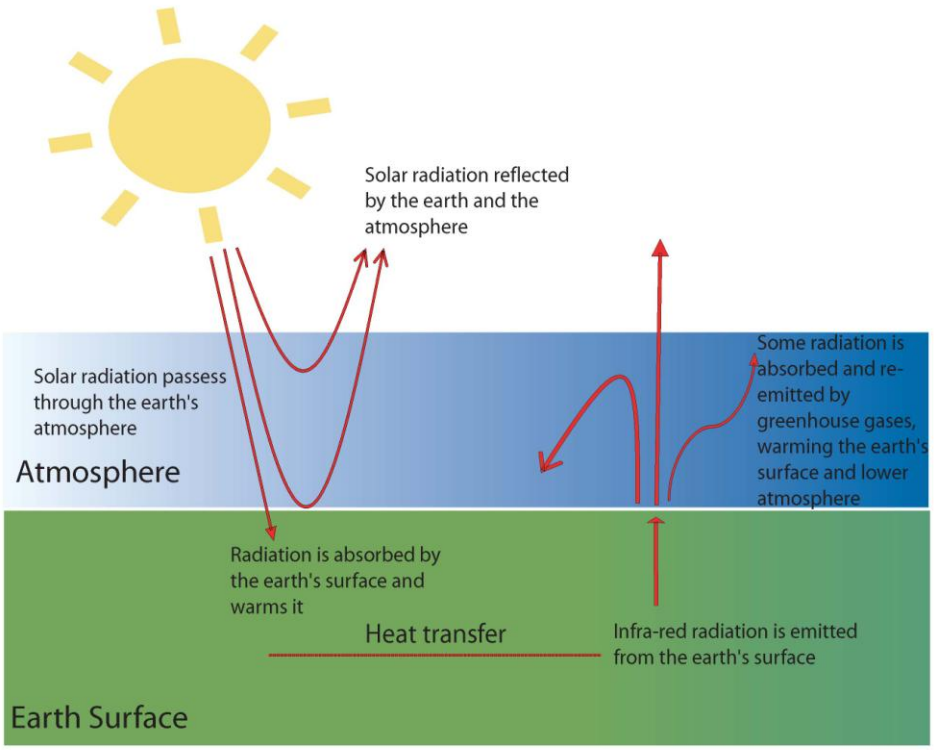
1. Introduction

We inhabit a dynamic and changing planet, and a changing climate is, clearly, nothing new. In fact, the earth has undergone significant climatic change in the timeline for which we have evidence. Such an observation has given rise to much questioning of the real importance of climate change as an emerging critical issue, in South Africa and globally. As a result, it is important to be completely clear as to how climate change functions.

Of particular concern today is the fact that the warming of the earth's climate is occurring at a faster rate than previous climate changes experienced on the planet. Of further concern is the fact that, in contrast to such previous changes, the changes that are, for example, the focus of the concluded Copenhagen negotiations have a clear anthropogenic or man-made component (Solomon *et al.* 2007).

The earth's atmosphere consists largely of nitrogen, oxygen, and a small amount of what are termed 'greenhouse gases', including carbon dioxide (CO_2) (the best known); but also water vapour and methane (amongst others). Without the presence of greenhouse gases in the atmosphere, the planet would be unable to sustain life as we know it today, and Earth would be a cold and (relatively) lifeless planet.

Figure 1: The Greenhouse Effect



Source: Adapted in part from IPCC 1990. Climate Change: the IPCC Scientific Assessment. Houghton, Jenkins and Ephraums, eds. Cambridge, UK. Cambridge University Press, pp. xiv.

Figure 1 above shows how the presence of greenhouse gases in the atmosphere allow incoming short wave solar radiation to pass through to the earth's surface, yet absorb and re-emit a portion of the outgoing longer-wave reflected radiation, warming the lower atmosphere. Again, without the presence of greenhouse gases in the atmosphere, and without such a warming process, life on earth would look markedly different to that with which we are familiar.

Human activity is adding to the amount of greenhouse gases naturally present in the atmosphere - partly through land cover change and agricultural activity, but largely through the by-products of industrial activity, such as the CO_2 emitted from fossil fuel combustion. Increased amounts of greenhouse gases in the atmosphere create an 'enhanced' greenhouse effect, retaining additional heat energy within the lower atmosphere. Essentially, the process described in Figure 1 is exacerbated; with a range of accordant effects.

In South Africa, the latest greenhouse gas inventory indicates that most emissions (79%) are still produced by fuel combustion for the purposes of energy supply and use (Department of Environmental Affairs, 2010). Non energy emissions (including agricultural activities, waste and land transformation) continue to contribute far less. The energy sector is thus the most significant area for mitigation (Department of Environmental Affairs, 2010), as evidenced by South Africa's commitments at the December 2009 climate change negotiations. More specifically, the inventory indicates that between 1990 and 2000, agriculture and waste show a significant reduction in emissions, whereas industrial processes and energy sector emissions increase over the decade (Department of Environmental Affairs & Tourism, Government Gazette, August 12th 2009). While a uniform increase for all greenhouse gases is indicated, the methane (NH_4) emissions from livestock and from solid waste disposal on land, as well as the indirect N_20 emissions from managed soils comprise a small proportion of the emission equivalents from the energy sector (Department of Environmental Affairs & Tourism, Government Gazette, August 12th 2009).

Measurements in South Africa indicate that climate change is already occurring, with increases in surface temperature evident over both South and southern Africa (Kruger & Shongwe 2004, New *et al* 2006). Further details are provided below.

Southern Africa is predicted to be particularly severely affected by climate change, and hence is considered a priority area for supporting adaptation (Archer *et al.* 2008, pg 98). The Intergovernmental Panel on Climate Change (2007) state, for example, in their chapter on Regional Climate Change Projections, that "All of Africa is likely to warm during this century" (Christensen *et al.* 2007, pg 866). Such warming is likely to be more pronounced in drier subtropical regions than in the moister tropics. Further, hydrological changes indicated for southern Africa are expected to include a likely decrease in precipitation for the already arid and semi-arid areas of western South Africa (Christensen *et al*. 2007, pg 866).

It is now commonly accepted that climate change will greatly stress livelihoods in parts of

Africa, including the effects of such high temperatures and water stress (Archer *et al.* 2009, Archer & Tadross 2009, Benhin 2006, Boko *et al.* 2007, Department of Environmental Affairs 2010, de Wit M. & Stankiewicz 2006, Kurukulasuriya & Mendelsohn 2006, Leary *et al.* 2008, Midgeley *et al.* 2005, Reid & Vogel 2006, Stige *et al.* 2006, Tadross *et al.* 2009, Thomas *et al.* 2005, Tubiello *et al*. 2007, Washington *et a*l 2006, Ziervogel & Taylor 2008, Ziervogel & Zermoglio 2009). Understanding such processes greatly supports critical efforts in South Africa and in the SADC region to improve strategic response. Essentially, a 'business as usual' scenario with regard to global greenhouse gas emissions may approach tipping points in the planet's highly interdependent spheres, resulting in potentially catastrophic change. As such changes and stresses become more evolved, response becomes progressively more challenging and costly, in all senses of the word.

2. Addressing the climate change controversy – what do we know?

Before proceeding, it is important to acknowledge the controversy that arose prior to the Copenhagen negotiations, and in the light of recent interrogation of climate change science, both nationally and internationally. It is thus essential to acknowledge here key points that are not contested.

Firstly, CO_2 and other greenhouse gases have been shown to alter radiative balance in the earth's atmosphere, as stated in the introduction (e.g. Quaas 2009, IPCC 2007). Again, without the presence of greenhouse gases (whatever their sources), our planet would bear little resemblance to our experience of it today.

Secondly, greenhouse gases have increased in the earth's atmosphere – well beyond the concentrations estimated to have existed in the atmosphere over the past 100 000 years and beyond (IPCC 2007). The IPCC Synthesis Report (2007) indicates that anthropogenic (human induced) emissions of greenhouse gases have increased since the pre-industrial era; increasing by 70% over the 1974-2004 period.

Thirdly, for the 1970-2004 reference period, energy supply, transport and industrial activity account for the largest greenhouse gas increase (IPCC 2007). Building, forestry (including deforestation) and agricultural activity source emissions show a slower rate of increase over the reference period (IPCC 2007). Such global findings are locally evident in the latest South African greenhouse gas inventory described above.

Lastly, observed climate change is already evident. Examples of this globally and for South Africa are described in more detail below.

3. Climate change as an emerging issue in South Africa

Le Roux and Van Huyssteen (2010), in their presentation of the South Africa socio-economic and settlement landscape, show that economic activity is concentrated in metropolitan areas, and along major nodes and corridors. While the mining industry and associated industries have experienced a downturn and some down-scaling in recent years, the primary sector, including mining and agriculture, remains of critical importance in districts such as Bojanala (Rustenburg), Ekangala (Witbank/Middelburg) and Govan

Mbeki (Secunda) (le Roux and van Huyssteen 2010). Primary industries are likely to be particularly vulnerable to the effects of climate change, and the structure of South Africa's economic activity should be seen within this context. In addition, the demands of primary (and other) industry in terms of energy may complicate the energy planning process, even in the light of aforementioned anticipated greenhouse gas emissions cuts.

It is essential to note that South Africa's current national circumstances include a range of critical socio-economic and development pressures that have frequently increased societal vulnerability to current climate conditions (including climate variability). Such circumstances could amplify the potential future impacts of climate change, especially if inappropriately managed. Critical vulnerabilities include those implicated in socio-economic inequities and poverty, such as the service delivery crisis and spatial differentiation in service delivery and development, the crises of supply and infrastructure in the water and (aforementioned) energy sectors, historic and future escalations in urbanization, water demand and land use transformation, and a challenging human disease burden.

3.1 Observed and projected changes in climate

Science on observed trends in climate and projected future climate change has evolved substantially in the last few years. Different sub-regions of South Africa have shown, and are likely to continue to show, distinct climate changes. Surface air temperature has increased significantly over the past thirty years at least, and is projected to further increase into the 21st century. For example, as mentioned earlier, Kruger & Shongwe (2004) demonstrate significant increases in surface temperature over South Africa, as well as significant changes in rainfall variability over certain regions. New *et al* (2006) further demonstrate that significant temperature increases have occurred over southern Africa more broadly.

More specifically, the assessment of the implications of climate change for South Africa's Western Cape province (Midgley *et al* 2005) indicates that significant warming trends are evident for particular seasons over the Western Cape. Further significant temperature increases are evident in the records for minimum and maximum temperature. Lastly, away from high altitude areas, trends in precipitation confirm preliminary projections for South Africa's winter rainfall area (MacKellar *et al* 2007).

South Africa's Second National Communication describes the likelihood of increased temperature as being greater towards the interior, and less in coastal areas. Assuming a moderate to high growth in greenhouse gas concentrations (SRES A2 scenario), by mid century, the coast is likely to warm around 1°C and the interior around 3°C (Department of Environmental Affairs 2010). By 2100, again using the A2 scenario, the temperature increase is likely to approach 3°C on the coast, and 5°C in the northern interior. By mid century, projected increased temperatures appear similar under all emissions scenarios [1].

There are significant regional differences to future projected rainfall changes, where projections for a wetter east coast in summer, and a drier west coast, must be seen in the context of the location of the transition zone between areas of greater and lower rainfall being uncertain. Drier conditions are predicted for the south west of the country in both

[1] Emissions scenarios represent future likely combinations of greenhouse gas emissions for particular sets of driving forces.

seasons. Rainfall intensity is likely to increase, but to not necessarily imply an increase in total rainfall, with important implications for impacts (see below) (Department of Environmental Affairs 2010). Greater evaporation rates are likely to increase drought incidence and intensity (as defined by the response of available soil moisture and available free water), possibly even in regions where total rainfall increases (Department of Environmental Affairs 2010).

3.2 Impacts, vulnerability and adaptation in selected key sectors

The relevant key vulnerabilities can be usefully considered in a cross-sectoral way with a view to guiding effective adaptive strategies, although this may be challenging for policy development and the implementation processes. Hydrological changes drive many of the relevant impacts, and can usefully indicate vulnerabilities. It is also challenging, but useful, to consider as full a range of potential future climate scenarios as is feasible. We certainly have enough information available to plan and act.

In the hydrological system, the potential increases in summer rainfall described above may be offset by projected future increased temperature and evapotranspiration (Department of Environmental Affairs 2010). Since the hydrological system amplifies rainfall changes, more extreme run-off may be expected if rainfall intensity increases.
Further, projected warming and lower flows may result in compromised water quality (which may lead to increased cost of water treatment, as well as further risks to human health) (Department of Environmental Affairs 2010)

Projected increasing temperatures and changes in rainfall timing, amount and frequency, have critical implications for the full range of agricultural systems in South Africa. Agricultural production is generally responsive to current climate variability. Degradation of South Africa's natural agricultural capital may be exacerbated by climate change (as well as existing challenges to the agricultural sector) (Department of Environmental Affairs 2010).

Increasing evaporation and reduced water availability will compromise both dryland and irrigated agriculture, as well as a variety of livestock farming systems. Livestock farming systems are further affected by higher temperatures, through greater stock water requirements and livestock heat stress. Water supply and water quality challenges will compromise irrigated agriculture. Some positive effects due to rising temperatures may accrue, such as those relating to a reduction in frost incidence, but these are not well quantified. The link between rainfall, land use and degradation is important in rangelands, since climate change can modify both the magnitude of and frequency with which limits and threshold of desertification processes are exceeded. Climate change may accentuate potential desertification due to overgrazing. The potential benefits of rising atmospheric CO_2 on crop and rangeland production are poorly known under South African conditions. Impacts on pests and disease vectors are poorly known, and require future consideration due to their important implications and the potential for adaptation responses (Department of Environmental Affairs 2010).

Increasing temperatures may support expansion of the borders of vector and water borne diseases (for example, malaria and cholera) (Department of Environmental Affairs 2010). Climate change may also potentially trigger new and emerging infection epidemics and

environmental toxins caused by disruptions to human well-being and to agricultural and natural ecosystems.

The most critical impacts on South Africa's unique biodiversity are projected in the winter rainfall biomes, the Fynbos and Succulent Karoo, with between roughly 20 and 40% of the areas supporting these biomes exposed to novel climate conditions by mid-century (Department of Environmental Affairs, 2010). The combined effects of climate change, wildfire frequency and alien invasive species (alone, and interacting), as well as land use and habitat transformation may make the sector increasingly vulnerable to climate change over time (Department of Environmental Affairs 2010).

Poverty is an important determinant of climate change vulnerability. The immediate health impacts of extreme climatic events with longer term psychological impacts and possible livelihood loss are well established and documented, particularly in settlement populations with existing high exposure to extreme events, and where infrastructure is lacking (see, for example, the work of the Disaster Impacts Mitigation Programme at the University of Cape Town) . Such populations are also more vulnerable to South Africa's current disease burden. Critically, climate change impacts may make agriculture and other land uses such as agro-forestry increasingly unfeasible as a livelihood strategy for the rural poor. This will be particularly important in developing policy and strategy for the emerging agriculture sector.

3.3 Adaptive responses in selected sectors

Adaptive responses can be usefully viewed as extending current efforts to respond to present climate risk, and as supporting strategic efforts to adapt to longer term but more gradual climatic changes. All of these, however, can be usefully based around efficient and effective meteorological, water and air quality monitoring services, which are an essential component of an early warning adaptive and impacts mitigation strategy, including, for example, greater flood and drought warning and response capacity (Department of Environmental Affairs 2010).

Sector-specific strategic adaptation to longer term climate changes include enhanced water storage capacity and increased water supply for the water sector, as well as improved catchment management (e.g. removal of invasive alien species). The Second National Communication states, significantly, that "The Water Act, the water management institutions that it creates, and the ongoing commitment to the delivery of basic water supply and sanitation infrastructure all have high relevance for adaptation" (Department of Environmental Affairs 2010).

In considering adaptation for the health sector, adequate and reasonable healthcare delivery services are required that address all aspects of South Africa's complex health burden. For example interventions in vulnerable communities should focus on reducing water borne disease risk, indoor pollution exposure, and significant support of existing public health infrastructure and planning (Department of Environmental Affairs 2010).

For agriculture and agro-forestry, improved management practices have great potential in addressing climate change as one important objective of improved management practices with multiple benefits. Such practices could include a move to intensive yet

environmentally sustainable livestock production, sustainable rangeland production and forestry practices, more efficient water use, and the inclusion of carbon sequestration and greenhouse gas emission minimization objectives. For the forestry sector, targeted response to potentially increased fire risk, as well as specific breed programmes to match possible shifts in suitable growth areas should be considered (as should alternative forms of silviculture). As mentioned earlier, projected climate change impacts are likely to complicate the efforts of land reform beneficiaries and/or the emerging agriculture sector in rangelands. Strategies and policies supporting this sector should integrate such considerations (Department of Environmental Affairs 2010).

A range of adaptation responses are available within the biodiversity sector, including the establishment of partnerships to enable effective management of areas not under formal protection, as well as using climate change projections as one input into expanding the formal protected area network (Department of Environmental Affairs 2010). As in other sectors, a 'multiple benefits' approach, simultaneously addressing a range of objectives, which include climate change adaptation, carbon sequestration and greenhouse gas emissions mitigation, biodiversity conservation and sustainable livelihoods, should guide strategy in this sector. Awareness of the value of biodiversity in supporting adaptation to climate change is growing, but further policy relevant research in this area is required (Department of Environmental Affairs 2010).

4. Conclusions

It is essential, again, to note that South Africa has existing critical vulnerabilities that will exacerbate the effects of climate change in most sectors, and compromise effective responses if inappropriately managed. In terms of policy and response, most sectors in South Africa could benefit from the 'multiple benefits' strategic planning approach mentioned above, with particular attention paid to cross-sectoral strategies (for example, water, invasive alien species and fire management) (Department of Environmental Affairs 2010). The role of the National Planning Commission is critical here in ensuring that departments are monitored not only on their sectoral response, but on their coordination with other departments in responding to climate change.

Lastly, given the magnitude of the problem, and in light of findings presented above, it is essential that South Africa builds upon on existing strategies and policies that have real or potential climate change objective components, rather than developing policy unrelated to existing strategies in place or planned. Again, cross sectoral communication and coordination is key here.

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