THE KAROO HYDRAULIC FRACTURING DEBATE: ACCOUNTING FOR FUTURE GENERATIONS

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Abstract

The temporal complexities of anthropogenic Global Climate Change (GCC) force us to extend our moral deliberations beyond what appear to be straightforward, contemporary issues to include the interests of future generations. The Karoo hydraulic fracturing debate is a case in point. The ethical debate thus far has focused on the present-day environmental aspects of Shell's limited exploratory drilling proposal using hydraulic fracturing technology; but the shale-gas reserves that are believed to underlie the Karoo could assist in mitigating South Africa's significant carbon emissions, the main contributor to anthropogenic GCC. Thus, I argue that the *actual* ethical debate is whether to allow gas *exploration* over the Karoo or to disallow the entire possibility of *exploiting* any gas reserves that may have been found. A consequentialist weighing up of the respective potential harms to all of the morally-considerable interests involved, including future generations, makes clear that not only is allowing exploration of the Karoo the morally *correct* decision, but it is ethically *obligatory* to do so.

Declaration

I declare that this research report is my own unaided work. It is submitted for the degree of Master of Arts, Applied Ethics for Professionals, in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

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Robinn Yale Yale-Kearney

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I am also grateful for the love and support I received from my husband Chesney and children Matthew and Shannon. They had greater aspirations for me than I did for myself.

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1 Introduction

With all moral issues related to the environment, one of the more difficult challenges is to ensure that all entities with an interest in the outcome are recognized and represented in some way. This is especially so when considering actions that will have an impact on the effects of anthropocentric Global Climate Change. In such cases, we need to take into consideration not only the current generation, but also those potential future victims of unjust decisions today.

These sorts of complications apply to the moral issues around Shell's application to carry out hydraulic fracturing of the Karoo in the search for shale-gas reserves. What at first glance appears to be primarily an environmental issue, one that needs to consider the potential harms to the Karoo from a limited exploration program, is complicated by the fact that gas is proving to be an important way for countries dependent on coal for their energy needs to shift to a relatively "clean" fossil fuel to address anthropogenic Global Climate Change (GCC). Therefore, taking a decision to refuse gas exploration in the Karoo is, in fact, making a *de facto* decision to disallow any exploitation of viable gas reserves that might have been found and used in South Africa's emission mitigation undertakings. Thus, the research question I will address in this research report is: "Is it ethically sound to permit the exploration for shale-gas using hydraulic fracturing in the Karoo when considering all competing moral interests, including those of future generations?"

I am going to argue that allowing the exploration for shale-gas in the Karoo is not only the morally *correct* decision, but it is *ethically obligatory* to do so because of the nature of the potential harms to some of the morally-considerable interests at stake,

particularly those of future humans. Furthermore, I shall argue that should viable shale-gas reserves be found during the exploration program, the same ethical obligation extends to the exploitation of those gas reserves with a vastly expanded hydraulic fracturing program.

The most important premise of my argument is that anthropogenic GCC is unjust because of the potentially life-threatening harms it poses for future generations if left unchecked. Support of this fundamental claim requires some background information about GCC and the ways humans may be exacerbating, if not causing, this climatic phenomena. I will also explain the threats it poses to future "others" – including future humans, the future environment in general, and the future Karoo specifically.

The reason that GCC must be taken into account when addressing the Karoo hydraulic fracturing question is because gas is a relatively "clean" fossil fuel and, internationally, has become an important source of energy production as countries take steps to address their carbon emissions. Thus, the second premise I defend is that extensive shale-gas reserves are believed to underlie the Karoo and, if this is the case, those reserves would go a considerable way toward bridging South Africa's economic and technological gulfs between "dirty" coal and "clean" renewable energy production for new energy-generation capacity in the medium-term as the country addresses its own considerable carbon emissions.

But this crucial transition can only be made if, according to my third premise, exploration for shale-gas with hydraulic fracturing is allowed and is followed by the exploitation of any viable reserves. To do so, however, will mean that there will be damage done to the Karoo, the extent and severity of which are unknown at this stage.

My final premise is that the environmental harms that will be committed against the Karoo and any morally-considerable entities whose interests are aligned with those of the Karoo, even from full-blown shale-gas production, are less than the potential life-threatening harms that future generations face from unchecked GCC. In order to support this final premise, I argue that future humans have a special moral status in this debate because they must be accorded some of the most basic of human "rights", that of their right to the basic means of survival. But it is important to recognize that the Karoo itself is particularly vulnerable to the effects of GCC: the environmental damages that might be visited on the Karoo from shale-gas production, damages from which it will eventually recover, pale in comparison to the expected ravages of anthropogenic GCC on the "future" Karoo, damages from which it may never recover.

On the basis of these four premises, my conclusion is that the "right action" in this debate is to allow gas exploration over the Karoo: our failure to act to address anthropogenic GCC - in this case by disallowing exploration and any possible exploitation of the Karoo's shale-gas - is unethical because of the nature of the harms that will befall future generations from unchecked anthropogenic GCC. This conclusion is a result of a consequentialist weighing of the respective harms (outcomes) of our choices to take no action and thus "save" the current Karoo biome from possible environmental damages or to take action against GCC by allowing exploration of the Karoo and, in doing so, taking what steps we can in order to prevent potentially life-threatening harms to future humans. I argue that our *failure to act* now on GCC may be committing what will become an act of gross historic injustice when future generations look back on what we did or didn't do to limit our emissions. Righting an injustice-in-the-making requires positive duties of action to address GCC in whatever way possible,

actions that are ethically demanded of us, even if these actions result in other, but lesser, harms. Therefore, in order to acknowledge our culpability in contributing towards GCC and to take responsibility to ensure intergenerational justice, I conclude that not only is allowing exploration of the Karoo the morally correct decision, but it is ethically *obligatory* to do so.

2 The Karoo Hydraulic Fracturing Debate

I begin by describing the Karoo hydraulic fracturing issue in order to establish the main ethical concerns associated with it. Understanding the hydraulic fracturing process itself, which is used to determine the existence and viability of gas resources, is important only insofar as determining the extent of the possible harms that it may cause. One of the purposes of this report is to consider the technology from an *ethical* perspective rather than an emotive one; I will explain why the technology is controversial, but develop my argument about the morality or otherwise of its use in the Karoo when viewed in a much broader ethical context.

Continued improvements in hydraulic fracturing drilling technology have made vast worldwide resources of "unconventional gas"[1] economically viable. In South Africa, international oil company Shell Exploration Company BV (hereafter referred to as "Shell") has applied to explore the vast shale beds which are believed to underlie portions of the Karoo within the country's interior. A requirement of the exploration

1 "Unconventional gas", also known as "tight gas", is that which is trapped in rock, in this case dense sedimentary shales formed from deposits of mud, clay and organic material.

application process was the filing of an Environmental Management Plan (EMP) for each of the three 30 000 km^2 precincts over which Shell seeks exploration rights.

There are many affected parties, or stakeholders, with interests in the Karoo hydraulic fracturing debate, some more obvious than others. The obvious stakeholders, those most directly affected by Shell's exploration plans that have made submissions to the EMP, are termed "Interested and Affected Parties" (I&APs) [2]. Thus far, the identified I&APs include landowners and farmers (in their personal capacities, through their legal representatives, and through agencies such as Farmers' Unions and the Treasure the Karoo Action Group), the Karoo biome as a whole[3] (represented for instance by the Centre for Environmental Rights and the Federation for a Sustainable Environment), individual threatened species (i.e. the riverine rabbit and the blue crane represented by the Endangered Wildlife Trust and Birdlife SA), specific environmental entities (such as the Karoo's water and heritage), and, to a very limited extent, the poor communities spread across the Karoo through district representatives.

Nearly all I&APs, with the noticeable exception of the local poor communities, were unanimous in opposing the granting of the exploration permits. A primary concern related to the hydraulic fracturing technology that will be used to determine the

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2 "Interested and Affected Parties" are any stakeholders interested in or directly affected by an issue for which an Environmental Impact Assessment is being undertaken. This term is useful to describe the various stakeholders who have tabled formal inputs into the EMP, but it does not capture all the morally-considerable entities and, thus, will only be used when discussing the EMP itself.

3 Referring to biomes or to species as interested and affected parties might appear to be a strange use of language. However, many environmental ethicists have defended the claim that species, ecosystems and other such 'wholes' are morally considerable – a claim I broadly support. On this basis, I think it is reasonable to include these entities as interested and affected parties.

economic viability, or otherwise, of the shale beds. Hydraulic fracturing is used to release “tight-“or “unconventional gas” from its host formations – i.e. the gas trapped in the deep-underlying shales – by “… creating fissures, or fractures, in underground formations to enable natural gas to flow” (Golder Associates 2011,100). Hydraulic fracturing is described by the U.S. Environmental Protection Agency as “a well stimulation process used to maximize the extraction of underground [gas]” and the “*hydraulic fracturing process* includes the acquisition of source water, well construction, well stimulation and waste disposal” (U.S. Environmental Protection Agency 2011c). Once a vertical well is drilled to the target gas-bearing shale deposit, up to 5000 metres below surface, horizontal or directional wells are drilled up to thousands of metres away from the vertical borehole. Because the host formation, shale in this case, is dense, the trapped gas must be released from the host rock in order to flow to the surface. This is done by fracturing the shale beds by means of injecting a slurry of sand, water and chemicals at pressure into the horizontal well. The sand (known as the proppant) keeps the fractures open while the “fracturing fluids” – the chemicals and water that act as solvents, gelling agents, and surfactants, among other things - are returned to surface as waste, followed by the newly-freed natural gas.

The most controversial aspects of the hydraulic fracturing process are twofold, both having to do with the scarce water resources of the arid and semi-arid Karoo biome. First is the amount of water required per borehole (between 300 000 litres and 6 million litres) (Golder Associates 2011, 109). The second issue is the potential contamination of underground aquifers as a result of leakages inside the boreholes of the chemicals used in the fracturing process to open the fractures or of the target hydrocarbons (if present), or by the seepage of chemically-tainted waste water from surface. Because

the Karoo's water is so limited and, thus, particularly precious to its various inhabitants, these are reasonable grounds for concern.

If the only moral issue was the question of "to explore or not to explore", a simple appeal to the "Precautionary Principle"[4] would likely be sufficient to determine the rightness of granting Shell exploration rights. It would be necessary, when doing so, to consider the mitigation of the possible harms to the Karoo's scarce water sources. Firstly, it should be noted that the scale of Shell's proposed exploration plan is very limited (24 boreholes, each with a "footprint" of 1 ha over its 9 million ha exploration target area) (Golder Associates 2011, 85). Secondly, Shell states, of the 900 onshore gas wells that it drilled in North America between 2007 and 2010, that "[n]o subsurface water contamination occurred as a result of hydraulic fracturing operations" (Golder Associates 2011, 100). The limited exploration program and Shell's experience with hydraulic fracturing technology go some way towards containing the ethical concerns that arise on the basis of the "Precautionary Principle" and could be sufficient to support the moral acceptability of Shell's exploration program.

However, the issue is not as simple as this. It must be borne in mind that *refusing* Shell's exploration application raises a more complicated ethical problem: any decision to disallow Shell's *exploration* plans would mean that a *de facto* decision would also have been made to disallow any future *exploitation* of the estimated trillions of cubic metres of potentially viable gas reserves that might have been found. Thus, a decision not to allow exploration for shale gas also constitutes a decision never to be able to

4 The "Precautionary Principle", as applied in the environmental sense, is the principle that if an action has the possibility of causing harm, and if that harm could be substantial, then that action should not be undertaken as a precautionary measure.

obtain any of the possible future benefits of exploiting whatever gas reserves might have been found.

The reason this must be brought under consideration in our moral deliberations is because exploiting potential gas reserves could be an important means toward mitigating the effects of anthropogenic Global Climate Change. Thus, the ethical debate central to the Karoo hydraulic fracturing issue is not simply one of weighing the moral interests of the current I&AP's; i.e. weighing the harms that could be imposed upon the Karoo biosphere against the economic benefits of job creation for the Karoo's poor. Because unchecked GCC has significant implications for interested and affected parties in the future, too, it is necessary to recognize and take into consideration the moral claims of the most vulnerable of the morally-considerable entities that are not currently represented as I&APs: those potential victims in the future of unjust decisions today. Therefore, the actual ethical question in the Karoo hydraulic fracturing debate is whether "to explore or *not to exploit*".

My research report will establish the moral considerability of the Karoo which encapsulates most of the proximal I&APs: property owners and farmers; individual inhabitant species of plants and animals; the Karoo's water, air, land, and landscape; as well as the "sense of place" the entire area represents for its human residents. However, what is missing in this sweeping consolidation of what I believe to be the moral interests associated with the Karoo are the poor communities spread throughout the region. The local poor are vulnerable to the potential loss of land that may be used for subsistence farming, but they are even more vulnerable, and dangerously so, to the future effects of GCC. I will show that their moral interests are more closely linked to those "silent and vulnerable" interests that have had no representation in this debate,

the outcome of which could have a serious impact on their well-being: the *future* humans, plants, animals, and atmosphere that will bear the ultimate consequences of anthropogenic GCC many decades hence. The challenge is to establish the moral considerability of future generations in the hydraulic fracturing debate and to weigh their moral interests against the others at stake to make an ethically justifiable decision.

3 Anthropogenic global Climate Change is unjust

Fundamental to my argument that allowing hydraulic fracturing for gas exploration in the Karoo is ethically obligatory is my first main premise – which I defend in this section – namely, that *anthropogenic* Global Climate Change (GCC) is unjust. It is important in justifying this claim that I first make clear the distinction between GCC that is a result of natural climatic cycles and the aspects of GCC that are human-induced, or anthropogenic. I will argue that our lives and well-being have been "financed" by cheap and abundant energy derived from fossil fuels, primarily coal and oil, and that the emissions from burning this "cheap" energy are the leading contributors to anthropogenic GCC. Thus I will show that it is our *actions* – burning "dirty" fuels to generate cheap electricity - that continue to contribute to the problem. Linked to this is our *inaction* in taking the necessary steps to mitigate the problem by switching to cleaner energy-producing sources.

I will argue that anthropogenic GCC is unjust because it is a result of our actions and it threatens future generations with considerable harms. With respect to GCC, the linking of cause and effect – or action and consequence – is temporally disjointed because it is "a *substantially deferred* phenomenon" (Gardiner 2006, 403). The harmful consequences of our actions and inactions with respect to anthropogenic GCC are

compounding into the future to the point that they represent serious harms to future generations, harms that we may never experience but for which we have responsibility.

It is important when developing this part of my argument that I defend the moral considerability of future generations. In order to do so, I will first appeal to Rawls' "original position" (Rawls 1971) to establish the moral status of future humans and then expand this moral considerability to other future entities, such as the Karoo biome itself. I will discuss the future harms that unchecked anthropogenic GCC poses to both future humans and the future Karoo[5], harms that make it unjust. As the development of my argument proceeds in later sections, I will show why the nature of the harms that future humans may face from anthropogenic GCC - potentially life-threatening harms – outweigh those of the Karoo. In this section, however, I seek merely to defend the claim that anthropogenic GCC is unjust because of the nature of the harms facing future humans. On these grounds I will go on to argue that we have a moral responsibility to *cease* our current actions that exacerbate the problem and *take action* to address the problem, even though those necessary actions may cause other lesser harms.

While there remains uncertainty about how much of GCC is attributable to anthropogenic interference rather than natural climactic cycles of warming and cooling over thousands of years, there is no such uncertainty about the existence of the "enhanced greenhouse effect": human-produced pollutants primarily as a result of our energy production. Scientific evidence produced in 2007 by the Intergovernmental

5 I define the "future Karoo" as the ecosystem itself and the non-human life forms that will inhabit the Karoo in the future.

Panel on Climate Change (IPCC)[6] shows there has been a 0.74° C warming of the Earth's mean surface air temperature over the past century[7]. There is a broad scientific consensus that much of GCC can be attributed to the "greenhouse effect" whereby gases in the Earth's atmosphere trap heat and re-radiate it back to the Earth's surface, instead of letting the heat escape out of the atmosphere. Some of the greenhouse gases are naturally occurring, but it is the human-, or anthropogenic-, sources, such as carbon dioxide, methane and nitrous oxide (measured in CO_2 equivalents), that are of concern in my argument, because the resultant "enhanced greenhouse effect" has contributed to and exacerbated natural climatic cycles by speeding up the earth's warming (U.S. Environmental Protection Agency 2012). If our emissions were a consequence of some activity we could not change, then there would be no ethical debate about our actions. However, anthropogenic GCC is a consequence of actions that we can change and, as such, it is a moral issue.

The choices that we make with regard to how we produce the electricity to support our lifestyles are those of most concern. By far the highest percentage of CO_2 equivalents responsible for the "enhanced greenhouse effect" are emitted in the mining, distribution, and combustion of fossil fuels for energy production (U.S. Environmental Protection

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6 The IPCC is a scientific body founded in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to assess information about and understanding of human-induced climate change with a view to finding ways to mitigate and adapt to climate change. Because it is neither linked to any specific government (membership is open to all members of the UN), nor does it have any political affiliation, its research on climate change is generally-accepted to be an unbiased and objective source of climate change research.

7 This figure was updated from the previous estimate of 0.6° C in the IPCC's Fourth Assessment Report: Climate Change 2007. http://www.ipcc.ch/publications_and_data/ar4/wg1/en/tssts-3-1-1.html

Agency 2011b). Because of their abundance and thus relative inexpensiveness, fossil fuels (specifically coal and oil) are by far the most important fuels for energy production around the world. An important factor in determining a country's contribution to anthropogenic GCC is how "clean" its choice of energy production is – as measured by CO_2 equivalents produced per unit of total primary energy supply. Coal in its various forms (anthracite, coking and bituminous coal, and lignite) is the "dirtiest of the fossil fuels, producing between 800 and 900 grams of CO_2 per kWH energy produced. The "cleanest" fossil fuel is natural gas at 370 grams CO_2 per kWH, less than half that of coal (International Energy Agency 2011, 39). However, if the impact on climate change is included in the analysis of determining "clean" or "dirty" energy-producing choices, coal features even worse. A study recently published in the *American Economic Review* measured the "Gross External Damages" (GED) of coal power generation – the physical, economic, *and* climate change costs – in absolute and relative terms. Coal's GED of 68.7 swamped the GEDs of competing fossil fuels: petroleum (2.5) and gas (3.4). Measuring GED to kWh energy production, coal (at 0.0359) is 31% worse than petroleum and 540% worse than gas (Muller, Mendelsohn and Nordhaus 2011). The conclusion made by Nobel-winning economist Paul Krugman in his NYTimes.com blog of 30 September 2011 is that "…if consumers did have to pay the full cost [including the very large external costs associated with coal-powered energy], they would use much less electricity from coal – maybe none". But our choices on how we should produce our energy are not based on a "full cost" that includes how we are contributing climate change.

We are choosing to use the cheapest (and unfortunately the most "dirty") energy source to "fund" our preferred lifestyles. Thus, the quantity of total emissions per country is linked to both the pace of its economic development and its choice of fuel for the

energy needed to underpin its economic growth. The major industrialised economies have historically produced the most emissions and those countries overly reliant on coal are the worst of the worst emitters. According to statistics produced by the International Energy Agency, China has overtaken the USA since 2007 as the most profligate producer of CO_2 effluents in the world and coal is responsible for 84% of its CO_2 emissions. South Africa is the worst CO_2 emitter in Africa (more than double the next highest country) and ranks as the 12th worst polluter in the world. Because of its dependence on coal for energy supply, South Africa also has the worst ratio of CO_2 emissions per unit of energy produced on the continent and ranks in the quartile of "dirtiest" energy producers in the world (International Energy Agency 2011, 47). It seems clear, therefore, that a not insignificant degree of warming is as a result of human activity, and as such we are morally responsible for it.

We have choices, then, about how we will produce our energy and can make choices that reduce the harmful emissions responsible for anthropogenic GCC. An example of this is what is happening in the USA. Total energy production in 2009 was equal to that of 2004 (some 3,900 terawatt hours), but energy-sourced CO_2 emissions over the same period *declined* by 10% (International Energy Agency 2011, 46). This is a result of a measurable shift away from coal-fired power stations in favour of natural gas. It is clear, therefore, that our actions – i.e. our decision to continue burning "dirty" coal when there are cleaner alternatives such as gas – will result in the continued disbursement of dangerous emissions into the atmosphere which contribute to anthropogenic GCC.

As long as we fail to recognize the "true costs of coal", i.e. taking into account the impact on the earth's atmosphere from burning this "dirty" fuel, we disregard our responsibility for the changes in the earth's climate that are taking place now and that

will manifest in the most dangerous ways by compounding into the future. The environmental impact of the measured 0.74° C increase in the earth's average surface since 1900, while seemingly negligible, has already been significant: glaciers and polar ice caps are melting, tropical corals and plankton are dying, flora and fauna are migrating, and the ranges of some diseases such as malaria are extending (IPCC Fourth Assessment Report: Climate Change 2007). Yet there are still climate-sceptics who refuse to acknowledge anthropogenic GCC, despite the compelling evidence. This may be because these changes have yet to affect our daily lives in any meaningful way. Stephen M. Gardiner describes anthropogenic GCC, in his widely cited paper "A Perfect Moral Storm", as a "substantially deferred phenomenon" because the "full cumulative effects of our current emissions will not be realised for some time in the future" (Gardiner 2006, 403). We are shifting the worst consequences of our acts of atmospheric contamination into the future and, thus, onto others who have no ability to apply any form of "mutual coercion" to protect themselves from our misanthropy.

Global climate change models predict many ways that the future environment, future species, and future humans could be impacted. A major concern is that a climactic "tipping point"– an unpredictable critical point of a number of seemingly independent consequences of GCC – will be reached resulting in significantly accelerated warming. Examples presented in Steve Connor's article "Scientists identify 'tipping points' of climate change" (The Independent, 5 February 2008[8]) are the melting of the ice caps, the cessation of Asian and African monsoons, and the deforestation of Amazon and Boreal forests. Each event is critical in its own right with potentially frightening

8 Archived at http://www.wildlandsleague.org/attachments/Tipping_Points_Climate_Change.pdf

consequences, but the atmosphere's response to the combination of the events is beyond even the GCC-impact prediction models.

South Africa, like many developing countries, is particularly vulnerable to the deferred effects of GCC because more than 90% of the land is arid or semi-arid. The government's Green Paper on its "National Climate Change Response" states "…should multi-lateral international action not effectively limit the average global temperature increase…, the potential impacts on South Africa in the medium- to long-term are significant and potentially catastrophic". Projected temperature increases by 2050 of 1° to 2℃ at the coast and 2° to 3℃ over t he interior will completely alter the country. Continued desertification of the interior would result in the destruction of agricultural land, increased fires, and the loss of water. Coastal areas will be affected by a rising shore line, increases in severe weather events, flooding, and the spread of diseases such as malaria and water-borne hepatitis (Government of the Republic of South Africa 2010).

These environmental issues will impact future humans in extremely harmful ways. The shifting of water sources, loss of food-producing capabilities, and spreading disease, for instance, cannot but have a significant impact on human life, particularly the future poor who do not have the wherewithal nor the freedom to move to places where their livelihoods and lives are not threatened. Stephen Gardiner points out "…insufficient action may make some generations [of humans] suffer unnecessarily… [and] create situations where *tragic choices* must be made" (Gardiner 2006, 406). Taking little or no action now on human-produced carbon emissions, those for which we are responsible, is turning a blind eye to an egregious act of injustice against innocents, albeit innocents of the future. But in order for me to defend the premise that anthropogenic GCC is

unjust because of the deferred harms it may inflict on future generations, I must establish that we do, in fact, have a moral obligation for the welfare of future generations of persons and/or the environment; i.e. that future generations are morally-considerable entities and, as such, that their interests must be taken into consideration in the ethical debate.

Of the many ethical dilemmas that arise from anthropogenic GCC, none is likely as complex as those associated with future generations and the harms that anthropogenic GCC poses for them. I argue that future generations of the environment as a whole, and humans as a particular species, do have separate and distinct moral statuses that we must recognize and respect. I will begin defending this claim by discussing the moral status of future generations of persons. It is particularly apt, as Behrens states in this regard, that "…if we are unable to coherently account for moral duties to future persons, it is highly unlikely that we will be able to do so for other entities" (Behrens 2011, 120). Such is the case in this debate.

Future generations of persons can be defined in the simplest terms as "…those people who will be born at a later date, not yet conceived…" (VandeVeer and Pierce 2003, 652) or as "…people living in the (remote) future" (Meyer 2008, 6). Unfortunately, the further into the future that we attempt to extrapolate the definition of future generations, the more difficult it becomes to argue for their moral considerability, much less to establish our obligations to these totally hypothetical beings and overcome the motivational hurdles to shoulder the responsibilities (if any) we may have for them. From a theoretical perspective, I believe that extending John Rawls' Theory of Justice arising from the "original position" to include one's generation of existence seems to

best capture our intuitions that future generations (of humans at least) do have moral standing (Rawls 1971).

John Rawls' influential contractarian approach to social justice envisages contractors negotiating the principles of a fair society from an "original position" - the hypothetical situation where "…no one knows his place in society, his class position or social status nor does any one know his fortune in the distribution of natural assets and abilities, his intelligence, strength, and the like" (Rawls 1971). If one also does not know to which generation she belongs, then she and others acting rationally under this "veil of ignorance" can be expected to collectively make decisions and choices that are fair for everyone, no matter which generation they happen to belong to. From an intergenerational perspective, this decision-making under uncertainty ensures that participants will strive to choose alternatives or take actions whose worst possible outcome (i.e. for any generation) is better than the worst outcome of any other alternative (the "maximin" principle) (Rawls 1971).

Rawls believed that the way to ensure concern for future people was that the parties of his "original position" should see themselves as "heads of families"[9]. This perspective would establish familial concern for one's children and grandchildren. Although, from a theoretical perspective at least, concerns have been expressed that "chain linking" our familial ties to future generations will result in a severe discounting problem as one

9 Rawls was one of the first philosophers to argue that we had obligations to future people. He adapted his "original position" to include the concept of "heads of families" to establish that, morally, the least we owe to future humans is the equivalent of what we received from previous generations. He called this concept "just savings" which has additional components of duties, but which are not relevant for this example.

moves farther into the future (Partridge 2003, 433), some specific features of the Karoo hydraulic fracturing debate overcome this concern by shortening the time period of concern.

By the year 2050, as mentioned earlier, it is predicted that South Africa will face measurable and dangerous temperature increases, particularly across the Karoo. In order to address its own contributions to anthropogenic GCC over this same time period, South Africa has made commitments to the international community, as part of global GCC mitigation efforts, to cap its CO_2 emissions sometime between the years 2020 to 2025 and to reduce its emissions from 2036 to 2050[10]. The future generations of humans that will come into existence by the year 2050 – less than 40 years from now - let alone those in the next 10 to 15 years when GCC mitigation efforts are underway and/ or the potentially ravaging effects of temperature increases continue to take their toll, will be our children, grand-children, or great grand-children. Thus, the "chain-linking" of familial concern, according to the Rawlsian theoretical approach, need only extend to our grand-children or great-grandchildren in this ethical debate. We are, in a philosophical sense, lifting the "veil of uncertainty" and assuming our place as the head of family for our foreseeable offspring. Assuming our moral duties in this role requires that we take the necessary precautions to ensure that they, too, can flourish in the

10 There will not be a direct link between South Africa's mitigation efforts and adequately addressing the predicted temperature increases that make the country particularly vulnerable to GCC. No matter what steps South Africa takes to mitigate its own emissions, the nature of anthropogenic GCC means that any effective action to counter temperature increases will require all countries to take similarly drastic action.

same way as we have[11]. In the context of anthropogenic GCC, our familial partiality circumvents the "…tension between partiality and equality" (Brighouse and Swift 2009, 43) which may arise because of the type of "special interest" that a parent has for a child. This is because our descendants will share the same atmosphere and will suffer the same consequences of GCC. Our desire – or motivation - to take whatever steps necessary to ensure our descendants' well-being, in this case, affects all of their contemporaries as well. It would thus seem that the issue of determining the moral status of future generations of humans is grounded in the temporally immediate sphere of concern for conceivable offspring.

The question of whether future entities that do not yet exist can be said to have rights is theoretically perplexing. There is also still much debate around whether currently living non-human animals and environmental entities such as ecosystems have rights. Even with respect to future humans, it is difficult to insist that some of the rights we take for granted, such as the "right to life", can apply to persons who do not even exist. But future generations of humans, particularly seen as a group of potential moral agents, will have rights when they have come into existence. Since this is so, it makes sense that we ought not to create a situation which will, in the future, deny them at least the most basic of rights – the right to be able to meet their physiological needs. Our basic physiological needs include clean, breathable air; access to clean, drinkable water; the ability to produce food for basic sustenance; and shelter. Anything beyond these most

11 This discrete and relatively short time frame also brackets the theoretical hurdles with respect to future humans of "non-contingency" (establishing a moral standing to someone who does not exist) and, when they do come into existence, they are who they are because of the unique convergence of circumstances that resulted in their conception (the "non-identity" problem). These philosophical technicalities are not an issue when we consider our own future offspring and our intuitive concern for their well-being.

basic physiological human requirements are *adventitious*, meaning added or fortuitous, needs and desires. While we cannot predict what adventitious needs and desires future humans may have and, thus, cannot be made responsible for providing them, we *can* safely assume that foreseeable generations of people will have the same basic physiological requirements that we have. If we accept our role as a "head of family" and agree that we must pass on to future humans at least what we were bequeathed from our forefathers, then our *obligation* is to ensure, at the very least, that the physiological needs of future generations are not threatened by our actions. Anthropogenic GCC threatens those basic means of survival for future humans.

This grounds my claim that anthropogenic GCC is unjust because of the harms if poses to future generations: the compounding effect of today's atmospheric pollutants and CO_2 emissions threatens the very ability of future generations of humans to meet their basic physiological needs. Edward Page states "present persons…should not act so as to undermine the possibility that members of future generations will enjoy their basic capabilities to function…[T]he aim of … justice [will be]… to preserve an environment that enables future persons to retain the same substantive freedoms to be healthy, well fed, and well clothed that their ancestors possessed" (Page 2006, 70). This is the tragedy that must be recognized and faced. Without substantial mitigating efforts, anthropological GCC represents a serious harm to future generations of humans by compromising the quality of air available, reducing the amount of clean water in water-vulnerable areas, reducing the ability to produce food in areas that are currently agriculturally bountiful and extending the ranges of certain diseases. These are the predictable risks facing future generations, but if a climactic "tipping point" is reached, the outcome of our inaction could force future humans into potentially catastrophic situations requiring harmful actions against other future moral beings. With their very

basic needs to ensure their survival at risk from our contributions to GCC, future generations of humans will be harmed in the very worst way by our “unjust” inaction today.

It is helpful to emphasize the gravity of the harms that GCC poses to all future people by envisaging our children and grandchildren in danger, which is effectively the case given the relatively short time period over which South Africa must take mitigating action. This truncated “chain of concern” overcomes many of the theoretical objections to the recognition of future generations by appealing to our instinctive concern for the welfare of our immediate and foreseeable offspring. Our natural, parental concern for the well-being of our offspring ensures that we will take any steps necessary to provide for their survival at the very least; our moral duties demand it.

A question remains whether the extension of familial partialism to future generations of humans generally is sufficient to capture the moral interests of future generations of the Karoo’s poor specifically. The future poor are equally susceptible to the deterioration of the atmosphere if CO_2 emissions continue to pollute the air and damage the means necessary for human survival. Certainly, one cannot deny that today’s poor have equal concern for their future offspring as any other human would have and to which my appeal to familial partiality is made above. However the category of the “future poor” of the Karoo in this debate does require additional attention because they are more vulnerable than future generations of the relatively wealthy to the effects that GCC is predicted to have on the Karoo.

With reference to the Karoo hydraulic fracturing debate, Shell’s 90 000 km^2 area of prospecting interest spans portions of the Eastern Cape (Cacadu, Chris Hani,

Ukhahlamba, and Amatole district municipalities), Northern Cape (Karoo Hoogland and Pixley ka Seme district municipalities) and Western Cape Provinces (Central Karoo district municipality). Every single one of these district municipalities is sparsely populated and between 90% - 95% Coloured and African. Unemployment is high (typically around 40%) and some areas report rural poverty rates as high as 82% (Elsenburg Report 2009). Agriculture is important, both as a source of employment (although not necessarily in reducing labourers' poverty) and for subsistence farming, also known as 'home production for home consumption' (HPHC). The offspring of these poor are particularly vulnerable to projected GCC and the impact it will have on the Karoo's water and, thus, their food production capabilities. They have, and will likely have, less ability – none of the financial wherewithal, adaptability (because of their lack of skills and education), or mobility - to avoid the gradual desertification of the interior and the predicted destruction of their subsistence way-of-life by moving away. The mitigation of anthropogenic GCC effects on the Karoo is a matter of survival for the future poor of the area, and not merely one of their "flourishing". However, it is not difficult to continue to extrapolate the continued debilitating effects of anthropogenic GCC further into the future to surmise that at some not-too-distant point in time it could become a matter of survival for *all* future generations. Therefore, the interests of the future Karoo's poor seem to be adequately encompassed by the moral standing of future humans if one accepts the vulnerability of everyone – ultimately – if anthropogenic GCC is not addressed.

Intuitively, conceiving of future generations only in terms of humans is incomplete when the environment, or a specific biosphere such as the Karoo with respect to the hydraulic fracturing debate, is temporally boundless and immutable. If universalism, defined by Brian Barry as "…the core idea…that place and time do not provide a morally relevant

basis on which to differentiate the weight to be given to the interests of different people" (Barry 1997, 100), it seems as inappropriate to disenfranchise the *future* Karoo of moral standing if I can successfully establish its moral status.

If one accepts that none of the Karoo's individual constituents, or some subset thereof – i.e. its plants, animals, air, soil, water, and even humans – is more important than their collective inter-connectedness which, in aggregate, comprises the Karoo biosphere, then the holist "land ethic" theory can establish the Karoo's moral status today[12]. Aldo Leopold proposed that, in the way a standard of ethics determines how the "community" of humans interact, then equally

> …the land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land… A land ethic of course cannot prevent the alteration, management, and use of these "resources" [i.e. the soil, waters, plants, and animals], but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state (Leopold 2003, 216)

A right action under the land ethic is that which "tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 2003, 223). But Leopold recognized that there exists a tension between pure conservation – preserving a biota in its natural state - and the need to "respect" the biota while using it as an *economic* resource. He stated "(a) land ethic, then, reflects a conviction of

12 While the land ethic theoretically treats humans no differently than any other constituent entity that comprises an ethically-considerable biome, this is sufficient to encompass the moral interests of the "wealthy" landowners and famers in the Karoo hydraulic fracturing debate, but is insufficient for the regional "poor". The distinction is discussed in more detail further in this report.

individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity" (Leopold 2003, 222).

It would appear that the land ethic goes a long way in capturing the various interests of I&APs in the Karoo hydraulic fracturing debate with an important exception. Human interests in general, which are not mentioned specifically in Leopold's description of the land ethic, are eventually addressed by J. Baird Callicott as the theory has evolved. It seems only reasonable when establishing moral standing to the whole that human interests should count neither more nor less than any other member's interests. But Callicott "saves" the theory from criticisms of being inhuman and inhumane by confirming that humans have intrinsic rights that cannot be superseded. Callicott explains "Nonhuman fellow members of the biotic community have no 'human rights', because they are not, by definition, members of the human community…[but] (a)s fellow members of the biotic community, however, they deserve respect" (Callicott 2003, 234).

If the Karoo were a unique and pristine biosphere, in the same way the St Lucia Wetlands (proclaimed as the iSimangaliso Wetland Park in 2007) is unique and pristine for instance, one could argue that the land ethic makes it a moral requirement to preserve this inimitable "gift of nature" and take whatever steps necessary to ensure it is kept in its most natural state: i.e. the land ethic would establish "intrinsic" value to the Karoo. However, the Karoo is vast – spanning some 400 000 km^2, a third of South Africa's total area (in comparison, Shell's application area is 90 000 km^2 and iSimangaliso is 3 280 km^2 extent). It is not pristine: primary land use is grazing for sheep, goats, and cattle and over-grazing is one reason for existing soil erosion and

encroaching land degradation. In addition, the World Wildlife Fund (WWF) notes that "…pastoralism, alien invasive plants, mining, (and) agriculture…threaten the ecoregion's biodiversity" (World Wildlife Fund 1998). The Karoo, despite its beauty and "sense of place" to many, has an economic worth to farmers and property owners. Their sometimes strident demands and nature of complaints in the EMP suggest that the Karoo is of "instrumental value"; i.e. its worth to many of its wealthy and poor inhabitants lies in terms of its value in meeting human needs. If this is the case, it begs the question why the degradation of the landscape is acceptable for commercial exploitation by farmers and landowners, but unacceptable for other commercial interests. Appealing to the land ethic to establish the Karoo as a morally-considerable entity recognizes its economic value, as long as the land is left with the ability to "renew" itself.

However, this ability to "renew" itself becomes moot if concerted global intervention to mitigate GCC fails to attain the emission targets necessary to keep anthropogenic-sources of global warming in check. The Karoo is part of the 90% of South Africa that is arid or semi-arid and is particularly susceptible to GCC and is singled as such in the government's White Paper on Climate Change. The projected average 2° to 3℃ temperature increase across the region by 2050 - if global mitigation efforts are unsuccessful - suggest that "…there will be an increase in the frequency of extreme events [related to GCC], including drought… [and an] overall decrease in water availability", the most adverse effects of which "… are projected in the Fynbos and Succulent Karoo" (Government of the Republic of South Africa 2011). What appears to be a minor temperature increase has the potential of exacerbating the desertification of the Karoo, a process that has already been documented in some areas of the region. Creeping desertification could leave swathes of land uninhabited and uninhabitable. It

is no use to agree that the Karoo has moral standing today that may provide the ethical imperative to protect its biodiversity from the potential environmental degradation of an extensive gas exploitation program, but that same Karoo – in as little as 40 years' time – has lost all beauty and biodiversity ("intrinsic value") as well as economic, "instrumental", value because of anthropogenic GCC. Applying the land ethic to the future Karoo becomes nonsensical: the Karoo deserving of protection today will be fundamentally – if not irrevocably – harmed in the future. Its diversity and beauty that were worthy of protection today will not exist in the not-too-distant future. Thus, anthropogenic GCC poses a serious, environmentally-destructive, harm to the *future* Karoo biome: the future Karoo, like future humans, faces "life-threatening" harms from unchecked GCC.

I have argued that unmitigated anthropogenic GCC is a result of human action (continued emissions) and inaction (failure to change our choices about energy production). I have also shown that anthropogenic GCC will cause harms to future humans and to the future Karoo: threatening the basic means of survival for future humans and causing the potential desertification of the future Karoo. On this basis, I conclude that anthropogenic GCC is unjust because of those harms to future generations. But I believe it is necessary to distinguish between the types of harms faced by humans and by the environment to argue that it is, in fact, the *nature* of the harms that will face future humans that is needed to overcome any motivational objections and which will establish the necessary *obligations* on us today to take action against the injustice, an important point in the Karoo hydraulic fracturing debate. I will weigh up these harms in the development of my argument below. It is too easy to ignore the consequences of our actions *and* our inaction today and continue with our lives and value systems unchanged and unchallenged because we are not the ones

who will suffer the worst harms of our behaviour. Our ignorance, or - worse - disregard, of the harm we may be imposing on future generations is a moral failing and one we must take steps to avoid at all costs. One of the steps we can take to mitigate anthropogenic GCC is by switching our energy production away from coal and to natural gas.

4 Addressing Anthropogenic Global Climate Change with Gas

I have established that anthropogenic GCC is unjust because of the nature of the dangers it poses to future generations, particularly future generations of humans. If it is our inaction, or failure to address the human sources of GCC, that is unjust and unethical, then action is demanded of us to prevent the harms that GCC poses to future generations. One of the most effective ways for countries to mitigate the potentially life-threatening consequences of GCC is to shift their energy production away from coal. Moving to “clean” renewable energies such as solar- and wind-power is the ideal solution, but this is neither technologically nor economically feasible for South Africa at this point in time, as I shall show below. There is, however, a cleaner fossil fuel that has become increasingly important internationally as an intermediate power source until such time that the renewables are a viable alternative to coal: gas. Therefore, the next main premise I defend is that shifting energy production to gas is an effective, if not ideal, step in addressing anthropogenic GCC until clean energy becomes a viable alternative.

In order to justify my claim that shifting to gas would help SA move towards reducing its contribution to GCC, I will show that the use of gas as a source of energy is in fact a

better option than continuing to rely on coal. Although, from an emissions perspective at least, it would be ideal to eliminate the use of *all* 'dirty' fossil-fuel energy sources in favour of renewable and relatively 'clean' options, I will argue that shifting to gas-fired energy production is more cost-effective than renewables and coal, with the relative benefit over coal of having much less "residual costs" associated with the delayed impact of carbon emissions.

As discussed in the previous section, fossil fuels are by far the most important fuel for energy production around the world and are the primary source of CO_2-equivalent emissions responsible for anthropogenic GCC. Many countries have recognized the deferred dangers of anthropogenic GCC and have responded in various ways to address their emissions derived from energy production from fossil fuels. Renewable energy sources such as hydroelectric, wind, solar, and geothermal are particularly desirable because they have limited environmental impact and – as the name implies – they never deplete. However, the transition to renewable energy sources has been slow internationally due to their high cost. In the U.S. Energy Information Administration's "Annual Energy Outlook 2011", a comparison of the "Total System Levelized Cost"[13] for each energy source shows that of the 16 different energy plant types (including coal, gas, nuclear, wind, solar, geothermal, biomass and hydroelectric),

13 The "Total System Levelized Cost", as defined by the U.S. Energy Information Administration in its "Annual Energy Outlook 2011", is defined as the dollar cost per megawatt-hour of building, operating, maintaining, and financing an energy-generating plant, including the cost of fuel input, and adjusted by a capacity utilisation factor. Renewable energies, such as wind and solar power plants, have zero fuel costs, but very high capital costs resulting in total costs as high as $312/MwH. Although gas-fired plants have the lowest capital costs, but the highest fuel costs and operating costs, the overall total cost is the lowest of all the fuels at around $65/MwH.

solar plants are by far the most expensive of all energy sources. The most cost efficient are gas-fired plants which are between 3X and 5X cheaper than solar plants and 25% cheaper than the cheapest renewable which is hydropower (U.S. Energy Information Administration 2010). If the transition to renewables is slow in developed countries because of the cost, the financial implication of the transition is even more acute for a developing economy such as South Africa because of currency exchange rate fluctuations. South Africa would have to import the capital equipment to build renewable energy plants and any devaluation of the Rand has a direct and expensive impact on total costs.

Therefore, these cleaner renewable energy alternatives are not yet viable enough to be relied upon as providing a complete solution to the problem of anthropogenic GCC. In the medium term, at least, we will need to continue to use fossil fuels as a source of energy. Since this is the case, it seems clear that our next best option is to try to shift our energy reliance towards relatively less "dirty" fossil fuels where possible. It therefore becomes important to establish how relatively "clean" the affordable energy sources are, measured by CO_2 produced per unit of total primary energy supply. Coal in its various forms produces the highest percentage of CO_2 emissions and is, thus, the "dirtiest" of the fossil fuels with respect to its contribution to anthropogenic GCC. Natural gas is the "cleanest" fossil fuel, producing only a fraction of the emissions of coal or oil.

Shifting current and planned energy production throughout the world from "dirty" coal to "less dirty" gas has become increasingly important in mitigating CO_2 emissions worldwide. Gas currently accounts for 22% of world net electricity generation and this percentage is expected to increase as world generating capacity nearly doubles until

year 2035 (U.S. Energy Information Administration 2011). In addition to its (relatively) "clean" credentials, gas is attractive because of the vast "unconventional", or "tight", gas resources throughout the world recently made economic by technological advances. Unlike "conventional" gas which is typically associated with oil deposits and can be recovered by vertical wells, "unconventional" gas is that which is trapped in sedimentary rock formed from tightly compacted deposits of mud, clay and organic material deep underground. The development of horizontal drilling technology – or hydraulic fracturing as described earlier - from the base of vertical wells has made "tight" gas accessible and economically recoverable.

South Africa has already recognized the importance of using low-carbon fuels for future energy production. Its dependence on coal for electricity production has made the country one of the world's worst CO_2 emitters. In recognition of its contribution toward (i.e. its own CO_2 emissions) and vulnerability to GCC, South Africa has made specific commitments to its "fair contribution… to achieve the stabilisation of greenhouse gas concentrations in the atmosphere" (Government of the Republic of South Africa 2010, 5). In order to achieve its targets of peak CO_2 emissions between years 2020-2025 and a decline in absolute terms from 2036, the most important mitigating efforts "will have to come from reduced emissions from energy generation and use...In the medium-term, the mitigation option[s] with the biggest mitigation potential [is] *shifting to lower-carbon electricity generation* (my italics)" (Government of the Republic of South Africa 2011, 26).

According to The Economist magazine ("Coming Soon to a Terminal Near You", 6 August 2011) South Africa is believed to have the largest shale-gas resources on the African continent. It is estimated that there are up to 13.7 trillion cubic metres of

technically recoverable shale-gas resources (Newell 2011), although the economic viability – if they do exist – has not yet been ascertained by exploration in the Karoo. If proven economically recoverable, such valuable reserves would help provide the "low-carbon" energy generation required to fulfil South Africa's medium-term commitments to bring its own carbon emissions under control, and make its "fair contribution" to mitigating anthropogenic GCC. As discussed above, the total costs of establishing and running gas-fired energy plants are the lowest of all possible energy sources, even lower than new coal-fired plants. The highest proportion of the total cost of a gas plant is the fuel cost which, if this can be sourced economically from domestic reserves that may exist in the Karoo, can be reduced even further. Therefore, gas is not only a cleaner alternative than coal, it is a cheaper one as well. On these grounds, I argue that South Africa ought to be investigating the viability of its shale gas reserves as an alternative to its current over-reliance on coal.

Having argued that, if it turns out to be a viable option, South Africa should seek to move away from its current reliance on "dirty" coal by shifting to the relatively "cleaner" gas as a source of its new energy capacity, I now address some possible objections to this claim. Opponents of exploring for gas in the Karoo on the basis that gas is just another hydrocarbon and that it is not much better than coal are conveniently ignoring studies of the true total cost of coal, measured by its "Gross External Damage" which is 540% worse than gas (Muller, Mendelsohn and Nordhaus 2011). South Africa's CO_2 mitigation commitments in its White Paper are to halt its "emissions growth trajectory between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter" (Government of the Republic of South Africa 2011, 25). Key to achieving this goal in the medium-term is "shifting to lower-carbon electricity generation options" (Government of the Republic of South Africa 2011, 26), thus acknowledging

that it is unrealistic – economically and technologically – at this stage to harness "clean" renewable energy to any meaningful extent to achieve its mitigation targets without compromising its developmental objectives. An increase in nuclear energy capacity is the only economically-viable alternative to gas in the country's medium-term mitigation efforts. Nuclear, while not a renewable energy, is nevertheless a very "clean" technology with respect to atmospheric emissions. Establishing and running a nuclear energy plant, including waste disposal, is cheaper than most other "clean" energy, but is at least 75% more *expensive* than a gas-fired plant (U.S. Energy Information Administration 2010). There are also the hidden costs, such as the risk of a reactor "meltdown", that create ethical legacy issues for future generations that is worthy of an entire ethical research report on its own. Therefore, gas-fired energy is still the best alternative, economically and ethically in terms of contribution to anthropogenic GCC.

A further objection is that of "cheating" with respect to shouldering our fair share of GCC mitigation. If South Africa chose to do nothing about its own substantial emissions, then there would be no reason to seek alternative fuel sources to seek alternatives for the plentiful and cheap coal that fires most of the country's energy plants. As such, South Africa's transition to a lower-carbon economy as envisioned in this essay would be unnecessary and, thus, the obligation to access the potential gas reserves in the Karoo disappears. One could argue that, although South Africa is in the top 12 CO_2 emitters in the world, it is dwarfed by the developed economies, some of which have been reluctant to take a national stance on emission mitigation. There will be costs linked to mitigation and "cheaters" who fail to shoulder their share of those costs do so at the expense of nations who accept their responsibilities. But it is the longer-term "costs" to future generations that are of primary concern: the projected harms of anthropogenic GCC cannot be ignored. South Africa cannot, ethically, fail to

take action to mitigate its own shameful emissions. It is ranked amongst the developed nations as a major polluter, but is likewise ranked amongst the developing nations as one of the most vulnerable to the future effects of anthropogenic GCC. South Africa has recognized its moral obligations toward GCC mitigation, but it does so with the proviso that “developed countries meet their commitment to provide financial, capacity-building, technology development and technology transfer support” (Government of the Republic of South Africa 2011, 25). In this way, the country is tempering the economic costs of its efforts by shifting some of those burdens to developed nations, thus redistributing some of the economic benefits (or loss avoidance) that the major “cheaters” are gaining unfairly. Even the USA, which long held the distinction as the largest producer of CO_2 emissions, has been shifting its energy production to gas for economic, if not climate change reasons, and its emissions have been declining since 2007.

Switching to natural gas from coal for South Africa’s future energy needs is not only ethical from a GCC perspective, it is actually more economical to do so. This means that we should be looking for domestic gas reserves as a matter of urgency and, to do so, exploration of the Karoo must get underway.

5 Gas Exploration over the Karoo is Necessary

So far, I have argued that anthropogenic GCC is unjust because of the harms it poses to future generations, in particular the future generations of humans. In order to address some unjust aspects of anthropogenic GCC, I have also argued that shifting energy production from “dirty” coal to “less dirty” gas is proving an effective intermediate step for countries to reduce their CO_2 emissions from energy production. South Africa needs to shift its energy production away from coal as a matter of urgency

and it may have potentially enormous domestic gas reserves to do so. The gas that is believed to be locked in the shale beds underlying the Karoo could be the “lower-carbon” alternative to coal until such time that renewable energy becomes technologically and economically viable as an alternative to all fossil fuels. The third main premise I defend is that the only way to determine whether gas resources exist is through exploration with hydraulic fracturing and, if they do indeed exist, expanding hydraulic fracturing to exploit economic gas reserves. However, since exploration for gas cannot be achieved without some harm to the Karoo, I will need to examine the nature and extent of those harms before being able to defend my claim that they are outweighed by the harms to future generations that would result if South Africa did not go ahead with gas exploration.

Herein lies the basis of the public’s general unhappiness with Shell’s application to explore for gas in the Karoo: what environmental damage will hydraulic fracturing cause to the Karoo during the exploration for gas? If this was the full extent of the ethical debate, then the answer would be determined by weighing the harms that a gas exploration program using hydraulic fracturing would have on the Karoo (with its moral considerability established under the land ethic) against the benefits that may accrue for the Karoo’s poor and for the country as a whole. The ethical question, however, is not that simple: failing to allow the exploration for gas over the Karoo means that, should there be viable gas reserves, then our failure to allow *exploration* means that we would not be able to *exploit* those reserves in order to reduce our carbon emissions which contribute to unjust anthropogenic GCC. Nonetheless, it is still necessary to discuss the environmental harms that face the Karoo from hydraulic fracturing in order to determine the potential moral trade-offs when deciding the ethical stance that is required of us.

As mentioned in the description of the Karoo hydraulic fracturing debate, Shell's proposed exploration program is to drill only 24 boreholes, each with a "footprint" of 1 ha, representing some 0.0003% of the its entire 9 million ha prospecting area (Golder Associates 2011, 3). But the ethical debate is not around this very limited surficial impact: if exploration confirms that there are economic gas reserves, then the exploitation of that gas is the next step. But what does exploitation mean for the Karoo? Drilling operators in the U.S.A., for instance, are commonly allowed one horizontal well for every 256 ha, but the "infill drilling programs" as the shale-gas reserves start producing can be as dense as one well every 16 ha and, in some instances, one per 8 ha (Sumi 2008). It is not difficult to understand some I&AP's decrying the "forest of drill rigs" burgeoning across the Karoo landscape and the web of roads scarring the fragile biosphere under this scenario.

Every aspect of the hydraulic fracturing process has a potential impact on the Karoo's already scarce water: the amount of water needed, the disposal of waste water, and the contamination of underground aquifers from the drilling process or from the seepage of waste water from surface. Shell estimates that vertical drilling will require between 300,000 litres and 900,000 litres per borehole (Golder Associates 2011, 109). Initial fracturing, if gas is found, could use up to 6 million litres per well; but experience suggests that wells can be re-fractured up to 10 times to ensure that gas continues to flow and each fracture requires at least the same amount of water (Sumi 2008). The water used for the fracturing process has a number of chemical additives, many of which are common in our homes; however, there is little chance that one would wish to intentionally ingest "household items" such as borate salts (used in laundry detergents), ethylene glycol (antifreeze), isopropanol (antiperspirant) or swimming pool acid (Golder

Associates 2011, 108). There are fears that this chemically-tainted waste water, or methane and other hydrocarbons intersected by drilling, could contaminate underground aquifers via the wells themselves, i.e. the boreholes are not properly sealed and allow leakage into the groundwater. Secondly, the waste water must be transported somewhere for treatment and/or disposal and, if not properly contained, could seep into groundwater from the surface.

There is sufficient public concern in the U.S.A. to prompt the U.S. Environmental Protection Agency to spend millions of dollars in 2012 reviewing “any potential impacts of hydraulic fracturing on drinking water and groundwater” (U.S. EPA 2011a). With anecdotal, if not scientific, evidence of water contamination due to hydraulic fracturing, the worst-case scenario should be assumed. This could mean the potentially irreversible contamination of the Karoo’s scarce groundwater with chemicals and gas.

But there are mitigating empirical factors that must be taken into account. Shell believes its hydraulic fracturing technique and the depths (some 5 km below surface) of the targeted shale make it virtually impossible for groundwater to be contaminated by chemicals or hydrocarbon leakage from incorrectly sealed wells (Golder Associates 2011, 102). Most of the Karoo’s potable groundwater (93%), in contrast, lies at depths less than 30 metres below surface with none found below 100 metres deep (Golder Associates 2011, 63). Each borehole is lined with steel and cemented in place which, if done properly, checked in advance and monitored through the process, is expected to prevent any leakage of fracturing fluids or hydrocarbons from the well itself and to also prevent any deep level brackish groundwater using the borehole as a conduit to shallow aquifers (Golder Associates 2011, 97). As mentioned above, there is yet no scientific proof of groundwater contamination due to the technology. The American

Petroleum Institute states “[h]ydraulic fracturing has been used in nearly one million wells in the United States and studies by the U.S. EPA and the Ground Water Protection Council have confirmed no direct link between hydraulic fracturing operations and groundwater impacts” (American Petroleum Institute 2009).

Shell also claims it will not use any shallow, “sweet” groundwater for its water-intense drilling. It plans to source the necessary water from the deep-lying, typically saline or brackish and therefore un-potable, water that may be in the vicinity of the well. There is also the option of transporting sea or other brackish water to site. It is encouraging that technology has developed in the US, where hydraulic fracturing is producing over 50% of the country’s natural gas, to treat expended fracturing fluids to drinking purity, even “cleaner” than some bottled water (Barnett and Vavra 2006).

Another environmental concern is the impact of the checkerboard of drill sites and associated infrastructure (i.e. roads) on the Karoo’s fragile flora and soil which could be devastating. The potential density of well-sites in a producing gas field has already been described above and each well needs to be supplied with water and the waste water removed. As an example, a single hydraulic fracturing well on the Barnett shale in west Texas “can have 100 water-haulers servicing the well during fracture stimulation [and]…as many as 700 truckloads to transport the [waste fracturing] fluids to a disposal facility (Sumi 2008). Although Shell believes this can be mitigated to some extent by “stockpiling” topsoil to be replaced after de-commissioning, the arid and semi-arid landscape could suffer scarring that requires many decades to recover, if ever.

There is uncertainty: both in Shell’s ability to rehabilitate the Karoo’s fragile, water-scarce landscape and to prevent the contamination of the few water resources that do

exist. Lack of evidence of the former (i.e. successful rehabilitation of the land) and anecdotal evidence of the latter (contamination of underground water) would be sufficient to appeal to the "Precautionary Principle" to protect the *current* Karoo, if the debate were merely centered around the harms of exploration only. The Precautionary Principle states that if there is uncertainty about whether an action could cause harm, but the harm that it *could* cause *could* be substantial, then that action should not be taken. However, the Precautionary Principle is grossly inadequate when applied to the "real" ethical debate around hydraulic fracturing of the Karoo because it is unable to handle the temporal paradoxes of the Karoo hydraulic fracturing debate. Because the Precautionary Principle invokes action (or non-action as the case may be) under uncertainty, it may be sufficiently *proscriptive* on allowing hydraulic fracturing due to the feared water contamination in the case of the exploration program, but it is equally *prescriptive* in demanding the exploitation of any possible gas reserves because of the uncertain harm that may be inflicted on future generations when anthropogenic GCC is factored into the ethical equation. The right action determined by the Precautionary Principle in the full context of the hydraulic fracturing debate needs to consider the harms to the current Karoo *and* the harms facing future generations. In both cases, the harms could be substantial, so, according to the Precautionary Principle, exploration of the Karoo should not be undertaken but the exploitation of gas reserves should be done, which is contradictory. The Precautionary Principle is unable to advance the ethical debate by determining which mutually-exclusive action is the correct one.

Considering the lack of evidence to support its decision, it seems that the Department of Mineral Resources has invoked the Precautionary Principle – in form if not in substance - to impose its current moratorium on Shell's application process. On 21 April 2011, Bloomberg reported that "the department will lead an investigation into the

implications of hydraulic fracturing…that will include assessing the environmental effects"[14]. However, I will discuss in the next section why, ethically, this is the incorrect stance to take. Because of the life-threatening harms that unchecked anthropogenic GCC poses to future generations, including the future Karoo, and because of their moral considerability, we have an obligation to include their moral interests when making the ethical decision. The debate is more than a simple environmental issue: we are able to take action to address the harms of anthropogenic GCC by shifting our energy- producing needs to gas and, if there are gas reserves underlying the Karoo, we have a moral obligation to exploit them despite the impact that such action may have on this sensitive biome. This requires weighing up of the respective moral interests in the Karoo hydraulic fracturing debate because, in order to take the just decision which necessitates action, some harm will have to be done in order to prevent another, more serious, harm.

6 Weighing Harms to Future Generations and Harms to the Karoo

The final part of my argument that we have a moral obligation to allow exploratory hydraulic fracturing in the Karoo involves the weighing up of the respective harms to the morally-considerable entities that will be affected by the outcome of any decision. There are two main categories of moral interests that must be considered: those of future generations and those of the present Karoo biome. My first premise explained why anthropogenic GCC is unjust: not only is it a result of our actions and inactions, but its deferred effects will result in significant harms to future generations, with future humans

14 "South Africa Endorses Plans For Karoo Gas-Drill Freeze, Ending Shell Hopes", http:www.bloomberg.com/news/2011-04-21

facing potentially life-threatening harms, if left unchecked. Since it is our actions that are the cause of anthropogenic GCC, I argued that we do have the ability – and responsibility - to take action to mitigate those harms by shifting the reliance of our energy production from coal to gas. There are believed to be significant gas resources underlying the Karoo which would enable us to make that shift, but the only way we can determine the extent and economics of those possible gas reserves is to allow exploration of the Karoo to proceed. And, if economic reserves are proven, exploitation of those reserves will result in some unquantifiable environmental damage to the Karoo and thus cause harm to it and the morally-considerable entities linked with the Karoo.

But herein lies the ethical dilemma in this debate: to prevent harm to future generations (specifically future humans) from anthropogenic GCC, we must allow some harm to be done to the current Karoo if, in doing so, we are taking actions to address our carbon emissions. Thus the next step in my argument is to weigh up these respective harms to show that the harm to the Karoo from hydraulic fracturing is outweighed by the harm to future generations, including its future self, if we do nothing leading us to the conclusion that the exploration and possible exploitation of gas over the Karoo is ethically required of us in the name of intergenerational justice.

As a starting point, Clark Wolf comments:

> …many different people, both current and future, have competing morally significant claims at stake. The solution to this problem is deceptively simple and is supported by a widely held and relatively uncontroversial moral principle: people should usually be left free to do as they wish provided that their actions are no[t] harmful to others (Wolf 1995, 803)

The moral interests that are at stake in this specific debate are the humans today who inhabit the Karoo (the wealthy and the poor) and the Karoo biome itself, each of which have protectable, but in some cases competing, moral interests. We also have to consider the future generations of humans (particularly the poor who will depend on the Karoo for their livelihood) and the future Karoo, each of which also have protectable moral interests, but both of which are particularly susceptible to the deferred harms of GCC. I will begin the process of weighing the harms by re-capping the harms that each of these moral interests faces.

There are two main categories of human interests that are particularly susceptible to an extensive hydraulic fracturing program in the Karoo. The first is the vocal and well-represented category of wealthy farmers and property owners and the second is the poor and indigent who have had little representation in the formal EMP process thus far. The Karoo farmers and property-owners have two somewhat related concerns: the possible pollution and degradation of their lands (an environmental concern protectable under the land ethic) and their rights to private property. I have argued that the current Karoo has protectable moral interests by appealing to the land ethic which I believe adequately encompasses the interests of Karoo farmers and property owners. The environmental damage of a full-blown gas exploitation program will cause harm to the Karoo and, by association, its resident landowners; but this damage is a harm from which the Karoo *should* eventually recover.

Future generations, however, face more serious harms from anthropogenic GCC-harms from which there may be no recovery without our active intervention. The future Karoo biome may “die” as a result of the desertification effects of GCC, but it is the

threat to the basic means of survival to *all* future humans which we must take action to prevent. Future humans have the basic "right" to the means of survival, and it is our obligation to ensure that our actions do not threaten that right. Failure to act now on anthropogenic GCC is committing an act of gross injustice against future generations, including the future Karoo; therefore we must take whatever steps are necessary to mitigate anthropogenic GCC, even if it means using the present-day Karoo as a means to this end. In the context of the Karoo hydraulic fracturing debate, this means that we must allow not only the exploration for gas in the Karoo, but also for a full-blown exploitation program if proven economically viable; however, we must have the ethical wherewithal to establish our duties to *commit* harm in order to *prevent* a greater harm.

Taking a consequentialist approach establishes some basis for identifying the "right action" in this debate. Consequentialism can be summarised as "the view that whatever values [one] adopts, the proper response to those values is to promote them" (Pettit 1993, 231). A "right act" is dependent on "…the value of the consequences of *that* act, compared with the value of the consequences of any other act the agent could do under the circumstances" (Darwall 2003, 9). With respect to the Karoo hydraulic fracturing debate, the relative seriousness of the *harms* facing the various moral interests must be weighed so that the most harmful consequences of any act are minimised. In "The Case for Animal Rights," Tom Regan states that the only time it is permissible to inflict harm is when one course of harmful action will have less serious consequences than another (his worse-off principle) (Regan 1983, 308). The determination of the relative seriousness of harms is based upon their respective impacts on "vital human interests", or those interests connected to human survival. Applied to the Karoo hydraulic fracturing debate, it would appear that inflicting a harm (the act) on the present-day Karoo by allowing hydraulic fracturing in order to reduce

the potential life-threatening consequences of GCC on future generations is a permissible harm. The Karoo, in this instance, can be used as a means to an end to achieve the best consequences; i.e. to reduce the harms of anthropogenic GCC.

However, the right action in the Karoo hydraulic fracturing debate is actually choosing between committing a harm (to the Karoo) to protect vital future human interests and doing nothing. If we were prevented, from a moral perspective, from ever intentionally causing harm to a morally-considerable entity, no matter what the positive consequences of that harmful act would be, then objections to this consequentialist approach arise. In context of this debate, this means that an act of harm against the current Karoo can never be done, even though the consequences of this contemporary harm could mean the saving of future lives. And yet, returning to the basic issues at hand, failing to take action to address the risks of GCC is just wrong. Kristian Skagen Ekeli writes:

> it is *prima facie* immoral to impose risks upon future generations in cases where the following conditions are fulfilled: (1) the risk poses a threat to the ability of future generations to meet their physiological needs, and (2) the risk assessment is supported by scientifically based harm scenarios (Skagen Ekeli 2004, 442)

Although it has been established that the Karoo can claim moral standing under the land ethic, the point has been made that within the next 50 years, GCC is expected to change the Karoo so dramatically that it will be unrecognizable and possibly uninhabitable. As unpalatable as it may seem at first, if one can make a case for a “just appropriation” of the Karoo on behalf of future generations, including *its* future self, then the relatively short-term harms that must be visited on the Karoo become of secondary

importance to the ethical decision[15]. There are conditions that make an "appropriation…not only permissible, but obligatory, since it is necessary to protect the interests of future generations" (Wolf 1995, 801). Wolf explores the morality of property appropriations with respect to preserving resources (coral reefs are used as an example) for future generations; however, it is equally applicable in establishing an argument for appropriation - which in itself is a type of harm – to ensure the survival of future generations.

Wolf distinguishes between what he terms "needs and desires" to establish the basic conditions of a just appropriation. "Basic needs", he explains, are those things "that it is necessary for us to have if we are to live adequately decent human lives" (Wolf 1995, 807). Adventitious needs or desires are those over and above meeting the basic physiological human requirements. If a claim to appropriate the Karoo was as simple as referring to the needs of the various claimants, then Wolf continues "…claims justified by reference to basic needs will defeat competing claims that are justified by reference to merely adventitious needs". In the Karoo hydraulic fracturing debate, meeting the basic needs of future generations, specifically future humans, at risk from GCC is more important than current private property rights or environmental concern for the current Karoo. Additionally, the basic needs of the Karoo's future poor- as a specific and

15 My appeal to a "just appropriation" of the Karoo is in terms of its philosophical moral standing and not in terms of the private property rights of the resident landowners and farmers. The Karoo biome, as a morally-considerable entity, is "owned" by all South Africans. A "just appropriation" of the Karoo in this case is the moral act of transferring that "ownership" to future generations to be used in whatever way necessary to ensure that they, the future generations of humans particularly, are left with "enough and as good" (as demanded under the Lockean proviso of property acquisition (Wolf 1995, 801)), which I interpret in this argument to be the basic means of survival.

particularly vulnerable moral interest holder in the debate – are at high risk to changes in the future Karoo from GCC.

But is it ethical to ignore the moral standing of the Karoo (which does not have "rights") when it is the subject of the appropriation, in the first instance, and could be harmed after appropriation, in the second? Assuring basic human rights for future generations must "…'trump' claims of need, utility, or interest" (Wolf 1995, 791); thus in the hierarchy of competing moral interests, those of the Karoo must be subordinated to those of humans in general and future generations of humans specifically.

The second aspect of a just appropriation is the intention of the appropriation, or the "nature of the claims we can legitimately make" (Wolf 1995, 811):

> We may have valid claims to use and control appropriated resources and to enjoy their fruits, but our rights include no claim to use these resources in ways that might inexcusably deprive future persons of what they need to survive and to live (Wolf 1995, 811)

The context of Wolf's quote above is arguing for the preservation or sustainable use of natural resources. If our rights to appropriation do not allow us to harm or prejudice future persons in our use of the appropriated resource (the Karoo), then likewise we must take steps to ensure that the Karoo does not turn into a desert waste land as a result of GCC.

To take the necessary steps to confront GCC – to demand that the Karoo is used as a means to an end in this case - is a matter of ensuring justice in the name of future generations. The unique conflation of circumstances that threaten future generations

has changed what can be considered a just act or an unjust incursion. Jeremy Waldron, when exploring historic injustices, states that "…claims about justice and injustice must be responsive to changes in circumstances" (Waldron 1992, 25). He gives an example of a water hole on the savannah held privately by "P":

> [S]uppose there is an ecological disaster, and all the water holes dry up except the one that the members of P are using. Then in these changed circumstances, notwithstanding the legitimacy of their original appropriation, it is no longer in order for P to exclude others from their water hole (Waldron 1992, 25)

Applied to the context of this debate, anthropogenic GCC (the ecological disaster, but one of our own making) has altered not only the priority of needs and rights of affected parties, but has also changed what is and isn't a just act. Merely avoiding causing future harm to future generations is not enough: justice demands confronting "injustice in discrete doses" (Waldron 1992, 14) by taking whatever steps are necessary to address the injustice:

> Though the … arrangement was an unjust event when it took place, … its injustice … consisted primarily in the *injustice it promised for the future* (my italics). To judge that [arrangement] unjust is to commit oneself to putting a stop to the ongoing situation; it is a commitment to prevent the perpetuation of the injustice…(Waldron 1992, 14)

Seldom are we offered such an obvious opportunity to act now to avoid what will otherwise be looked back on by future generations as an act (or inaction) of historic injustice. We may not intend to kill future people by our failure to address our emissions today, but the inevitable consequences of our failure to act is the potential

deaths of future humans and, in context of this debate, the “death” of the future Karoo. Preventing the perpetuation and escalation of anthropogenic GCC requires substantive and decisive positive duties: the life-threatening consequences of the alternative are sufficiently serious circumstances to justify the violation of other, but less important, moral interests.

However, a couple of objections must be overcome, the first being associated with a possible “economic taint” to the consequentialist approach. Introducing an economic perspective to the weighing up of outcomes under consequentialism is liable to result in discounting future moral interests because of increasing uncertainty; for instance, the immediacy of potential harm to the Karoo could conceivably carry more weight than the future projected, but discounted, negative impacts of GCC on future generations. But there are two potential rejoinders to this type of objection. First, from an economic perspective, the compounding effects of GCC result in exponentially-growing harms in the future which, when discounted on a linear basis back to today, will outweigh any current negative impacts. The complexities of GCC mean that “future people … will be *much worse* off than we are if we fail to act, suffering costs that are far worse than the sacrifices we would have to make to prevent them” (Fitzpatrick 2007, 387). Secondly, the Karoo’s poor may have little direct representation in the debate, but there are nine times more of them than the farmers and property owners. Therefore, applying a consequentialist reckoning to the debate may mean that the preservation of the current Karoo may be more important than the devastation of the future Karoo (as a result of its preservation), but the sheer numbers of the poor measured against the wealthy must favour the interests of the poor whose moral interests are most closely aligned to those of future generations. Thus, on this basis, the net positive consequences (or least possible harms) are greatest if hydraulic fracturing of the Karoo proceeds.

Another important objection to the argument is raised by Marc Davidson:

> It is important to note that although climate damage constitutes a wrongful harm, this does not imply a moral duty to prevent all harm. First, such a duty would be impossible to fulfil since the risk of harm can never be entirely prevented. Second, many minor risks of harm can only be prevented against unreasonably high costs. Therefore, positive law generally requires taking reasonable care, i.e. preventing the risk of harm which exceeds the cost of precautions. Intergenerational justice would thus require a similar prevention of 'unreasonable risk' (Davidson 2008, 478)

Appealing to this line of thought could suggest that the possible environmental damage to the Karoo from hydraulic fracturing is too high of a price to pay for future harms that can only be guessed at and are not even entirely of our making. But, again, the relative harms to future generations that are predicted are serious enough to jeopardise their basic means of survival. The harms that could be imposed on future generations are 'unreasonable risks' which far exceed the cost of precaution which is the possible "temporary" environmental impact which can be minimised by appropriate regulation. Intergenerational justice again comes back to the conclusion that the ethical action is to allow the hydraulic fracturing of the Karoo.

We are facing a “moral flashpoint”[16] - the historic point (which may be decades long as ethical theory evolves) at which the confluence of individually seemingly clear and well-developed moral issues protecting the environment, the flora and fauna of that environment, and individual rights (among others) must be weighed against the growing awareness of the moral interests and most basic of rights of future generations. But one or more of the moral interests in a debate such as this will appear to be violated by whatever decision is taken and, thus, the ethically correct action requires special attention, deliberation, and sensitivity.

The nature of the harms to future humans, and even those to the future Karoo, are sufficiently serious to appeal to consequentialism and intergenerational justice to ensure that we take whatever steps are necessary to prevent those harms. However, this does mean that, in doing so, we must commit a different, but less serious harm in the spectrum of all harms. A just appropriation of the current Karoo is necessary in order to overcome our moral unease of causing harm to this lovely biosphere in order to fulfil our obligations to future generations.

7 Gas Exploration is Ethically Obligatory

I have established that all of the main morally-considerable entities in the Karoo hydraulic fracturing debate have protectable interests. But, as per my first and most important premise, anthropogenic GCC has altered the ethical “playing field”: the true costs of our economic prosperity will be borne by future generations in ways that

16 A flash-point is defined as a “… crisis caused by: (a) collisions between differing Deep Values Systems contending for new resources, overlapping niches and strategic spaces...” http:www//old.disinfo.com/archive/pages/article/id1498/pg1/index.htm.

potentially threaten their very means of survival which makes it unjust. It is the nature of those harms – threats to the most basic of human rights – that trump all other moral claims in the debate. Anthropogenic GCC therefore represents the type of "changed circumstances" envisaged by Waldron that make what may have been seen at one point in time as an "unjust incursion" into a "just acquisition" at another point in time (Waldron 1992, 25).

The unique characteristics of GCC have forced us to re-examine our ethical intuitions. If intergenerational justice is to be achieved, difficult decisions must be taken to address the nature of harms that we will be committing against future generations of people, non-human animals, plants, and the environment. Painful and, for some interests in this debate, ostensibly counter-intuitive actions are not only necessary but obligatory: to act otherwise, or worse – *fail to act* against anthropogenic GCC – is to effectively abandon our offspring and their offspring to possible life-threatening climactic and atmospheric change, an intergenerational act of injustice that could result in the deaths of many, perhaps unintentional but for which we are accountable.

But while I have argued the moral ascendency of the future generations of humans above all others, the ethical imperative to act in ways that may harm the present-day Karoo in order to protect the moral claims of future generations relies on an appeal to consequentialism: the best consequences in this debate are those which minimise the possible threats to the survival of future humans. It is also necessary to consider the justice of the required action to allow exploration and exploitation of the Karoo for gas which may appear to be an unjust act against this morally-considerable biome. Taking into account the nature of the harms facing the Karoo and future generations (including the future Karoo), it is necessary to "justly appropriate" the current Karoo such that it

can be used as a “means to an end”. Abhorrent as this may be to environmentalists representing the interests of the Karoo and to the farmers and land owners whose interests are linked to those of the Karoo, there are mitigating factors that must be acknowledged. The Karoo – in the not-so-distant future – is at particular risk from GCC. The paradox is that, while the moral interests of today’s Karoo may be established under the land ethic due to its beauty and diversity, in a couple of decades from now, creeping desertification under GCC threatens to eliminate all that was protectable today. The moral interests of the *future* Karoo therefore become intertwined with those of future generations of humans: the Karoo must be harmed today to prevent more destructive and serious harm tomorrow, even to itself.

However, the potential harms that will be visited on the Karoo by extensive gas exploitation must be minimised in every possible way. There are well construction and integrity guidelines developed by the American Petroleum Institute over the more than 60 years since the first well was hydraulically fractured. These guidelines “help to ensure that shallow groundwater aquifers and the environment will be protected, while also enabling economically viable development of oil and natural gas resources” (American Petroleum Institute 2009). These guidelines - which cover groundwater and the environment, well design and construction, and the drilling and completion process – should set the minimum standards of operation and Shell, and every other company involved in gas exploitation, should be monitored to ensure adherence at risk of severe financial penalties for failure to do so. Fresh water resources should not be used for the fracturing process. Shell claims that it will be able to use brackish underground water and seawater to fracture the wells; it must be a condition of permitting exploitation that they do so. South Africa has comprehensive and strict environmental regulations set out in the National Environmental Management Act (No. 107 of 1998) which must be

adhered to. Also, as is the case for any mining operation in South Africa, all companies must set aside not insubstantial financial reserves for the rehabilitation of the area to the best possible pre-drilling standard.

Such restrictions may be little comfort to those who believe they are protecting the Karoo's interests, but the nature of anthropogenic GCC requires sacrifices today for the sake of justice tomorrow. Even though our natural inclination to take care of our offspring removes some of the conceptual hurdles of caring for people who do not exist, it is still difficult to take the harmful actions necessary for their protection. In closing, a quote from Waldron seems appropriate:

> To be disposed to act morally, it is not enough to be equipped with a list of appropriate principles. One also needs a sense of the type of situation in which these things may suddenly be at stake, the temptations that might lead one to betray them, and the circumstances and entanglements that make otherwise virtuous people start acting viciously. That is what history provides: a lesson about what it is like for people just like us – human, all too human – to face real moral danger (Waldron 1992, 5)

We have the opportunity to recognize the moral danger of anthropogenic GCC as it unfolds and prove that the difficult, but ethical, decisions and sacrifices necessary to stop the harms that will otherwise befall future others can and will be made. We may not have the intention to harm future people, especially when we consider that it is our children, grandchildren, and great-grandchildren who will begin to suffer from the effects of unchecked anthropogenic GCC, but we are responsible for the problem and, therefore, we are accountable for its consequences.

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