

Ethical Challenges in Climate Change Impact Mitigation in South Africa

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ABSTRACT The world is heading for disaster as global temperatures are soaring and climate change is a reality. South Africa, like all nations, is also severely affected by the resulting climate changes. This paper's basic argument is that urgent steps need to be taken to avoid national disaster and it unpacks the issue of climate change and how it impacts South Africa. It seeks to promote the view, that unless the country takes firm steps to alleviate the negative impacts of global warming and climate change and adapt to the ever-changing conditions which are faced, the looming disaster will become a reality of cataclysmic proportions. Consequently, the national government should place the issue of tackling the problem at the top of its political agenda. The researcher will seek to provide some strategies that may be of use in mitigating especially local climate change.

INTRODUCTION

There is ample evidence which suggests that the world is becoming increasingly warmer and that in many parts of the globe, sea levels are rising and huge shifts in climate are occurring. These changes are due to human activities, most notably, the emission of greenhouse gases. "Global warming", or "climate change", refers to the increase in the planet's overall temperature as a result of the anthropogenic (human-related) increase of greenhouse gasses in our atmosphere. Climate change has rapidly developed into an issue of extensive and foremost concern where efforts for mitigation and adaptation to the changing conditions are strongly suggested by the IPCC (2007b). Climate scientists tell us regularly that even if the nations of the world effectively implemented a significant mitigation program today, a greatly warmer world presently exists when it comes to the climatic system. The World Bank (2010) states that South Africa is getting much hotter over the past four decades. The average minimum monthly temperature is at 13°C and average maximum monthly temperature at 26°C. There is additionally an increase in the number of warmer days and a reduction in the number of cooler days. The national average rainfall, estimated at 450mm per annum, is equally well below the average of 860mm (World Bank 2010). In fact, by 2100, it is anticipated that average global temperatures will increase by between 1°C and 6°C. Most of this warming will be at the poles rather than at the equator. The possible

impacts of global warming will then range from severe changes in rainfall patterns which will affect agriculture, river courses and wetlands, as well as changes in the distribution of biodiversity, including disease-causing organisms (Midgley et al. 2002).

METHODOLOGY

The methodology in this paper is based on phenomenological qualitative research. A conceptual perspective and an analytical approach is used to analyze climate change and its impacts and what can be done to lessen the impact on South Africa. The research is thus based on the philosophical assumption of Interpretivism. This means that the researcher understands that the research is full of values and that biases will be present in what is found in the literature and how it is interpreted. When there are biases we say that the assumption is axiological and that values play a role in what is stated (Cooper and Schindler 2003). The study will hopefully stir greater Socratic debate and climate mitigation.

OBSERVATIONS AND DISCUSSION

Mitigation against climate change is very important because without it sustainable development becomes very difficult and it is critical to meet the needs without compromising the ability of the future generations to meet their needs (World Commission on Environment and Development 1987). However most of the great-

est emitters of greenhouse gases, have done very little, more offered lip service to it and so global warming continues. Generally the global policies are discussed very far away from individual citizens while they still need to obtain local public support in order to be successfully executed (Zuñiga 2004). Very often governments fail to solve problems effectively and they thus advocate a greater involvement by civil society in global governance issues (Yamin 2001).

There needs to be a concerted effort to change human behavior in ways that will appreciably slow down the rate of global warming. In the time saved, engineers may be able to innovate and develop effective technological way of taxing climate change problems that exist (Newell 2000). In South Africa, the government must enforce regulations which are aimed at reducing greenhouse gas emissions as time is of the essence. Interestingly, one also notes that mitigation activities in developing countries often offer many politicians in industrialized countries a useful escape mechanism so as to divert the attention of their constituencies away from their blatant failure in reducing greenhouse gas emissions domestically. National GHG emissions reduction obligation are implicitly a stance on two ethical concerns, namely, an atmospheric GHG concentration goal; and a nation's realistically fair share of safe global GHG emissions. Since all GHG emissions add to atmospheric GHG concentrations rising, a national goal is. In effect a stance on what it considers to be tolerable concentration levels of atmospheric GHGs. This begs the ethical question what indeed may be considered to be an acceptable atmospheric GHG concentration?

Countries must accept their ethical duty to reduce emissions to what their realistic share should be without harming other nations (UNFCCC 1992: Preamble). The nations of the world have immense duties to fulfil. They have all agreed to adopt policies and measures so as to prevent 'dangerous anthropogenic interference with the climate system' under the UNFCCC (UNFCCC 1992: Article 2). However, despite the knowledge nations possess on the negative effects of global warming and the impacts on climate change, atmospheric concentrations of CO₂ have already surpassed 400ppm and are increasing annually (Cointe et al. 2011). Climate change in South Africa is considered in terms of growing unemployment, poverty and huge inequali-

ty in the society which are legacies of the apartheid era. It has thus become critical to seek to create 'green jobs', especially in the private sector, as per the New Growth Path (2011), which seeks to address these plaguing issues.

Climate change impacts agriculture, fisheries, shipping and a wide range of other sectors. It affects companies across the globe as it disrupts, supply chains and commodity prices and exposing them to both political risk and costly regulatory changes. Severe weather events and varying weather patterns, as well as current or imminent regulations imposing a cost on carbon and a transformed competitive environment have an inexorable impact on many business sectors, supply chains, customers and products and the global economy as a whole (Ceres 2016).

There is also opportunity for businesses and investors to develop innovative products and novel technologies to mitigate pollution and limit our reliance on fossil fuels. New markets could be created as well as a range of new jobs. This is very important given that in 2000, more than seven percent of aid flows were spent on greenhouse gas emissions mitigation actions. Yet in terms of the Millennium Development Goals the contribution of emissions mitigation development in the central development objective of reducing poverty is very limited. Projects that address the impoverished masses are very exceptional. Where there are minor renewable energy projects in outlying rural areas these invariably benefit the wealthy farmers and ultimately the better off urban population. The evidence points to the fact that as the middle class expands quickly, energy consumption and greenhouse gas emissions tend to rise. This is why it is prudent to tackle the middle class energy consumption levels with measures such as efficient and public transport. It has been found that where there is rural renewable energy provision in poor countries, this tends to have a much higher impact on poverty, but also a much lower impact on greenhouse gas emissions as such (Scholte 2004). It is diabolical that people and nations in one part of the world, especially the developed nations, place others, generally the under-developed and developing nations such as Bangladesh, Venezuela, Sudan and Somalia far away at great risk by their unethical industrial practices which drive global warming up and causes massive climate changes. They essentially place current and future generations at great risk (World Bank 2011).

Ethical Issues

Given the apparent lack of concern for the ethical implications of climate change due to human actions resulting in global warming, greater efforts need to be made to inculcate in civil society as well as the public and private sectors, an awareness of what ethical failures of both national climate policies and industrial actions mean for humanity in general. The groups that cause the problems need to be seen to be 'punished' for their misdemeanours. As our limited natural resources become tainted by pollutants, the health of people is diminished. Especially developed nations need to act responsibly and fulfil their obligations and duties towards less developed nations, by particularly not continuing with their huge carbon emissions. All GHGs need to be reduced. South Africa has stated it will reduce its emissions by thirty-four percent below the anticipated 2020 levels. However, the Long-term Mitigation Scenarios (LTMS) have recognized that total the decline would only begin subsequent to 2030. Consequently we could argue that 'The South African government has pulled a public relations stunt' as has been asserted by Bond (2010). Whatever commitment is made should be quantifiable and deemed to be urgent. This implies that behavioral patterns need to change drastically, but this would not be enough and more serious endeavours are called for when it comes to policy direction and strategies. Climate change can thus be taken to be an ethical problem. Economic self-interest cannot be the primary consideration when both the private and public sectors have ethical obligations towards the poor. Failure to serve the people is in essence a negation of human rights and therefore compliance with laws on environmental degradation is non-negotiable. Clear public records on every nation's human rights compliance is required as this will allow conscious governments and global citizens to pressure 'unconscious' governments to live up to their human rights obligations (Bodansky 2010). South Africa asserts that the developed nations should make funds available and provide 'green technology' expertise if they expected the developing and poor nations to be involved in major activities to safeguard the environment. Equally, the wealthy nations should not make climate change issues a scapegoat to establish trade barriers against the weaker states.

It makes all round sense to expect developing nations to gradually reduce emissions on their own accords, while the real polluters, the developed nations take severe steps to mitigate climate change. Climate change is destructive and the UNEP (2008) states that "humanity is living beyond its environmental means and running up ecological debts that future generations will be unable to repay as a result of global climate change."

South Africa is a very vulnerable country when it comes to global warming and the resultant climactic change as explained by an SABC (South African Broadcasting Corporation) report in which the organization states that the country is warming up at a faster pace than the global average. South Africa is widely known as a beautiful country with an exceptional range of biodiversity and some of the greatest wildlife viewing on the planet, alongside Kenya. However, the current pattern of changes is increasingly posing a great threat to the ecosystem and the production of vital food crops such as maize and wheat. This means that for the first time in many years, the country needs to import what are basic staple foods. Not only does our inability to produce food pose a problem to us, but also to our neighbouring states of Lesotho, Swaziland, Namibia, Botswana, Zimbabwe and Mozambique, that rely on our exports of food to them at reasonable prices based on our SADC connections. A lack of foodstuffs and the purchasing of these at higher prices due to importation, also threatens to stifle our social and economic development. Climate change and global warming go hand-in-hand and have a very negative impact on South Africa and her diverse population. The local populations are not simply passive or keen observers of climate changes but they also actively attempt to adapt to the rapidly changing conditions (Macchi et al. 2008).

Review of Literature

The researcher found and used very rich interpretations which are known as "thick descriptions" of the issue of climate change to provide credibility in the findings (Ponterotto 2006). South Africa plays an important role in the international climate change negotiations and has made a concerted effort to support the interests of the entire African continent. Bond (2010) states that it was South African negotiators who led

the G77 and who demanded that ‘at least 1 per cent of global GDP should be put aside by the developed nations to aid the developing nations so as to empower them to undertake relevant research relating to climate change and mitigating measures to relieve their plight (Bond 2010).

At the outset it should be stated that most of the damage to natural systems is done by multinational and transnational corporations. The primary legal response to such action has been to enact laws on the environment to attempt to discourage behavior that is detrimental and which promotes climate change. “Greenhouse gases” (GHGs) comprise a variety of natural atmospheric gases that are responsible for trapping the sun’s heat on the earth, which then enables life as we know it to exist. If we try to ascertain the economic costs of climate change mitigation over a long period, we are invariably led to the premise that the net benefits or costs are incomprehensible because of the profound uncertainties that are involved (Pearce and Weyant 2008). Many factors such as land-use changes and the burning of fossil fuels, allow GHGs to increase. Water vapor and carbon dioxide are the main GHGs but it is mainly the release of carbon dioxide from burning fossil fuels that has the greatest impact on the earth’s climate. Methane and nitrous oxides are two of the most potent greenhouse gasses and from the start of industrialization, methane has more than doubled in concentration and nitrous oxides have risen by 8 percent. This does not bode well for our planet. South Africa acknowledges its status as the highest GHG emitter on the African continent and it has made pronouncements on its desire to reduce emissions voluntarily so as to make a meaningful contribution to help limit the global concentrations within the desired range of only a 2 degree warming upper limit. In essence, this seems good, however the target set will in actual fact provide for big increases in South African GHG emissions by as early as 2020. In 2013 an Intergovernmental Panel on Climate Change (IPCC) identified the global carbon emissions finances necessary to constrain global GHG emissions so as to limit warming to 2°C and thereby offer a glimmer of hope in evaded far more hazardous climate change. It is evident that South African policy makers are acutely aware of the fact that there a huge costs linked to GHG emission reduction efforts and that there are significant short- and long-term social and economic

benefits, not least of which is improved international competitiveness from a transition to a lower carbon economy. South Africa’s reaction to climate variation makes a reasonable contribution to the international effort to steady greenhouse gas (GHG) concentrations in the atmosphere. It also seeks to more effectively manage the impacts of climate change via carefully considered interventions that ‘build and sustain South Africa’s social, economic and environmental resilience and emergency response capacity’ (NCCR 2004). Globally very little changed in terms of fighting climate change between 1980 and 1990 (Easterly 2002). In the 1980s development funds thus generated very little with respect to mitigation on climate change.

Numerous steps have been taken in the last few decades to fight climate change but to very little effect, for the most part. Essentially nothing happened to improve wealth and living conditions for the poor of the world. However from about 1994, a new focus appeared, namely, to eradicate poverty. To many this was the same old story of non-performance again (Cling and Roubaud 2002). The great ideas proved to be futile attempts to pretend to care (Menzel 1992) and so donor bodies, politicians and even non-governmental organizations (NGOs) began to disinterest, which was growing amongst their constituencies. Targets that were set were never reached and in fact climate change intensified. From 1986, international climate policy appeared as an innovative key area in the policy making of the governments. The UN Conference on Environment and Development held in Rio de Janeiro (1992) concentrated on both development policy and environmental policy, with an exacting emphasis on international climate policies. From that period, donor nations have used development funds at any rate, to some extent for climate policy intentions (OECD/DAC 2002). The 1997 Kyoto Protocol defined the legally binding greenhouse gas emission commitments for all of the highly industrialized nations. This allowed certain nations to be in a position to obtain emission credits (Certified Emission Reductions CERs) from their projects which reduced greenhouse through what was termed the “Clean Development Mechanism” (CDM).

The National Environment Management Act (NEMA), Act 107 of 1998 asserts that nature must be protected and sustainable development is non-negotiable. It thus prescribes national

environmental management principles that need to be applied by the organs of state when deciding on issues that affect the environment. In terms of this Act, the party that causes damage to the environment should pay the costs associated with its behaviours which degrade the environment, and so there is a 'duty of care' on each individual and company to prevent pollution from occurring, continuing or recurring (NEMA s28 1998). The directors and board members and other members can all be held liable for environmental crimes in their personal capacities. Other Acts of the South African Parliament of significance include the National Water Act 36 of 1998 and the National Environmental Management: Air Quality Act 39 of 2004. In terms of the latter, Metropolitan as well as district municipalities are responsible with implementing atmospheric emission licensing systems and must additionally act as licensing authorities (AQA s 36[1]). While South Africa applies the ISO 14000 series of environmental management standards, from a corporate governance standpoint, environmental issues fall under the King Committee on Governance which developed the King III Code to establish general principles of good governance while every organization has *carte blanche* to decide how best to act out the principles of the Code. It is clear that there is a need for organizations to go beyond the triple bottom line sustainability reporting and that there must be a corporate Environmental Management System (EMS) in place to ensure compliance with applicable environmental laws. All risks and impacts must be considered and the requirements of all laws met. Basically, all reasonable measures must be taken to avoid posing threats on the environment. Environmental concerns must take centre stage.

In the United Nations Framework Convention on Climate Change (UNFCCC), South Africa is a Non-Annex 1 country and is a signatory to the Kyoto Protocol which it ratified in 2002. This necessitated that it adhere to the obligations imposed by the UNFCCC, but only as a developing nation. South Africa was not obligated to meet the set targets under the Kyoto Protocol until only 2012. The firmly established links between climate and development policy grew stronger and this opened up innovative areas of activity for donor agencies. In a rather surprising move, given its dependence on coal and energy, South Africa announced during the

course of the 2009 Copenhagen climate change negotiations, South Africa freely declared that it would take strong actions to decrease domestic GHG emissions by up to thirty-four percent by 2020 and would strive to reach a target of forty-two percent by 2025. The Department of Environmental Affairs (DEA) is the foremost role-player in wide-ranging mitigation potential analysis and a search for viable options, which will enable it to review current and future emission tendencies of key industrial sectors. The national Integrated Resource Plan (IRP) 2010 asserted that this would also support South Africa's commitments to mitigate climate change as expressed by the nation in Copenhagen (Department of Energy 2011).

Climatologists have been trying to reconstruct past climate variations based on a whole lot of regional and global scales. They have also sought to establish the mechanisms which they term 'forces', which are responsible for driving climate change. Climatologists have settled on two categories of forces which they have termed these natural forces anthropogenic forces. The former relate to processes that recur and which have been in evidence for millions of years while the latter are very recent processes founded on human activities.

The orbit of our planet around the sun gives us the four seasons. In the southern hemisphere, June is cold as the sun's rays fall less directly on it, and the sun is seemingly higher in the sky; in the Northern hemisphere, June is hot as the sun's rays strike the earth at an acute angle, and the sun appears high in the sky. In addition to this, the orbit of the Earth around the Sun is also a strong natural force as it varies over thousands of years and is thus considered to be responsible for ice ages and also for the warmer interglacial periods which includes the current Holocene epoch in which we are living which began roughly 10,000 years ago (Meehl et al. 2007). The climate change we are experiencing does not merely imply a steady change in climate – even though changes may be gradual and subtle – the long term effects are more severe as they impact negatively on both the health and wealth of our country (Global Warming 2010). South African has set a GHG emissions target at levels required of it by ethics and equity principles. It then proceeded to state that the target could only be reached if it received financial support from the developed nations. This means

that developing nations could then make explicit what part of an emissions reduction target was their responsibility of all the developed nations. The implication of such actions would be that developing nations would then need to devise an ethical and equity standard in which there would be cleared demarcation as to who has the main financial responsibility to act to adapt in part and then stop climate change.

Climatologists all agree that the warming tendency we are experiencing for the last few decades cannot be accounted for by any of the natural forces. We cannot for example blame sunspot cycles, in which the temperature of the sun's output is increased, raising temperatures in our atmosphere for the climate change we experience. The sun is then not to blame for the current period of global warming (Meehl et al. 2007). In fact, the comparatively mild temperatures of the last 10,000 years or thereabouts have been sustained by the greenhouse effect which is a natural and self-regulating phenomenon. The Intergovernmental Panel on Climate Change (IPCC 2007a) 4th Assessment Report states that there is a "very high confidence that the global average net effect of human activities since 1750 has been one of warming." People emitted eight billion metric tons of carbon into atmosphere in 2007 (Boden et al. 2009), so we cannot claim innocence.

How the country could adapt its economic sectors, ecosystems and health systems to cope with the dire consequences of climate change is highly problematic because there is intransigence in this regard by most of those in power who are quite happy in their 'comfort zones'. We could be looking at better ways to combat carbon related problems and thus many life forms, such as avian species, marine and plants are moving to cooler climates and shifting their feeding spaces so that they can sustain their livelihood. If we fail to take urgent and appropriate steps, up to about 1 million species could be eradicated by 2050 (Scholes 2015). All the evidence suggests that that climate changes are increasing and this will cause wide-ranging shifts in climate variables (Al-Amin and Filho 2011). According to various other researchers, climate change is growing and is leading to great shifts in climate variability which is highly problematic from a sustainability perspective (Al-Amin and Filho 2011). South Africa is experiencing an ongoing, but constant change in climate conditions. Temperatures have risen sharply over the

last six decades. There has been a large rise in temperature of 1-2°C in coastal regions, and 3-4°C changes are expected in the interior regions such as Gauteng Province by 2050. The severe heat waves of January 2016, are showing that this is indeed a reality (SANBI 2011) and it will get worse.

Climate change will create crop failure and this will lead to a *loss of food security*, especially for rural people in provinces such as the Eastern Cape, Limpopo and Mpumalanga provinces. These people will also be at risk for an increase in many types of human and animal *disease*, for example, cholera, malaria, diarrhea. Where there is severe flooding this will cause damage to infrastructure like roads and telecommunications facilities and result in social and economic losses (Brown 2014). The extreme changes in rainfall and temperature and severe weather related events create great variations in both food and agricultural production. The result is higher prices that the poor cannot afford to pay. Less water is available and the access to water is confined to the wealthy in society who have the means to pay the higher prices. The poor thus suffer malnutrition and their health status is hugely impacted upon in a negative sense (Stern 2006). The El Nino phenomenon results in storms where there was previously drought and vice versa. This promotes the outbreak of tropical diseases such as malaria. Where pools of water remain after storms, this tends to increase the risk of cholera. These are especially taxing problems for informal settlements where there is very little or poor sanitation. Many poor people have no access to safe drinking water and the government is obliged to truckloads of water for them. If we follow the example of Arctic communities' on climate changes, we too will discover that it is important to consider local knowledge and perceptions as these tend to influence people's decisions both in deciding whether or not to act with regard to climate change (Alessa et al. 2008).

Marine Impacts

The coastal regions are also expected to have an increase of approximately 3-4°C while interior regions will experience a 6-7°C increase by the turn of the century (SANBI 2011). South Africa is getting hotter, at a faster rate than other nations across the globe. Our nation's oceans are also becoming more acidic as a result of carbon

dioxide emissions and the acid levels affect species with hard calcium carbonate shells and this makes them far more vulnerable as well. The marine environment is changing its physical characteristics, as there is a rise in sea levels and a warming of the Agulhas and Benguela currents on the east and west coasts of South Africa respectively. On 15 February 2016, a pod of Southern Right whales beached themselves in Port Elizabeth in what is an uncommon occurrence for that part of the coastline (The Times 2016). There is also a noticeable decrease in marine avian species in ocean productivity, which is also clearly related to climate change. Matters are so critical that the African penguin which is endemic to South Africa and Namibia, is at risk of extinction due to the climate change which has raised sea temperatures and compelled breeding penguins to abandon their nests. Fishermen also complain of lower fish catches due to the decreased ocean productivity. There is thus overfishing as fishermen jostle for declining marine resources as fish migrate.

The world is at present heading for an unprecedented warming of 3.7 degrees by 2100 (Climate Action Tracker 2013). Many marine species move further north or south as ocean waters have warmed up. This means that the ranges of many fish and shellfish species may change. Many marine species have certain temperature ranges at which they can survive. Some fish require water temperatures below 19°C. When water temperature rises they either leave or die. Changes in temperature and seasons could therefore affect the timing of reproduction and migration of fish and other marine species. In addition to warming, the world's oceans are also becoming more acidic due to increases in atmospheric carbon dioxide (CO₂). Increasing acidity could harm shellfish by weakening their shells, which are created from calcium and are vulnerable to increasing acidity. Where water is acidic may also threaten the structures of sensitive ecosystems upon which some fish and shellfish rely.

The socio-economic impacts of climate are massive. It is especially agriculture and fisheries that play critical roles in food security for our people and these also provide jobs for a great portion of our population. If agriculture and/or fisheries are challenged, the socio-economic impacts will be catastrophic. Many of these effects thus have serious huge implications on issues such as food security, employment, ex-

ports such as fruit, maize, wine etc. and tourism. The measures that are taken over both short and long-terms to mitigate climate change may bear fruit (Berkes and Jolly 2001). This means that we must consider the observations and perceptions of local people in whatever is done to gain a better comprehension of climate change, and its impacts. Only in this way can we adapt to it and mitigate against it. There is a far greater percentage of global fish stocks that are now over exploited or collapsed, more than ever before because the sea is overfished and species are dying due to climate change.

Agricultural and Other Land Impacts

The huge climactic variability and changes currently felt are severely compromising agricultural production and access to food and thus food security is threatened. In addition, South Africa's geography makes it for the most part vulnerable to climate changes. Most subsistence farmers rely on rain-fed agriculture for a sustainable livelihood while wealthier white farmers generally have the financial muscle to sink bore holes from which they are able to supply required water in times of need. There is currently a record drought in South Africa with little prospect of meaningful rainfall, and when it does rain, there are very severe storms and these may be accompanied by large hail. The problem with droughts and storms is that immediately after a drought the plants tend to be weaker. When storms come they often wash the plants away. Storms also bring floods which may wash most of the topsoil off fields and move it into nearby rivers. Farmers thus lose their topsoil and cannot grow their plants. The result is that the state is then forced to spend much money on dredging the topsoil from the rivers into which it has ended up (Griffin 2012). Our small scale subsistence farmers are the most vulnerable to the effects of climate change. Their agricultural practices in the country are mainly rain-fed and they are therefore particularly vulnerable to the impacts of climate change (Kgakatsi 2006). There are water shortages and our drought continues to threaten our economy and societies. Big commercial farmers are more likely to survive, due to their infrastructure, and the fact that they have boreholes, windmills, pumps and irrigation systems that help them to manage with shortage of water. Many communities such as crop farmers

and herdsmen, are now facing problems which are the result of climatic changes (Adger et al. 2003). No useful adaptive measures to the current and expected changes are in place and so the livelihoods of many are being harmed, and people who are already poor are becoming even poorer and desperate. Many thus flock to cities seeking a better life and find no jobs and end up in informal settlements where living conditions are sub-standard. Many resort to crime out of desperation.

In summer rainfall areas such as the Free State province, maize production is virtually non-existent. Research shows that wheat is very sensitive to ozone exposure, while maize is much more badly affected by heat. Given that these are staple food sources, it is highly concerning as maize needs to be imported and this is very costly for especially the lower-income citizens. Agricultural production is very sensitive to ozone pollution and this shows how important it is to think about the agricultural implications of air-quality regulations (National Science Foundation 2016). Climate change causes big fluctuations in hot and cold weather spurts. For every plant variety, there is a most favorable temperature for vegetative growth, with growth dropping off as temperatures increase or decrease. Similarly, there is a range of temperatures at which a plant will produce seeds. Outside of this range, the plant will not reproduce. Thus when it is very hot or cold, plants do not reproduce. A study published in *Science* advises that, because to climate change, southern Africa could lose more than thirty percent of its main crop, which is maize, by 2030.

The IPCC (2011) states that climate variability and transformation are already a stark reality. There is no certainty in predictions as to what will transpire in the future concerning climate variability and change but the likely consequences will be devastating for future generations. The agricultural sector especially requires to reconsider its operations especially given that Africa will be severely affected by climactic shifts (UNFCCC 2008). Food security and sustainable livelihoods in most of Africa will be sorely tested. To circumvent the most awful effects of climate change, South Africa needs to radically reduce global carbon emissions while simultaneously preparing for the significant and unavoidable consequences of carbon emissions including, for example, escalating temperatures,

ever shifting precipitation patterns, severe ocean acidification, rising sea levels and the mounting intensity and frequency of extreme weather events (WWF 2015). Private and public bodies need to work with the local communities, governments and other stakeholders to help natural environment and people get ready for the negative impacts of climate change. Most importantly, South Africa will need to adapt to the inescapable impacts of climate change and promote 'green' living. It is apparent from the devastation in agriculture created by climate change that there must be a promotion of 'green jobs' in renewable energies, agriculture, environment, water, energy, construction and waste management, and especially in innovative technologies. This should include jobs related directly to building and managing hardy and sustainable urban infrastructure and developing maintainable models of food production for the ever-growing world population. Every type of job has the potential to be more environmentally tuned – in, and then not every skill for green living is necessarily technical in scope (ILO/Cedefop 2011).

The agricultural sector plays a major role in the gas emissions and land use effects which are partly to be blamed for the climate change. It uses fossil fuels but also, adds directly to greenhouse gas emissions through practices such as for example, the raising of livestock. The Intergovernmental Panel on Climate Change, asserts that primary main causes of greenhouse gases increases over the past 250 years has been fossil fuels, usage of land and agricultural practices. CO₂ releases are clearly associated with deforestation, while methane releases from enteric fermentation in livestock as well as from rice cultivation.

Agriculture thus creates roughly fifty-four percent of methane emissions, and almost all CO₂ emissions linked in some way to land usage. Livestock account for up to nine percent of global carbon dioxide emissions and up to forty percent of global methane emissions. Livestock production globally accounts for occupies seventy percent of all land use (WWF 2015).

The Kruger National Park and many other parks and game reserves at great risk as thousands of grazing animals are dying of starvation and many perish due to lack of a water supply. The ecosystem and population dynamics are thus changing quickly. In some parts of the park, invasive alien vegetation, which are better adapt-

ed to the sudden changes are taking over and transforming the landscape into one in which only alien plants are visible (South African National Biodiversity Institute 2001).

The shift in rainfall patterns, together with rising temperatures and atmospheric carbon dioxide is increasing vegetation growth in some regions, which will result in bush encroachment in the Savannah regions such as the Kruger National Park. This alters both the ecosystem and population dynamics. It leads to a change in plant and animal communities. Some grassland, fynbos, and succulent Karoo biomes, which are known for their indigenous biodiversity are then also at risk from climate change. Many of the parts of the Kruger National Park are also threatened by invasive alien vegetation, which is better adapted to change, and then it is able to quickly out-compete the indigenous vegetation and take over the landscape (Seidel et al. 2008). Forests are the home to very many of the world's most endangered wildlife species. They also play a crucial role in protecting the earth by absorbing carbon dioxide (CO₂), a major source of pollution that causes climate change. However when we look at for example, the province of Mpumalanga, we find that most of the forests are used for the production of paper and furniture. This means that forests have only a short life. While young trees are planted to replace those cut down, the process to grow these trees to a meaningful size requires much water, which is also now lacking. This is because South Africa is becoming hotter and drier, leading to changes in agricultural production and biodiversity distribution. Even in the eastern part of the country where rainfall is expected to gradually increase, the impact will not necessarily be positive because the increased rainfall at inappropriate times may result in destructive floods and badly impact natural rivers and human infrastructure. Changes in rainfall will definitely affect food production.

Research shows that the freshwater systems will be impacted mainly by increasing unpredictability in rainfall, as well as the rising sea levels. Our groundwater and surface water (for example, in rivers and lakes) will decrease, and the increased evaporation from the ground will leave the soils much more salty. This will limit plant growth. What is more disturbing is the idea that by 2050, roughly 50-100 million people in Southern Africa are likely to experience water shortag-

es. The sea-levels will rise and this will cause increasing salinization of groundwater and all our marine estuaries, leaving less freshwater for humans, agriculture and for our fragile ecosystems.

Fossil Fuels and Air Pollution

Ceres, a non-profit organization advocates sustainability leadership. They mobilize powerful networks of investors, companies and public interest groups to accelerate and expand the adoption of sustainable business practices and solutions to build a healthy global economy. They state:

Fossil fuel companies are putting billions of investment dollars at risk each year by developing high-cost, high-carbon reserves that may never be burned. The Carbon Asset Risk Initiative (CAR) aims to prevent these fossil fuel companies from wasting investor capital by demonstrating how carbon risk poses an existential threat to their business models, accrues increasing levels of stranded assets, and puts trillions of capital expenditures at risk. Carbon asset risk is an issue for all fossil fuel companies. The threat of climate change, carbon regulations and other market forces are shifting our economy to a low-carbon future. There's a clean energy transition under way – we already know the world needs to invest an additional \$1 trillion per year in clean energy by 2030. At the heart of the matter, no single actor will solve this issue. Investors, insurers, regulators, analysts, credit raters and asset managers are increasingly asking fossil fuel companies to assess, disclose, and address carbon asset risk, while questioning why companies are still investing in projects that aren't economic (Ceres 2016).

South Africa's economy is very dependent on coal, and the World Energy Council, states that its coal resources are estimated to be in the region of thirty-four billion tons which in essence represents ninety-five percent of African coal reserves and four percent of world reserves. Coal thus provides approximately seventy-two percent of South Africa's entire primary energy supply in 2007 and accounted for about eighty-five percent of the electricity generation capacity. The government states that it is committed to taking measures to address the consequences of climate change, but the nation's huge dependence on fossil fuels for energy impede this

course of action. The extensive use of fossil fuels including gasoline, methane and propane which contain mainly carbon, are problematic since once these fuels are burned, they react with oxygen and the result is greater outputs of carbon dioxide. Coal is additionally a major source for the synthetic fuel industry, and the energy supply is thus profoundly carbon-intensive. When forests such as those in Mpumalanga are destroyed, this also adds to an increase in carbon dioxide production. Carbon dioxide cannot absorb the energy from the sun, but it can absorb some of the earth's heat energy. When a molecule of carbon dioxide absorbs heat energy, it reaches an excited and unstable state. It is able to regain stability by discharging the energy it absorbed. A certain amount of the released energy goes back to the earth and the rest goes out into space. This means that carbon dioxide allows in light energy but fails to let out all of the heat energy. We thus become like a 'greenhouse' and like a blanket in which carbon dioxide is increasing at the rate of about one part per million per year. This causes increases in the earth's temperature which may result in glaciers melting, which will in turn result in coastal flooding (WWF 2015). The denser the blanket becomes, the hotter the earth becomes. The oceans also absorb additional carbon dioxide which makes them far more acidic than they should be and this threatens marine ecosystems (WWF 2015). South Africa is cognizant of the fact that it is Africa's principal greenhouse gas emitter. Many studies of energy-efficiency investments make the assertion that many investments could be made at net negative costs today, that is, net benefits in order to reduce greenhouse gas emissions (EMF 2011).

Effects of Air Pollution

South Africa has been playing a dominant role as a developing country in international climate change negotiations. However, it is not yet obliged to make commitments to reduce carbon emissions. South Africa is unfortunately also part of the problem – the largest emitter of greenhouse gases on the African continent and home to the world's biggest single emitter of CO₂ (Sasol's Secunda plant, which converts coal to diesel and other fuels).

Air pollution leads to acid rain which ultimately destroys plant life and it therefore pro-

motes global warming. The smog levels in cities increase due to excessive amount of motor vehicles on the roads and the combined effect is to deplete the ozone layer. Not only is the filthy air an eyesore but more importantly it leads to severe respiratory illnesses which cost the state millions in health bills. Where there is Ozone layer depletion this is a serious problem. When ozone is near the surface of the earth, it is harmful but it is vital in the atmosphere since it blocks dangerous ultraviolet radiation from the sun. It has been proved that the decrease in stratospheric ozone comes from human use of CFCs and other chemicals and general air pollution (Archer and Brovkin 2008). Methane raises the temperature even more than CO₂, and the amount of methane in the atmosphere, like that of CO₂, is also at the highest level ever seen. Two thirds of the current emissions of methane are by-products of human activity. This means that things like deforestation, the production of oil and natural gas, decomposition of garbage and sewage, and raising farm animals are all to blame.

Human activity is responsible for the rise in CO₂, methane, and other greenhouse gas levels, and that the increase in these gases is causing the rise in mean global temperature that we are now experiencing.

Prinn et al. (1987) state that: *“Even if there is no tipping point (or we manage to avoid it), the acceleration of warming means serious trouble. In fact, if we stopped emitting greenhouse gases into the atmosphere tomorrow, temperatures would continue to rise for 20 to 30 years because of what is already in the atmosphere. Once methane is injected into the troposphere, it remains for about 8 to 12 years.”*

Millennium Development Goals (MDGs)

The MDGs have been developed in order to obtain measurable targets for poverty reduction. They include a framework, which provides for a multi-faceted definition of poverty and there are eight MDGs (UN 2005). These include *inter alia*, the eradication of extreme poverty and hunger; achievement of universal primary education; the promotion of gender equality and empowerment of women; a reduction in child mortality; better health for mothers; the combating of HIV/AIDS, malaria and other diseases; environmental sustainability and the creation of a global partner-

ship for development. There are undoubtedly linkages with climate policies. Clean energy is a critical factor as it would reduce at least indoor pollution and this requires the buy-in of private sector investors to tackle greenhouse gas emission cutback ventures. Socio-economically, South Africa is on the whole vulnerable to the impacts of climate change for various reasons. We have a huge part of our population living in impoverished conditions. Wherever we look, we see informal settlements established in localities that are exposed to extreme weather events (Scholes 2015). In South Africa there are nonetheless, formal mechanisms in place which provide stakeholders with substantial input into policy development processes. This has been done in part so as to seek to redress the evils of the apartheid era. There have also been great inputs by both industry and mining in steering national policy. South Africa importantly, also recognizes that the environment requires protection for the benefit of both present and future generations.

It is clear for all to see, whether in Cape Town or Johannesburg that there is a lack of satisfactory housing buildings to provide sufficient protection against the elements. Things are made worse by the very high prevalence of disease, which places poor people at further risk (Scholes 2015). There is ample evidence which shows that climate change is a real problem and it is caused mostly by human activity (WWF 2015). It is a fact that the many forests on the earth protect it by absorbing massive amounts of carbon dioxide (CO₂), which is the most plentiful kind of pollution that causes climate change. Forests are currently being destroyed or damaged at an alarming rate and this is also the case in South Africa. Where there is logging for example in Mpumalanga Province, and clearing land for agriculture or livestock, we find that huge amounts of carbon dioxide and other harmful greenhouse gases are released into the atmosphere. Thus reduces the regions ability to absorb carbon pollution (WWF 2015). One of the major causes of global warming is an increase in CO₂. Some scientists think this will help plants. Forestry is also greatly impacted by global warming as commercial forests have a large need for ample water resources. The changing rainfall patterns, means that normally wetter areas where commercial forestry is usually undertaken may not have enough water resources available to

allocate to their needs for forest growth. In addition, where there is an increase in temperatures and a steep drop in rainfall, the regularity and amount of wildfires will increase and threaten all types of vegetation (Griffin 2012). Adger et al. (2005) explains the need to make possible adaptation strategies among individuals so that nations make the most effective decision in vulnerability measures and adaptive strategies to fight against climate change.

There are some scientists with different opinions on the issue of global warming. For example, in the USA, the United States Environmental Protection Agency (U.S.E.P.A) predicts a 7 percent rise in precipitation by the year 2060 and a 5 degree rise in the temperature. If rain increases plants will have plenty of water (Effects of Global Warming 2016). If the weather gets warmer, this will mean a longer growing season and that plants will produce more fruit since they then have a longer growing season.

Plants also absorb CO₂ like we breathe oxygen so if there is warmer weather, and an increase in rainfall, and much more CO₂, plants will tend grow better instead of dying during global warming. Burning coal releases 70 percent more carbon dioxide than natural gas and this is a highly unsatisfactory situation. The Brundtland Report (1987), states that societies must meet the needs of the present without compromising the ability of future generations to meet their own needs. This means that we should be careful as to how we treat the planet.

The greater part of South Africa experiences low and uneven rainfall. The result is that there is less access to safe drinking water which creates a huge problem for many communities. Water shortages which are currently underway in South Africa pose a serious problem for the future of the nation, and climate change definitely makes this problem worse. People cause climate change and in the United States of America Scientists believe that as much as thirteen percent of global carbon emissions are the result of deforestation. This is then a far greater problem than the emissions from every motor vehicle, truck or aircraft on earth combined (WWF 2015). If, as predicted, global temperature rises up to another 3°C by the end of this century, the earth will be far warmer than it has been in about the last 3 million years. Carbon dioxide has a far longer residence on earth and it can last from about 70 to 120 years. Roughly at

least twenty percent of the CO₂ being emitted today from whatever source, will still affect the earth's climate 1,000 years from now (Seidel and Randel 2007). It is also interesting to note that Carbon dioxide emissions are higher by greater income groups.

Human Health Impact of Climate Change in Southern Africa

The South African government has taken various important steps in reply to climate change and its threats to the health of people. There is a National Climate Change Response Plan White Paper which clearly defines the states vision for successful climate change response and the desirable transition to a climate-durable and low-carbon economy. Various potential health challenges for South Africa are identified and these include, vector and water-borne diseases and heat stress. Climate change already leads to the problem of disease and premature deaths across the world. This will gradually worsen in poorer nations where incomes are low. Many people will die in heat waves, injury will increase and disease from heat-waves will also grow. There will be many more floods, storms, fires and droughts. A major problem for humans will be a greater incidence of heart and lung illnesses. These will most likely increase when ground-level ozone (a toxic gas), smoke and airborne dust increase in response to warmer temperatures. Higher temperatures may also lead to the rapid spread of malaria across densely populated parts of Zimbabwe and also spread onto the South Africa Highveld and Swaziland. Dengue fever, also carried by mosquitoes, may also spread into areas of southern Africa where it previously did not occur. We may even find ourselves with the Zika mosquito borne virus which is currently spreading in South America. Aside from the direct impacts of floods on human health, such as drowning, there are other flood-related impacts such as the outbreak of diarrhoea as water supplies become contaminated. There will also be many problems relating to food security. This is mainly due to the fact that we will have less food and when we have access to food, its nutrients will be low quality. This will lead to more malnutrition and starvation (IPCC Fourth Assessment Report 2007). The National Climate Change and Health Adaptation Plan, which was the brainchild of the National De-

partment of Health, elaborates on the many and stressing health challenges in the context of socioeconomic risk factors, such informal settlement housing. Climate change issues are not covered near enough in the curricula at schools globally, and are rather addressed in a very superficial manner which exaggerates individual human responses such as recycling, reusing and reducing, at the expense of a consideration of the wider social processes which drive climate change per se, such as multinational corporation degradation of the environment (UNESCO Bangkok 2012). What is critical is the buy-in of scholars and local communities and of course, industry. Poverty reduction is a hugely important aspect in seeking to ensure that there is effective mitigation of the severe negative impacts of climate change.

CONCLUSION

It is clear from the literature that in order to adequately address the climate change threats we face, an urgent reduction of carbon pollution is required. The carbon footprint of industry has to be eradicated and we need to get ready to meet the challenges of the shocking reality of global warming. Communities require governmental help in adapting and the latter must promote and monitor policies to fight the climate changes. Extreme weather events are here and we require greater preparation to face this challenge. Our cities need to switch to totally renewable energy sources and measures must be in place to improve ambient air quality and also to guard and conserve dwindling water supplies. Deforestation plays a key role in global warming and our forests need conservation as they produce O₂ and absorb CO₂. The latter is the major source of pollution that creates climate change. We thus need to ensure that global climate change agreements shrink forest destruction and degradation of the natural environment and protect all fauna and flora as we work with local communities to make them sustainable. Government and business have great roles to play. The former must advance policies that reduce carbon pollution and support clean energy technologies. In addition it must monitor industry carefully in how it operates. There is no doubt that South Africa must reduce carbon pollution to circumvent the worst consequences of climate change. A transition to clean energy sour-

es like wind and solar would be a critically important step. It is also clear that companies have a huge responsibility to diminish their inputs into climate change. Global warming is at this juncture a stark reality and is already affecting our climate in horrific ways. Prevention is not an option and only mitigation and a strong desire to adapt how business is conducted will suffice. South Africa correctly wants all developed countries to respond with leadership, and taking on legally binding reductions in their emissions. They should also agree on their respective responsibilities and then it may be possible to agree on a set of long-term goals, which we need as a matter of urgency. The CSIR states that South Africa is one of the most vulnerable countries when it comes to global warming according to their climate modeling capabilities. It is important for the media to play an active role in publicizing climate change issues and national policies need to be explained to people and proper enlightenment is required for especially the vulnerable people in climate change matters. Better management of agriculture is also a real way to deal with South Africa's carbon stock issues. It must be stated that while there is clear understanding of the problem of climate change, South Africa's policies on global warming nosedive when it comes to adequately addressing this issue. What is alarming is the slow move towards dealing with the major environmental issue of energy inefficiency, and the wasting of non-renewable sources of energy. When it comes to the issue of economic modeling of mitigating climate change this also raises dire issues to consider in climate policy analysis such as inter alia business impacts, per capita incomes and also discusses induced technological change (ITC) which embraces the modeling of enhanced energy efficiency as a way forward that would invariably change consumption, technology policies and even lifestyle patterns.

To address energy efficiency, we need to use less energy and then also make a firm commitment to move towards renewable sources including solar power, wind power and hydroelectric power. The degradation of oceans and our waterways requires intensive action as a matter of urgency. Given the severe water shortage issues, other aspects requiring action are urban and agricultural runoff, deforestation, overgrazing, municipal sewage, dealing with industrial wastes and atmospheric fallout. Also important

to consider are desertification, and salinization of water supplies. South Africa needs to use its limited resources wisely and in a strategic fashion and accept that it has indulged and continues to indulge in climate injustice. All stakeholders should be able to express their opinions and policies and decisions taken should be contested. Promoting the importance of climate change in education system is one of the most effective as well as financially effective means of confronting the climate predicament we face through its multiplier effect. Education can potentially to play a far more significant role in enhancing 'bottom-up' solutions to the problem that cannot or will not be addressed by those in authority.

RECOMMENDATIONS

There is an urgent need for South Africa to reduce the total greenhouse gas emissions from business operations, supply chains, products and services and also employees. The requirements of the law and more specifically the NEMA, must be met as organizations assume greater responsibility and make firm commitments to go beyond the triple bottom line. In the agricultural sector, farmers need to have improved and greater access to climate data and they should additionally acquire needed knowledge about the importance of climate change in order for them adapt effectively to what is needed. Farmers should be able to access required data and knowledge from sources such as the media and research institutions including the Agricultural Research Council, Civic societies and NGOs. All industries need to divulge the financial and quantifiable implications of climate change as well as their plans and goals for mitigating the risk by using effective EMSs. Essentially effective governance structures to manage risks at the board and CEO levels of companies are required in line with King III. NGOs and the media should not be partners in the failure of the government and civil society to ethically analyze climate change current and future policies. The pressing needs of poor and vulnerable people in South Africa should be considered when taking action in the environment and public awareness of ethical and justice issues must be excited.

Companies must, as a matter of course, develop products and practices that lessen greenhouse gas emissions and produce revenue for

the company and any vested interests that manoeuvre in opposition to the development of ethical climate change policy, needs to be uncovered by forceful processes that prevent and expose unfair influence and corruption in especially industrial sectors of mining and energy production. Investors also have a crucial role to play as they engage with corporations on their business strategies so as to help reduce the risks of climate change. They could in addition, integrate financial and material risks of climate change into their investment choices.

The government needs to monitor the adherence to its wide range of Acts on climate related issues and fine transgressors. They could further empower agricultural extension officers to serve communities beyond basics and provide education for especially uninformed farmers on aspects such as crop diversification in unusual climactic conditions. In terms of energy, there should be suspension on building further coal-fired plants and instant cessation on any new coal-to-liquid plants construction. Free basic electricity must be provided and carbon taxes introduced. Tree planting should also be promoted while steps should be taken to introduce greater awareness of environmental issues from the primary school up to university levels. Policy-makers and all politicians should be educated on the ethical issues that are intrinsic in climate change. Above all, the commitment of the government and all stakeholders to fight climate change is required. Records of state and private sector compliance and non-compliance need to be kept and monitored by an environmental watchdog agency. Where there are acts that promote climate change, the perpetrators must be fined or arrested.

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