Taufeeq Dhansay

Dr T Dhansay, Council for Geoscience, Polokwane, South Africa; AEON, Nelson Mandela University, Port Elizabeth, South Africa.

E-mail: *taufeeq.dhansay@gmail.com*

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Short- vs long-term vs the middle-ground in critical socioeconomic and environmental planning

Roman Krznaric's *The Good Ancestor* provides an account of how temporal thinking drives critical global planning. In particular, Krznaric denotes the effect of extensive short-term thinking, i.e. thinking driven by achieving goals in a present-day sense or a singular generational time frame. These goals may include garnering socio-political advocacy and those agendas driven by tangible economic and financial gains. Furthermore, Krznaric highlights how short-term thinking and policy developed with these kinds of considerations have a negative impact on the earth's natural environment. This may include, *inter alia*, accelerated extraction of natural resources and the effect of this on increasing land degradation and pollution across the Earth's Critical Zone, i.e. the region of the Earth's habitable zone where the atmosphere, hydrosphere, biosphere, pedosphere, and lithosphere overlap (Ashley 1998). Importantly, Krznaric notes that the long-term effects of these kinds of negative impacts are not extensively considered in the world and this is largely because short-term thinking, alone, may not be adequate to effectively enable long-term planning and mitigation.

Long-term timescales are notable in Geosciences. The geology of the Earth underscores the cyclic nature of natural processes. Furthermore, the temporal constraints of these processes highlight their long-term nature, especially relative to human development and interaction. Several key natural phenomena should be considered. These include the recycling and formation of oceanic and continental crust (Mitchell et al. 2012). These cycles occur over several hundreds of millions of years. Within this time frame, regions where the formation and destruction of crust occurs are defined by highly energetic natural phenomena. This includes concentrated seismicity, magmatic outpourings and associated biochemical Critical Zone change. The effect of these changes on the natural environment is clear and enormous at a global level (Palin et al. 2020). For example, the geological record suggests that there are at least five significant extinction events. These include extinction events at circa 440 million years ago, where about 86% of life was eradicated; circa 365 million years ago, where about 75% of life was eradicated; circa 252 million years ago, where about 96% of life was eradicated; circa 201 million years ago, where about 80% of life was eradicated; and, circa 66 million years ago, where about 75% of life was eradicated (Twitchett 2006). These events are periods where up to and more than two-thirds of fauna and flora were eradicated. Importantly, the very nature of these events are long-term, having occurred over several millennia. The short-term planning and associated factors linked to present-generation anthropogenic activities may also help cause what is noted as the present-day sixth extinction event.[1] This event is defined by the rate at which species are being eradicated, which is seemingly orders of magnitude higher than previously seen in the geological record.

It is important to note that the Earth will continue recycling and forming new continental and oceanic crust for millennia to come. Furthermore, there will be significant changes to the natural environment and the flora and fauna. However, as Krznaric reiterates, we still have an important role in enabling a sustainable future for the next several generations and ensuring that the rates of anthropogenic secular global change are not out of control.[2] There are key aspects of the Anthropocene that require attention. These include how we explore and extract natural resources and how we utilise these resources toward further development. A key feature is energy generation and its impact on climate change. Exacerbated global fossil fuel extraction and utilisation have resulted in accelerated greenhouse gas emissions, which have then resulted in several present-day and future-predicted climate variations that will have a direct bearing on humans and on our surrounding natural environment.

1 It's a combination – short-term thinking/planning on its own is not the only problem, while exclusively long-term thinking/planning would not be sufficient. The balance is critical.

2 Humans are short-term relative to the existence of the Earth. The Earth as a geodynamic machine will continue operating with or without humans. Natural global change can also be dire for human existence.

There is a concerted effort to combat climate change and to shift from the current heavy dependency on fossil fuels, especially with a shift toward the legal implications of mitigation scenarios (Dimitrov 2016).[3] Crucially, in the context of energy sustainability, a transition from fossil fuels cannot be immediate. In many developing nations the exploration for and extraction and utilisation of fossil fuels are key to socioeconomic development, especially of vulnerable populations. In South Africa, for example, the coal industry is one of South Africa's largest contributors toward the country's socio-economy. This includes being one of the largest mining producers and the largest employer. The coal industry employs nearly 100 000 people directly (Minerals Council of South Africa 2019). Furthermore, coal accounts for more than two-thirds of South Africa's energy generation. With energy being crucial to continued development and socioeconomic sustainability, transitioning toward a low-carbon economy must follow a Just Transition (Heffron 2021).

Considerations such as a Just Transition provide a temporal aspect of planning and thinking that is not well developed. It's the nuance between short-term and long-term thinking and planning. In an energy context, this is a critical nuance. An immediate shift from coal would realise carbon reduction targets. However, it would cause a huge socioeconomic dilemma. Conversely, a shift that is too slow will not meet carbon reduction targets and cause an equally large socioeconomic dilemma. The onset of *Techno-fixes*, as Krznaric denotes, becomes imperative to bridge this gap. One such fix is employing aspects of Carbon Capture, Utilisation and Storage. This technology aims to capture CO2 at the source and store it in geological reservoirs, therefore reducing CO2 while enabling the Just Transition. Moreover, the capture of CO2 enables several downstream industries that require CO2, e.g. petrochemicals, agriculture and geopolymers (Koytsoumpa et al. 2018). Moreover, another intermediate consideration is transitioning from CO2-heavy hydrocarbons, e.g. carefully controlled gasification of deep hydrocarbon resources provides a source of methane, hydrogen and Rare-Earth Elements. These could completely mitigate CO2 emissions, while ensuring energy and critical material supply (Bhutto et al. 2013).

The geological timescale is vast. The only way to gain an understanding of the important, finer, details of the Earth's workings is through geoscience

3 There are now legal implications linked to meeting CO2 reduction strategies. Moreover:
SA is targeting a 50% CO2 reduction in the next 10-years.
In the last two years, the carbon tax has been adopted at R120/tonne of CO2, Sasol Secunda would theoretically have to pay about R7billion.
The IPPP programme saw the reduction of wind and solar costs by three-quarters.
There is an onus on science now. We have the policies and regulations. Science now needs to develop the mitigation technologies.

investigations on a smaller scale. The closer we are able to investigate the geological record, the better we are able to ascertain a temporal understanding of the Earth. Such investigations are proving their importance. In South Africa, high-resolution geological mapping is defining potential onshore CO2 geological reservoirs (Surridge et al. 2021) that are orders of magnitude larger than previously thought. These are underground geological reservoirs where anthropogenic CO2 can be safely and permanently stored, immediately mitigating their potential atmospheric release. These will play a significant role in South Africa's CO2 reduction plans and may enable a Just Transition. In addition, the extensive nature of these kinds of geological sequences implies that such potential reservoirs exist in most parts of the world, and could be defined through similar high-resolution investigation. Furthermore, high-resolution integrated geoscience mapping is assisting in highlighting crucial mineral systems needed to accommodate the growing demand for *green technologies* e.g. Rare-Earth Elements and other battery and electro voltaic materials that are imperative for renewable and alternative sources of energy (Emsbo et al. 2021). This type of geoscience information is crucial to support the country's reduction strategies while mitigating undue negative consequences on the nation's socioeconomic development.

Enabling a transition from the currently dominant short-term method of planning and development toward long-term processes will require an effective *middle ground*. Many of these will need such *techno-fixes* to support critical policies and procedures needed for effective sustainability. This includes how we find a balance between much-needed socioeconomic development within many carbon-heavy developing nations, while enabling a Just Transition toward a low-carbon economy and enabling the sustainability of constantly accelerating exploration and extraction of "critical" minerals needed to enable a green economy. These must be considered together with more investigations of the Earth, especially at a very high resolution. Peering into the long-term geological past of the Earth will assist in modelling and planning effectively for the long-term of the future, especially within the Earth's Critical Zone (Dhansay 2021).

The Earth is a geodynamic machine that has been operational for more than four billion years (Allegre et al. 1995). Its cyclic nature of creating and recycling crustal material has vastly changed the natural environment over the millennia, including the existence and non-existence of many natural species. The Earth is long-term in its nature. Conversely, human interaction and the associated Anthropocene have existed for a small fraction of this time, short-term in its nature (Crutzen 2006). Sustainability may reside in controlling the rate of global secular change and maintaining a rate of change that is nett positive for socioeconomic-environmental development. Attaining this will require a deep understanding of our natural environment and how to effectively harness resources in a truly sustainable manner. This is not impossible. Natural research and development on an increasing scale do lead to innovative mechanisms of sustainability, however, these types of investigations need to be significantly increased, merging short-term action with long-term planning.

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