Is Climate Change Morally Good from Non-Anthropocentric Perspectives?

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Introduction

Anthropogenic climate change poses some difficult ethical quandaries for non-anthropocentrists. While it is hard to deny that climate change is a substantial moral ill, many types of non-human organisms stand to benefit from climate change. Modelling studies provide evidence that net primary productivity (NPP) could be substantially boosted, both regionally and globally, as a result of warming from increased concentrations of greenhouse gases. The same holds for deployment of certain types of climate engineering, or large-scale, technological modifications of the global environment in order to prevent or slow anthropogenic climate change. For example, solar radiation management with stratospheric aerosol injections could benefit plant life by promoting enhanced photosynthesis, increasing diffuse radiation, and reducing heat stress. This has a surprising implication: from some non-anthropocentric perspectives, certain scenarios of climate change and climate engineering might bring about morally better states of affairs when compared to emission-mitigation baselines.

In this paper, we present existing evidence that certain emissions trajectories and climate engineering scenarios are likely to benefit non-human organisms on the whole, using NPP as a proxy for non-human flourishing. We then argue that, on a non-anthropocentric perspective that affords independent moral value to non-human organisms, there is reason to deem such emissions trajectories and climate engineering scenarios to be morally better—in one important respect—than prominent alternatives, including aggressive mitigation. (Importantly, our claim here is axiological in nature, not deontic—we do not take a position on what anthropocentrism permits or prohibits. As we explain, this would depend on additional normative principles that we lack space to discuss.) If we are to take non-anthropocentrism seriously, then we should view current discussions of the ethics of climate change and climate engineering as incomplete, for they pay little attention to the well-being of non-human organisms in their own right. If our analysis is correct, however, giving non-anthropocentric perspectives a more prominent place in such discussions might substantially alter how we view climate ethics, as it would

challenge the widely held views that climate change and climate engineering constitute substantial moral ills.

The paper proceeds as follows. In the first proper section, we lay out what we mean by axiological non-anthropocentrism. In the second section, we present the science behind NPP. We then provide a scenario analysis in the third section, making the case there that NPP is likely to be higher in some global warming scenarios than in emissions mitigation scenarios, and higher in some geoengineering scenarios than in global warming scenarios. In the fourth section, we argue that this gives axiological non-anthropocentrists good reason to judge states of affairs under some climate change scenarios as morally better (in one important respect) than those under mitigation, as well as to judge states of affairs under some geoengineering scenarios as morally better (in one important respect) than those under climate change. We close by considering whether these implications are problematic for axiological non-anthropocentrism.

Axiological Non-Anthropocentrism

As we shall use the term in this paper, a view is non-anthropocentric in the relevant way if it recognizes value on the part of non-human natural entities, where that value is both independent of human interests and moral in nature. The independence condition excludes views that afford non-human natural entities merely instrumental value, such as the performance of services that benefit human societies. The moral condition excludes views that afford non-human natural entities merely non-moral types of value, such as economic or aesthetic value. Because doing so is not needed for our argument, we take no position here on the controversial debate regarding the *source* of non-anthropocentric moral value. We leave it an open question whether such value must be mind-independent rather than bestowed by human valuers, for example (see, for example, Callicott 1984; Norton 1992; Rolston 1982). Our focus is on what we call *axiological non-anthropocentrism*, which takes certain non-human natural entities to have independent moral value. This is to be distinguished from *deontic non-anthropocentrism*, which takes it that moral agents have moral obligations to non-human natural entities. The nature and extent of such obligations will depend on what the appropriate and relevant norms are. On rights-based views, for example, moral agents might have a duty to respect various moral entitlements (e.g., to life) on the part of

non-humans, whereas on consequentialist views moral agents might have a duty to promote the flourishing of non-humans. Axiological non-anthropocentrism is relevant for deontic non-anthropocentrism, of course. If nothing else, the former will tell us what entities matter morally, which is important if we are to know whose rights require respect or whose flourishing we ought to promote.

But there is also an important distinction between these two types of non-anthropocentrism. Taking a position on the moral value of non-humans does not automatically entail any particular set of obligations to them. The latter would require additional normative commitments, such as principles specifying what types of action are permissible and obligatory. There are many varieties of deontic non-anthropocentrism, including various forms of consequentialism, deontology, and virtue ethics. Because of this variety, taking on any particular deontic, non-anthropocentric view is bound to be controversial and so would require extensive defense, which we cannot provide in this paper. Fortunately, we need not take a position on deontic non-anthropocentrism, given that we will not argue that non-anthropocentrists ought to act in certain ways or favor certain policies. Instead, we will be arguing for the axiological claim that non-anthropocentrists have good reason to judge certain states of affairs to be morally good. To put this another way, our focus is on the good rather than the right. While we think this has deontic implications, some of which we will mention below, these implications will differ across competing varieties of deontic non-anthropocentrism.

The Science of Net Primary Productivity

Photosynthesis drives plant growth and is the biogeochemical process that draws CO_2 from the atmosphere to store the carbon as organic matter in soil. Gross Primary Production (GPP) is the total amount of carbon that is fixed through photosynthesis by plants in an ecosystem, measured as the mass of carbon per unit time (usually in units of gigatons of carbon per year). Global GPP is estimated at about 120 Gt/yr.

Not all carbon fixed through photosynthesis is stored as organic matter in soil or oceans, and a fraction of this absorbed carbon is re-emitted into the atmosphere through the process of plant respiration. Net Primary Production (NPP) is the difference between the gross production of carbon by

plants and the loss by plant respiration. If we represent respiration by plants as R_p, then NPP is defined as

$$NPP = GPP - R_p.$$

NPP represents the amount of excess carbon produced by plants that is available for consumption by herbivores, decomposition into the soils, and use by humans. NPP represents the short-term uptake of carbon by ecosystems, and global NPP is estimated at about 60 Gt/yr.

Consumption of carbon by herbivory and decomposition also releases carbon back into the atmosphere through respiration. If we represent respiration by herbivores as R_h and respiration by decomposers as R_d, then we can define the Net Ecosystem Production (NEP) as

$$NEP = NPP - (R_h + R_d),$$

which we can also express as

$$NEP = GPP - (R_p + R_h + R_d).$$

NEP represents the amount of excess carbon produced by plants with losses by herbivory and decomposition included. Most of this excess carbon is delivered to the soil as dead organic matter known as detritus. Only in the early stages of ecosystem development does an increase in NEP correspond to an increase in live biomass, and for older communities most of NEP is delivered to the soil or oceans. NEP represents the medium-term uptake of carbon by ecosystems, and global NEP is estimated at about 10 Gt/yr.

NEP and NPP can both be measured. One method involves physically sampling particular crops over an interval of time to measure the accumulated changes in vegetation and soil carbon stocks. Another method involves measuring the fluxes of CO_2 in and out of a system (known as the net ecosystem exchange, or NEE), which can be accomplished through in situ measurements as well as

remote sensing by satellites. Over long periods of time, we can also account for processes other than heterotrophic respiration that reduce the carbon stocks of living and dead organic matter. This includes anthropogenic contributions such as harvest and clearance as well as non-anthropogenic factors such as weather-induced fires. If we represent the release of carbon through anthropogenic processes as R_a and the release of carbon by non-anthropogenic processes as R_n, then we can define the Net Biome Production (NBP) as

$$NBP = NEP - (R_a + R_n),$$

which we can also express as

$$NBP = GPP - (R_p + R_h + R_d + R_a + R_n).$$

NBP represents the amount of excess carbon produced by plants after all loss processes are included, including anthropogenic effects. NBP represents the long-term uptake of carbon by ecosystems. In general, NBP has been considered to be close to zero, but measurements over recent decades have estimated global NBP at about 1 Gt/yr.

All of the quantities discussed above describe the growth of plants and accumulation of carbon stocks in soil and oceans. Plant growth is a complex phenomenon, and the response of plant ecosystems or individual plant species on environmental changes depends on a wide range of factors. In addition to field measurements and remote sensing, some researchers have also attempted to estimate global NPP numerically. One example of this expression is

$$NPP = f(T, CO_2, H_2O, NA, R)$$

which expresses NPP as a function of temperature (T), atmospheric carbon dioxide (CO_2), water abundance (H_2O), nutrient availability, and radiation availability (R). Such models attempt to encapsulate the response of plant ecosystems in a way that can be captured by computational models. This allows,

for example, for changes in NPP to be examined under scenarios of anthropogenic climate change, mitigation, or geoengineering.

Scenario Analysis

We consider the response of NPP under three scenarios: global warming (GW), strong mitigation (MIT), and solar radiation management geoengineering (SRM). Our discussion synthesizes results from computational climate models (Govindasamy et al. 2002; Jones et al. 2013; Kravitz et al. 2013; Vaughan and Lenton 2012; Glienke et al. 2015; Xia et al. 2015) to explore the general dependence of NPP on changes in global average temperature (*T)*, atmospheric carbon dioxide (CO_2), and diffuse downward radiation (*D*). We show that under certain circumstances, the collective effect on these key variables acts to increase NPP for GW and SRM but decreases NPP for MIT. This at least warrants consideration by non-anthropocentrists on whether GW and SRM are morally better than MIT.

Under GW, rising emissions contribute to an increase in CO_2, which causes an increase in greenhouse warming and thereby an increase in *T*. In general, GPP is directly proportional to changes in CO_2, which enhances photosynthesis activity, so we should expect GPP, and thus NPP, to increase under GW. GPP also tends to increase as *T* rises as well, although the optimal temperature for photosynthesis is species-dependent. Additionally, Earth's tropics (spanning from the equator to about 30 degrees latitude) may be prone to experiencing heat stress before the midlatitude and polar parts of the globe, which may limit the increases in GPP at tropical latitudes. Increases in *T* may also induce increases in plant respiration R_p, soil respiration R_d, and heterotrophic respiration R_h. These increases in respiration quantities may offset some of the increase in GPP under GW by reducing the long-term carbon storage represented by NEP and NBP. Climate modeling studies continue to investigate the latitudinal-dependence of, and any limit upper to, GPP increases under GW and SRM (Glienke et al. 2015; Xia et al. 2015), but on a global average we should generally expect GPP, and thus NPP, to increase under GW.

When we consider MIT, we see the opposite trend. Efforts to reduce contributions to warming cause a net decrease in CO_2, which reduces the greenhouse effect and thereby reduces *T*. This causes GPP to decrease due to the lower availability of CO_2. The decrease in *T* may actually cause an increase

in GPP at tropical latitudes, although GPP should decrease at midlatitude and polar regions. Lower T may also cause a reduction in R_p, R_d, and R_h, which increases NPP, NEP, and NBP. Accordingly, we should expect MIT to cause a decrease in GPP, and thus a decrease in NPP.

SRM seeks to decrease the amount of incoming solar energy absorbed at the surface of Earth in order to induce a decrease in T while CO_2 continues to rise. As with GW, the SRM scenario promotes enhanced photosynthesis and causes an increase in GPP. The decrease in T may cause an increase in GPP at tropical latitudes due to a reduction in heat stress, while midlatitudes and polar regions may experience a decrease in GPP from this effect. Lower T may also cause a reduction in R_p, R_d, and R_h, which further contributes to the increase in NPP, NEP, and NBP. Additionally, SRM with stratospheric sulfate geoengineering would cause an increase in the amount of downward-directed diffuse radiation D, as a result of enhanced scattering of sunlight from the presence of this aerosol, which would tend to enhance plant growth and thereby increase GPP (Mercado et al. 2009; Robock et al. 2009; Xia et al. 2015). The confluence of these three factors under SRM would act to increase NPP.

A caveat should be added to the above discussion. Many current climate-ecosystem models are limited in their ability to calculate soil nutrient cycles for elements such as nitrogen and phosphorus, which are essential for photosynthesis. Increases in NPP under GW or SRM could ultimately be bounded by soil nutrient limitations, and ongoing model development seeks to address this uncertainty (Kravitz et al. 2013; Jones et al. 2013; Glienke et al. 2015; Xia et al. 2015). As mentioned above, changes in NPP depend strongly upon latitude (Glienke et al. 2015), in addition to the future carbon dioxide emissions trajectory. Current models are lacking in realistic representations of key nutrient cycles (Glienke et al. 2015), which has led to wide uncertainty in the future evolution of NPP under GW, MIT, and SRM (Jones et al. 2013). Nevertheless, our argument takes a global approach and suggests that NPP should tend to increase under GW and SRM, regardless of the choice of future emissions trajectory. Nutrient limitations may place an upper-bound on the increase in NPP, but this limit is still expected to be higher than NPP today (Govindasamy et al. 2002). We can therefore conclude that our discussion of global trends in NPP, as they relate to our three scenarios, should be robust, even as climate modelers continue to provide better constraints on changes in vegetation under GW, MIT, and SRM.

The ocean also provides an important sink for CO_2, mostly as a result of photosynthesis by phytoplankton in the surface mixed layer. The ocean today is a net sink for CO_2, but models that include dynamic representations of the biosphere predict that this oceanic carbon sink will eventually be balanced by terrestrial sources under GW (Cox et al. 2000). Both GW and SRM result in increased atmospheric CO_2 that drives stronger photosynthesis, which could lead to algal blooms and enhanced growth of various bacterial species—some of which may be pose risks to human health (Paerl and Huisman 2009; Hallegraeff 2010). In general, the response of marine NPP to GW is less constrained by models than terrestrial NPP; other factors such as changes in the supply of nutrients or light may also be indirectly affected by increases in temperature (Taucher and Oschlies 2011), while the response of different organisms to temperature changes could lead to 'trophic mismatch' between key groups of organisms that alters the balance of marine ecosystems. Regardless of how ocean life responds to warming, another significant issue is ocean acidification, which remains under both GW and SRM. Increases in CO_2 under GW or SRM will increase the concentration of dissolved CO_2 in the ocean, which is expected to threaten the structural integrity of coral reefs and could cause the collapse of marine ecosystems (Orr et al. 2005; Hoegh-Guldberg et al. 2007; Doney et al. 2009). Ocean acidification could therefore contribute to decreases in marine NPP under GW and SRM, even if phytoplankton populations show enhanced growth from warming.

NPP tends to increase in both GW and SRM, while MIT tends to show a decrease in NPP. SRM also holds the potential to increase NPP even more than GW, due to the enhancement of diffuse radiation. Furthermore, the decrease in *T* under SRM would promote a reduction in respiration by plants, soil decomposers, and heterotrophs—similar to that under MIT—which would amplify the increase in NPP. The effects of *T* tend to promote opposite effects at tropical compared to midlatitude and polar latitudes, and these differences in growth of particular species may be relevant for certain non-anthropocentric perspectives. But in general, SRM avoids the problem of heat stress that could occur under GW. This global analysis suggests that NPP could increase more under SRM than GW, both of which could show a greater increase in NPP than MIT.

Implications for Axiological Non-Anthropocentrism

The foregoing scenario analysis has some surprising implications for axiological non-anthropocentrists. First, however, we should say why NPP is plausibly taken to be a reliable indicator of non-human flourishing. Because it correlates with the overall quantity of live biomass, we can reasonably expect increasing NPP to imply enhanced functioning on the part of organisms. This includes increased plant growth (through enhanced growth of existing plants, as well as the promotion of new plants) and herbivore nutrition (thanks to increased food availability), for example. In terms of the framework above, an increase in NPP will cause a corresponding increase in NEP and NBP, which makes more stored carbon available for use by non-humans (and possibly humans as well). We do not here assume any particular theory of non-human flourishing, as this is a controversial matter we cannot adequately address in a short space. However, any plausible theory thereof will view increased plant growth and herbivore nutrition as benefits to the affected organisms. All else being equal, enhancement of biotic functioning (e.g., growth and nutrition) would count as enhancement of non-human flourishing. Thus, if there is a *net* increase in primary productivity, then it is plausible to think there will be a net increase in non-human flourishing. To be clear, we do *not* claim that NPP is somehow a direct measure of non-human flourishing in its own right, nor that a large-scale increase in live biomass is *equivalent* to an increase in non-human flourishing, nor that an increase in NPP *necessarily* indicates an increase in non-human flourishing. Rather, we think that NPP is a reasonably reliable and accurate indicator of changes non-human flourishing, for the reasons just noted.

Different theories will offer competing accounts of *why* such changes are beneficial, but no plausible theory will deny *that* they are beneficial to the affected non-humans. For those who think that non-human flourishing has moral value, enhancement of such flourishing is morally good, although the deontic relevance of this (if any) will depend on the normative principle to which one is committed. Here there is a potential objection to our argument. One might claim that no axiological non-anthropocentrist is committed to the idea that an increase in the quantity of non-human flourishing (all else being equal) is necessarily a good thing, morally speaking. If that were correct, then our argument would be directed at a view that no one holds. However, we note that some axiological non-anthropocentrists do hold this view. A prominent example is Nolt, who argues that we should understand the goodness of living entities in terms of goodness *for* such entities, thus directly tying the value of non-human organisms to their own

flourishing or welfare (Nolt 2009). Moreover, even for those axiological non-anthropocentrists who do not *explicitly* endorse the claim that an increase in non-human flourishing is a morally good thing, it is difficult for them to avoid this implication. This is especially so for views that recognize independent moral value on the part of individual non-human organisms, as many views do (Rolston 1988; Taylor 1986). Consider Taylor's classic account, on which each individual organism is a "teleological-center-of-life" possessing inherent worth equal to that of any other organism. It would be very odd to accept this yet simultaneously deny that an increase in the flourishing of such organisms is a good thing. After all, if we are to be teleologists here, to flourish is no doubt one of the ends toward which an organism is teleologially directed. Plausibly, if some entity has inherent worth (in a moral sense) in virtue of being a teleological-center-of-life, then the achievement of its telos likewise carries moral value. But one need not be a teleologist for our general point to hold. Accepting that some class of entities has moral value in its own right, while denying that an increase in flourishing on the part of that same class of entities is (all else being equal) morally better, constitutes biting a rather large (and implausible) bullet.

We need to address a potential problem for our argument. The models showing an increase of NPP under certain scenarios describe the aggregation of both increased biomass on the part of existing organisms and an enhanced capacity for new organisms. This could matter for some (but not all) forms of axiological non-anthropocentrism. In many cases, enhanced flourishing of existing organisms (both plants and animals) will lead to enhanced reproductive capacity, which implies that increases in NPP pertain to both existing and future organisms. For virtually all such views, it is agreed that benefits to existing organisms (all else being equal) constitute axiological improvements. It may seem less clear that bringing some flourishing organism into existence constitutes an axiological improvement. Indeed, we might suspect that this raises a kind of non-identity problem (Parfit 1987). After all, if SRM or GW enhances NPP largely by bringing into existence non-human organisms that would not have existed under MIT, then arguably SRM or GW is (for the most part) not good *for* non-human organisms, at least if we assume that being brought into existence is not a benefit. This would be so because many organisms would not be better off under SRM or GW than they would have been under MIT, simply because they would not have existed under MIT. This motivates a concern about our argument, for it suggests that an increase in NPP might not be a reliable indicator of non-anthropocentric axiological improvement.

However, it should be noted that the non-identity problem is typically taken to raise deontic issues rather than axiological ones. For example, it poses theoretical difficulties for the view that we have obligations to future human persons, given that the identities of future persons might depend on our policy choices at an earlier time. Suppose we choose an environmental policy today that, due to far-reaching social impacts, substantially changes what persons are born in the future. Suppose further that this policy results in a relatively low level of well-being for those future persons. It is unclear that we have violated our obligations to those persons. Indeed, although our policy choice has resulted in their relatively low level of well-being, they owe their existence to that choice, and therefore they are not worse off than they would have been under alternative scenarios. This is deontically puzzling. However, the axiology of this scenario is much less puzzling. Suppose we had adopted a different environmental policy in the past, one that ensured a relatively high level of well-being on the part of future persons but resulted in different persons being born. Suppose that all else remains equal between the two scenarios. It is very plausible to think that, due to its higher level of well-being, the latter scenario is morally better than the former. This is difficult to deny if we admit that human well-being carries moral value. A similar point applies for non-human flourishing. It is difficult to deny that scenarios with more non-human flourishing (all else being equal) have more value than scenarios with less non-human flourishing. If one is committed to axiological non-anthropocentrism, then it is also difficult to deny that scenarios of the former kind are morally better than those of the latter kind, even if the organisms in such scenarios are non-identical to one another. Although this non-identity may have deontic relevance for non-anthropocentrists, it is not clear that such non-identity challenges the axiological implications we are identifying.

Our argument so far assumes that some increase in NPP will not be *fully* accounted for by an increase in carbon stocks in soils and oceans, but that some of that increase will be due to an increase in live biomass, thus tracking changes in biotic functioning. Calculations with climate models suggest that this would indeed be the case in likely emissions and climate engineering scenarios, although the absolute increase in NPP may ultimately be limited by soil nutrient availability (Govindasamy et al. 2002; Jones et al. 2013; Kravitz et al. 2013; Vaughan and Lenton 2012; Glienke et al. 2015; Xia et al. 2015) Nevertheless, Earth has experienced warmer periods in its geologic past, such as during the mid-Cretaceous period when Antarctica appears to have been populated by temperate forests, suggesting a

global average temperature of several degrees warmer than today (Barron 1983; Barron et al. 1995). Biodiversity also seems to be positively correlated with temperature in general across Earth's recorded history (Mayhew et al. 2012). Furthermore, some speculative discussion in the astrobiology literature suggests that some planets in the galaxy could be classified as *more habitable* than Earth, which implies that Earth today retains the potential to increase its total habitable capacity (Schulze-Makuch et al. 2011; Heller and Armstrong 2014). These arguments all imply that the increases in NPP under GW and SRM should contribute to actual increases in live biomass.

If this is correct, then non-anthropocentrists have reason to view GW as morally better than MIT and SRM as morally better than GW. Because increases in NPP tend to track increases in non-human flourishing, and because NPP tends to increase more in GW than in MIT (and more in SRM than GW), we should expect greater enhancements of non-human flourishing in GW than in MIT (and likewise with SRM relative to GW). Given that non-anthropocentrists generally place moral value on the flourishing of non-humans, this provides a *prima facie* case that non-anthropocentrists should judge GW as morally better than MIT (and SRM as morally better than GW) along one important axis of moral value. This is a surprising result. Although little has been written on climate change from non-anthropocentric perspectives, it is usually thought that climate change stands to be detrimental (on balance) to non-humans (Nolt 2011). If our analysis is on the right track, however, then this common view might be mistaken. It may be that further climate change and even geoengineering (via SRM) would yield outcomes that are on balance better for non-humans relative to MIT. Given the basic commitments of most non-anthropocentric theories, consistency might require non-anthropocentrists to view the states of affairs produced by further climate change or geoengineering as morally better than MIT, at least in terms of the value recognized in non-human flourishing.

We should issue several disclaimers regarding what we are *not* claiming here. First, as already indicated, we do not think that non-anthropocentrists necessarily ought to favor policies that allow further climate change or include SRM deployment. Again, our focus here is entirely axiological, and the question of what one ought to do involves deontic considerations—for example, regarding whether some policy is morally permissible, impermissible, or obligatory. It is certainly coherent for a non-anthropocentrist to hold a view according to which, although some state of affairs would be morally better, it is impermissible to

bring about that state of affairs, perhaps because the only available options for doing so are themselves impermissible. Nonetheless, for many non-anthropocentric views, such axiological facts will be deontically relevant, and so proponents of such views might have *prima facie* reason to favor policies involving further climate change or geoengineering, but we lack space to consider these implications further in the present paper. On a related point, we are *not* claiming that non-anthropocentric views will face problematic conflicts regarding the (deontic) question of what climate policies ought to be adopted. To take an example, suppose it turns out that SRM or GW appears to be (on balance) harmful to humans but (on balance) beneficial to non-humans. Non-anthropocentrists have well-known techniques for responding to cases of this kind, such as by showing that the conflict in question is merely apparent (Sterba 2000) or by utilizing principles to prioritize some duties over others (Taylor 1986). We offer no opinion on whether SRM or GW is likely to entail actual conflict between the flourishing of humans and that of non-humans, nor do we offer an opinion on whether non-anthropocentric views will be able to deal with such conflict in a plausibly way should it arise. Once again, our claims are purely axiological, so these issues are not relevant to our argument.

Second, we do not hold that further climate change or SRM would yield states of affairs that are *all-things-considered* morally better than those of MIT. While that is possible, we are only arguing here that states of affairs produced by GW or SRM are likely to be morally better than those of MIT in terms of non-human flourishing. Such an all-things-considered judgment would take all morally relevant value and disvalue into account, including values and disvalues associated with human flourishing. Virtually all axiologies (including non-anthropocentric ones) will recognize moral value on the part of things other than non-human flourishing. For example, climate change is expected to yield substantial harm to human beings, and in some scenarios the disvalue of that harm might be sufficient to offset the value of what is gained in terms of enhanced NPP. In such a case, the resulting state of affairs, although better than that of MIT in terms of non-human flourishing, might *on the whole* be worse than MIT, even from a non-anthropocentric perspective, and this would be the case because (virtually all) non-anthropocentrists assign moral value to human flourishing in addition to non-human flourishing. We cannot rule out this possibility, given the differing commitments of competing non-anthropocentric theories. Nonetheless, it is plausible to think that some such theories would require viewing GW or SRM as morally better than MIT.

For example, biocentric egalitarianism assigns equal moral value to human and non-human organisms (Taylor 1986). If, relative to MIT, GW enhances the flourishing of non-human organisms on the whole but reduces that of human beings, a proponent of this position will view GW as morally better than MIT in some respects but morally worse in others. Yet because humans and non-humans are given equal moral weight, and because there are many more of the latter than the former, the moral goods of GW might greatly outweigh its moral ills. Here it is reasonable to expect that a biocentric egalitarian would be compelled to view GW as morally better than MIT, despite the harm accruing to human beings.

Our argument would face an important objection if there were reason to think that, despite increased NPP, GW and SRM scenarios would *not* be (on balance) morally better with respect to *non-humans* than MIT scenarios. For instance, there is a possibility that GW and SRM would yield diminished biodiversity, even if they enhanced NPP. There is good reason to think this would be the case under GW, although it is not clear that SRM would reduce biodiversity. But let us suppose that both GW and SRM would diminish biodiversity while enhancing NPP. A non-anthropocentrist who values both biodiversity and the enhanced flourishing indicated by increased NPP would have reason to judge GW and SRM as morally better than MIT in one respect but worse in another. In a case like that, some axiological non-anthropocentrists might hold that GW and SRM are morally worse for non-humans. With that said, many non-anthropocentrists do not value biodiversity in its own right (Maier 2012; Nolt 2015), and so the aforementioned objection will not arise in such cases. However, even for non-anthropocentrists who do place moral value on biodiversity in its own right, two issues will matter a great deal, namely how much axiological weight is placed on biodiversity relative to non-human flourishing, as well as the magnitude of the actual changes to biodiversity and non-human flourishing under relevant scenarios. In some instance, it may turn out that, by the lights of some non-anthropocentric theory, the value of enhanced non-human flourishing significantly outweighs the disvalue of biodiversity loss under SRM or GW, such that it compares favorably to MIT. Of course, this cannot be shown *a priori* to be the case for all non-anthropocentric theories. We acknowledge that there are some possible positions that, by giving substantial weight to the moral value of biodiversity, may be able to resist our argument. Nonetheless, our findings would still apply for many non-anthropocentric positions, for the reasons just noted.

There is another strain of non-anthropocentrism that might seem able to avoid the implications we have noted so far, which we will call *non-interventionist* non-anthropocentrism. Views in this strain recognize moral value exclusively on the part of "natural" (in a very specific sense of the term) non-human entities rather than "non-natural" ones. By natural non-human entities, we mean those whose existence and functioning are independent of human interference. These might include native species of wild animals and plants but exclude domesticated species, for example. Proponents of such views recognize moral value on the part of non-human entities in their natural states. Accordingly, non-interventionists are likely to be unimpressed by enhanced NPP under GW and SRM scenarios. They might grant that non-human flourishing is increased under further climate change or geoengineering and yet deny that this increased flourishing carries moral value. They might justify this by arguing that the gain in flourishing is achieved partly due to gains among non-natural entities, such as invasive species. Now suppose that GW and SRM scenarios (relative to MIT) on balance damage the flourishing of natural non-human entities but substantially boost the flourishing of non-natural ones. In that case, the non-interventionist could consistently claim that states of affairs prevailing under those GW and SRM scenarios are morally worse than the state of affairs under MIT.

Non-interventionist non-anthropocentrism is controversial as a matter of environmental ethical theory. Critics have questioned whether (and why) we should privilege natural (in the specific sense defined above) entities over novel ones (Marris 2013; Ellis 2011). However, our claims so far do not depend upon rejecting non-interventionist non-anthropocentrism as an environmental ethical theory. This is so for two main reasons. First, even if the non-interventionist strain can avoid the implications we have traced, there are other strains of non-anthropocentrism that plausibly do imply that states of affairs under GW or SRM are morally better (regarding non-human flourishing) than states of affairs under MIT. Once again, biocentric egalitarianism is a plausible candidate for this, because it recognizes equal moral value on the part of all biotic entities, regardless of whether those entities are novel ones (Taylor 1986). In other words, our analysis might be correct for many non-anthropocentrist views even if it is not correct of non-interventionist views, in which case we would have an interesting, if somewhat limited, finding. Second, there is reason to think that our analysis might be true even for non-interventionist non-anthropocentrism. This is because enhanced NPP under GW or SRM likely will track benefits to natural entities, such as

enhanced growth in native species of wild plants. Because of this, even non-interventionists should recognize the moral value indicated by an enhancement of NPP. Whether the gain in flourishing for natural entities under GW or SRM is enough to constitute an improvement over MIT will depend on what proportion of increased NPP goes to natural entities as opposed to novel ones. But there are realistic scenarios in which GW or SRM could produce states of affairs that are morally better than MIT from the perspective of non-interventionist non-anthropocentrism.

Conclusion

These implications are surprising, but are they problematic for non-anthropocentrism? Perhaps the answer is affirmative. Few environmental philosophers (or environmentalists more broadly) doubt that anthropogenic climate change is an obvious and substantial moral ill, and something similar could be said for geoengineering. If axiological non-anthropocentrism is favorable toward further climate change and geoengineering, perhaps this indicates that something is amiss with that family of views. To reiterate, we take no position on whether our findings pose deontic problems for non-anthropocentrism. Even supposing that axiological non-anthropocentrism is problematic, it does not necessarily follow that theories relying on it will stumble in identifying how we ought to proceed as a matter of climate policy. Our suggestion here is only that non-anthropocentrism *might* be problematic in an axiological sense, given the implication that (by non-anthropocentric lights) SRM and GW appear to be morally better than MIT. On the other hand, perhaps this implication shows only that we are too quick in condemning climate change and geoengineering as obvious and substantial moral ills. Assuming that the flourishing of various non-human entities carries moral value, then we should take their flourishing into account when assessing the moral value of different climate scenarios. If that assessment runs counter to our expectations, then perhaps the error lies in those expectations themselves rather than in non-anthropocentric commitments. We take no position here on whether our findings are problematic for non-anthropocentrists, but we do believe that these findings suggest that non-anthropocentrists should consider this matter carefully, given the counterintuitive results of our analysis.

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