‘Facing Gaia’ in Science

by

Emma E. Bos

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Supervisor: Dr. Y.H. Hendlin
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Table of Contents

Introduction

Humanity is currently confronted with a huge ecological crisis. Global warming due to anthropogenic emissions, deforestation, mass extinction of species, and the plastic soup is only a small selection of all the human-induced problems that we are currently facing. Humans have had such a profound impact on the earth that we may have transitioned into a new geological epoch, the 'Anthropocene'. How did the situation spiral out of control? Why have humans been unable to take action against these problems? Bruno Latour argues that this can be traced back to the nature-culture divide, that separates the world into an unchangeable 'Nature' ruled by universal laws on one side, and a 'Culture' that consists of human beings with the capacity for voluntary and autonomous action on the other. All the aforementioned ecological problems show a connection between human activity and nature and therefore do not fit this notion of an inert nature. According to Latour, we are entering a 'New Climatic Regime'. A new way of looking at nature needs to be developed, in order to be able to cope with this ecological crisis and to persuade people to take action against it. In *Facing Gaia*, Bruno Latour develops such a notion, based on James Lovelock's Gaia hypothesis. Since I am studying chemical engineering, I would like to know the implications for scientists (and engineers) of this new way of looking at nature. Therefore, the research questions of this thesis are as follows:

1. *What is the role of science and scientists in the New Climatic Regime according to Latour, as described in 'Facing Gaia', and how does this compare to the role of science and scientists in the Old Climatic Regime?*
2. *What are some possible examples to practice science in the New Climatic Regime and how do these compare to Latour's theory?*

This thesis is divided in two parts, each part answering one of the research questions above. In the first part, I will describe the Old Climatic Regime and Latour's critical stance towards it. Then, I will give Latour's account of the New Climatic Regime. Latour argues that scientists in the New Climatic Regime have three roles: tracing the loops constitutive of Gaia, recognizing that the construction of facts is embedded in a network, and representing nonhuman actors in political negotiations. In the second part, I will give some examples from practice of what doing science in the New Climatic Regime can look like and how these examples compare to Latour's idea. These examples are Suzanne Simard's research on communication between trees, feminist epistemology, 'Make it Work' (a simulation of COP21 in 2015, which included non-state actors), and the Dutch national water authorities.

PART I

Old & New Climatic Regime

Old Climatic Regime

In the first chapter of *Facing Gaia*, Latour investigates why it is so difficult to take action against climate change, even though evidence for human-induced climate change is plentiful, and has been for a long time. According to Latour, this is a result of the distinction between two domains, namely nature and culture. However, these two domains cannot be separated. In order to define 'nature', you have to define 'culture', because the human is what escapes nature, and in order to define 'culture', you have to define 'nature', because the human is what cannot "totally escape" the constraints of nature. Instead, these two domains are the two halves of a pair pertaining to one single concept. This is why humans are unable to take adequate action against climate change: "it obliges us to experience the full force of the instability of this concept, when it is interpreted as the impossible opposition between two domains that are presumed actually to exist in the real world."[1] Furthermore, it makes the problem of global warming seem too distant for humans to be able to act. The standard notion 'deanimates' nature in the sense that it portrays nature as inanimate and thus irresponsive to human activity, thereby depriving these actants of their agency. In addition, it 'overanimates' human beings by raising them above nature by giving them the capacity for action: freedom, consciousness, reflexivity, a moral sense, and so on.[2] Humans and nonhumans all have the ability to act, so distinctions between nature and culture, humans and nonhumans are all meaningless.

In science, the distinction between 'nature' and 'culture' manifests itself as 'Globe-alization'. According to Latour, "The Globe grasps all things from far away, as if they were external to the social world and completely indifferent to human concerns."[3] This means that science, by claiming objectivity and value-neutrality, takes on a 'view from nowhere' by which it claims to be able to know everything from the outside. Science is seen as external, united, generating inanimate agents, indisputable, universal and atemporal.[4] According to Latour, this view completely disregards the way science is actually practiced. The construction of facts takes place through complex relations between scientists, universities and academies, offices and laboratories, scientific instruments, and so on.[5] Both social and non-social factors play a role. I will elaborate upon Latour's analysis of science in the section about the New Climatic Regime.

In *Down to Earth*, Latour discusses a second aspect of the notion of nature in the Old Climatic Regime, namely nature as a 'factor in production' or a 'resource to exploit'.[6] This is rooted in the distinction between human actors and nature (their resources): if nature is perceived as deanimate, inert, and thus indifferent to human actions, it follows that humans are free to exploit it as a resource and dispose of their waste in it. Indeed, the exploitation of fossil fuels and emissions of greenhouse gases on a massive scale is what led to climate change.

[1] Bruno Latour, *Facing Gaia: Eight Lectures on the New Climatic Regime* (Cambridge, UK: Polity Press, 2017), 19.
[2] Latour, *Facing Gaia*, 68.
[3] Bruno Latour, *Down to Earth: Politics in the New Climatic Regime* (Cambridge, UK: Polity Press, 2018), 66-7.
[4] Latour, *Facing Gaia*, 167.
[5] Ibid, 127.
[6] Latour, *Down to Earth,* 74-7.

IPCC and UNFCCC Analysis

Since the negative effects of human action on the climate are now widely recognized in climate science and policies, we seem to be moving away from the Old Climatic Regime. In a sense, nonhuman agency is recognized, for example in the form of dangerous sea level rise or extreme weather events threatening food production and water supplies. However, many elements of the Old Climatic Regime are still present in climate science and climate policies. I will illustrate this using two examples: the United Nations Framework Convention on Climate Change (UNFCCC), the framework on which the Paris agreement is based, and the reports of the Intergovernmental Panel on Climate Change (IPCC), a United Nations panel evaluating the science related to climate change.

Firstly, both of these examples make a distinction between nature and culture.[7] The UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods,"[8] thus explicitly distinguishing between 'climate variability' as a natural phenomenon and human-induced 'climate change'. The IPCC uses a broader definition of climate change, yet still makes this distinction:

> Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.[9]

Furthermore, in their reports, the IPCC distinguishes between warming due to anthropogenic forcings and warming due to natural forcings.[10]

Secondly, the idea of a 'view from nowhere' is also expressed in climate policies and reports. The IPCC claims to be able to make a distinction between anthropogenic warming and natural warming, but in practice, this distinction is difficult to make. The IPCC's distinction is based on extensive climate modelling and statistical analyses, and it is not possible to attribute individual weather events to either human-induced climate change or natural climate variability.[11]

The introduction of a 'dangerous' limit to climate change also illustrates the idea of a 'view from nowhere'. The aim of the UNFCCC is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[12] The Paris Agreement makes this more concrete, as this agreement aims to keep the rise of average global temperature rise below at least 2 °C, but preferably 1.5 °C of warming above preindustrial temperatures.[13] This limit is justified by appealing to climate science, and thus assumes that human knowledge is sophisticated enough to reveal the limits of nature and decide what constitutes 'dangerous' climate change. However, given the uncertainties surrounding the

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[7] Ylva Uggla, "What is this thing called natural? The nature-culture divide in climate change and biodiversity policy," *Journal of Political Ecology* 17, no. 1 (2010): 79-91.

[8] United Nations, *United Nations Framework Convention on Climate Change* (1992), Article 1.2. https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change

[9] IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Core Writing Team, R.K. Pachauri and L.A. Meyer (Geneva, Switzerland: Intergovernmental Panel on Climate Change, 2014), 120.

[10] For example, Figure 1.9 on page 48 in the Fifth Assessment Report.

[11] Paul N. Edwards, "Representing the Global Atmosphere: Computer Models, Data, and Knowledge about Climate Change" in *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, ed. Clark A. Miller and Paul N. Edwards (Cambridge, MA: The MIT Press, 2001), 33.

[12] United Nations, *United Nations Framework Convention on Climate Change*, Article 2.

[13] United Nations, *The Paris Agreement* (2015), Article 2.1a. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

impacts of climate change at different temperatures, it might be inappropriate to identify a single dangerous limit. While science can help to provide possible projections of climate change and its effects, what can be considered 'dangerous' climate change and what constitutes an acceptable risk is a value judgment and should be decided by society as a whole.[14] The notion that facts must be reconciled with values for scientific questions that have long-ranging or global effects has been previously discussed in philosophy of science through the lens of post-normal science. Post-normal science as a paradigm directs that when uncertainty is high or the possible risks or outcomes can be dangerous to society, that other values must be taken into consideration to best steer scientific programs and applications.[15]

This limit is also an expression of the notion of nature as a resource, since it implies that humans are free to exploit nature as long as the dangerous limit is not transgressed and it does not have negative consequences for humanity. However, this view still deanimates and ignores many actants. Firstly, the limit only takes greenhouse gas emissions and global warming into account, and neglects other problems such as water and soil pollution, thus neglecting the interests of these actants. Secondly, adverse effects will also occur below the limit. This can already be experienced in the form of increased extreme weather events such as heat waves or storms. These effects are not considered to be 'dangerous' enough within this paradigm, thereby neglecting the actors harmed by them. Thirdly, regional differences and questions of vulnerability are not taken into account. Some places will warm more than the limit of 1.5 or 2 °C, and others will already experience some of the effects considered 'dangerous' with warming lower than the limit.[16]

The Role of Science in the Old Climatic Regime

The role of science in the Old Climatic Regime, according to Latour, is to settle (moral) issues. Science serves as an 'impartial arbiter' to bring irrational people back to reason or to indisputable knowledge of deanimated objects. Scientific knowledge is not simply a description of the world, but also possesses strong prescriptive power and thus a political dimension.[17] For example, scientific reports on the adverse effects of climate change imply that anthropogenic emissions of greenhouse gases should be reduced. Because science possesses the 'view from nowhere' in the form of objective and impartial knowledge, it is placed 'above' politics. In the case of the IPCC, for example, scientists are separated from the political negotiations and in this sense given an elevated position. Their only role is to provide the world with objective reports on climate change that will guide the political discussions. In the New Climatic Regime, however, this role of science has become untenable. In order to escape the prescriptive function of scientific knowledge, you would have to deny the facts. This is precisely what is currently happening: even though the science regarding global warming is very strong, it does not settle the disputes with climate sceptics, because they simply deny the science.

Another role of science in the Old Climatic Regime is that, by discovering scientific facts, nature can be predicted and controlled. This is an expression of the view of nature as a resource. For example, in the field of chemical engineering, scientists develop and improve catalysts for processes that are important in the production of fossil fuels. By developing these catalysts, science is employed to produce resources as efficiently as possible (while neglecting the wider consequences), as a form of controlling nature. We view this as 'progress', even though drilling for fossil fuels and their subsequent refining and burning poses great dangers such as pollution of the air and oceans, deforestation, and the destruction of coral reefs. Thus, actants like the atmosphere,

[14] Christopher Shaw, "The Two Degrees Celsius Limit", Oxford Research Encyclopedia of Climate Science, April 26, 2017.
[15] Silvio O. Funtowicz and Jerome R. Ravetz, "Science for the Post-normal Age," *FUTURES* 25, no. 7 (1993): 739-755.
[16] For example, Tuvalu, a group of islands in the Pacific Ocean. Its highest point is at 4.6 meters, so it is at great risk of flooding as a consequence of rising sea levels, and many people are already fleeing the island.
[17] Latour, *Facing Gaia*, 25.

oceans, forests, coral reefs are deanimated and ignored in practices that are characteristic for the Old Climatic Regime.

In conclusion, the notion of nature prevalent in the Old Climatic Regime has become unstable. We cannot continue deanimating actors and controlling nature, since this is what has led us into the Anthropocene. We need to develop new ways of thinking, and the roles of science and politics need to change. In the next section, I will discuss the new notion of nature that Latour suggests.

New Climatic Regime

As an alternative to the Old Climatic Regime, Latour develops a theory based on the Gaia hypothesis. This hypothesis was developed by James Lovelock and Lynn Margulis in the 1970s. According to the Gaia theory, the surface of the earth can be considered a physiological, self-regulating system for environmental variables such as surface temperature and atmospheric concentrations of reactive gases like oxygen.[18] The reason for this is the life present on earth. This theory can be illustrated with a computer simulation called 'Daisyworld,' developed by Lovelock and Andrew Watson.[19] Daisyworld is a hypothetical planet that only contains two types of daisies: black and white daisies. The planet is irradiated by a star. The daisy growth rate is only affected by the temperature on the planet. Black daisies absorb light, which leads to heating of their environment, whereas white daisies reflect light, which leads to cooling of their environment. No daisies grow below 5 °C or above 40 °C. At the lower end of this spectrum, black daisies have an advantage because of their heating properties. At the higher end of this spectrum, white daises have an advantage because of their cooling properties. At low temperatures, therefore, there will be more black daisies than white daisies. This heats up the planet, because black daisies absorb light. At some point, the temperature will be so high that white daisies have an advantage. More white daisies than black daisies will grow. This cools the planet again, because white daisies reflect light, until the temperature drops enough for the black daisies to have an advantage again. The temperature keeps on oscillating around a certain value with the passage of time. This example shows how a planet with life creates a self-regulating system.

Lovelock started thinking about this hypothesis when he was working at NASA. He noticed that the Earth's atmosphere was in chemical disequilibrium, in contrast with Mars, yet remained stable. He concluded that the presence of life on earth keeps the atmosphere in chemical disequilibrium. According to Lovelock, organisms do not simply develop in and adapt themselves to an environment, like Darwinian natural selection states. This is only one side of the coin. Instead, the evolution of organisms and the evolution of environmental factors are a single, coupled process. Organisms constantly modify their environment while they are at the same time modified by it.[20] For example, methane is a gas that easily reacts with oxygen to form carbon dioxide. Therefore, if there was no life on earth, methane would have completely disappeared, like on Mars. However, there are small quantities of methane in our atmosphere. This is the result of methane-producing bacteria, that for example live in the digestive tracts of cows.[21] Thus, on the one hand, the composition of the atmosphere is produced by organisms, and on the other hand, they adapt to it.

This process of an organism modifying its (local) environment, called 'niche construction', implies that there is no clear distinction between organisms and their material environment. Latour takes this to be a redistribution of agency:

> If the compositions of the air we breathe depends on living beings, the atmosphere is no longer simply the environment in which living beings are located and in which they evolve; it is, in part, a result of their actions. In other words, there are not organisms on one side and an environment on the other, but a coproduction by both. Agencies are redistributed.[22]

[18] James Lovelock, *Gaia: De genezing van de aarde* (Deventer, The Netherlands: Uitgeverij Ankh-Hermes B.V., 2001).
[19] Andrew J. Watson and James E. Lovelock, "Biological Homeostasis of the Global Environment: The Parable of Daisyworld," in *Tellus B: Chemical and Physical Meteorology* 35, no.4 (1983): 284-9.
[20] Latour, *Facing Gaia*, 98-101.
[21] Lynn Margulis, "Gaia," in *De symbiotische planeet: een nieuwe kijk op de evolutie* (Amsterdam, The Netherlands: Uitgeverij Contact, 1999), 119-36.
[22] Latour, *Down to Earth*, 76.

This redistribution of agency gives rise to a complex assembly of actors and actants, similar to what Latour has previously called an 'actor-network'. This is what Gaia is, it is "the name proposed for all the intermingled and unpredictable consequences of the agents, each of which is pursuing its own interest by manipulating its own environment."[23]

Gaia is composed of agents that are neither deanimated nor overanimated.[24] They are not deanimated, like in the traditional conception of nature, because no actants are deprived of their ability to act. Organisms are necessary for explaining the behaviour of the earth, and they can no longer be reduced to the background of human action. Furthermore, they are not overanimated. Lovelock's theory is often described as taking the earth as a single, living organism, or it is criticized for being teleological. This is not surprising, since Lovelock named his theory after an ancient Greek goddess, and uses terms such as 'superorganism'.[25] Toby Tyrell, for example, in *On Gaia: A Critical Investigation of the Relationship Between Life and Earth*, accepts the theory of co-evolution but not the 'existence of an all-powerful thermostat'. [26] However, Latour provides an alternative interpretation of Lovelock. As a response to these criticisms, Lovelock has stated that "nowhere in our writings do we express the idea that planetary self-regulation is purposeful, or involves foresight or planning by the biota."[27] According to Latour, then, Gaia is made up of agents that are not prematurely unified in a single totality.[28] There are neither parts nor a whole. Each organism "intentionally manipulates what surrounds it 'in its own interest'";[29] it is not working for some greater whole. Gaia is the result of the combined actions of all of these organisms, but it is not something 'higher' than these actions.

The idea of the earth as self-regulating has also been criticized. For example, James Kirchner has argued that many feedback loops are in fact destabilizing and that the net effect of feedback loops is likely to amplify global warming rather than dampen it.[30] For example, global warming causes the melting of permafrost, which leads to increased methane emissions. Methane is a powerful greenhouse gas, and thus as more methane is emitted from melting permafrost, global warming increases; further accelerating this cycle. However, Latour does not specifically argue for a self-regulating or homeostatic planet, as his main focus is on the co-evolution of organisms and their environment. Thus, he seems to accept one of the weaker versions of the Gaia hypothesis rather than a strong one.

Science

The idea of an actor-network is also applicable to science. Instead of taking on a 'view from nowhere' and trying to grasp the world as 'The Globe', science should turn to 'The Terrestrial,' according to Latour. He writes: "The Terrestrial grasps the same structures from up close, as internal to the collectivities and sensitive to human actions, to which they react swiftly."[31] The construction of a fact takes place through complex networks consisting of scientists, universities and academies, offices and laboratories, scientific instruments, funding, and so on. This network is created by both social and non-social processes. In his earlier works, Latour investigated this process.[32] Scientific instruments translate material substances into 'inscriptions', for example,

[23] Latour, *Facing Gaia*, 142.
[24] Ibid, 87.
[25] Ibid, 94-5.
[26] Ibid, 130-136.
[27] James Lovelock, "Hands Up for the Gaia Hypothesis," *Nature* 344, no. 6262 (March 1990): 100.
[28] Latour, *Facing Gaia*, 87.
[29] Ibid, 98.
[30] James W. Kirchner, "The Gaia Hypothesis: Fact, Theory, and Wishful Thinking", *Climatic Change* 52, no. 4 (2011): 395-6.
[31] Latour, *Down to Earth*, 67.
[32] Gerard de Vries, *Bruno Latour* (Cambridge, UK: Polity Press, 2016), 31-6.

figures, diagrams, or tables. Scientists combine inscriptions from different sources with other data and information taken from journals, books, discussions with other scientists or lab technicians, and so on. On the basis of all these things, they compose a new text containing a new claim. This process is far from linear, however. Uncertainties, side-tracks and taking steps back are also involved. For example, in the case of human error or malfunction of equipment it might be necessary to go back to the original material substance, or a new methodology might be proposed after issues have been discussed with other scientists or lab technicians. If the text gets published, readers can comment on the text and add modalities to its claim. For example, a reader may observe that the claim that 'a mammal injected with a chemical structure XYZ will show an enhanced form of ABC behaviour' is still unfounded if the scientists only tested on rats and not on other mammals. As a result of these modalities, the claim will be modified, then more modalities will be introduced for the modified claim, and so on. If more and more modalities are introduced, it is likely that scientists will start pursuing more promising hypotheses. However, if at a certain point all modalities are dropped, a fact has been established.

According to Latour, the idea that both social and non-social processes play a role in science does not detract from its objectivity. For Latour, objectivity means that constructed facts are robust enough to withstand all objections.[33] Science has proven to produce facts that can do just that. All the processes that he describes thus contribute to this robustness.

An example of an (in this case, negative) social process in natural science is confirmation bias. This can be illustrated with Millikan's oil drop experiment, used to determine the electric charge of an electron. The value determined by Millikan was slightly lower than the value that is currently accepted, because his value for the viscosity of air was incorrect. Scientists after Millikan repeated the experiment, and when they found a higher value than Millikan's, they would try to find problems with their experiments and eliminate certain data points to get a value closer to his. Therefore, rather than immediately 'discovering' a higher value for the electric charge of an electron, the reported value only gradually increases with each subsequent experiment until it stabilizes at the currently accepted value.[34]

Politics

Politics has a history of invoking a supreme authority or impartial arbiter that we all have to give deference to. The rise of Judaism and Christianity marks the move from a multiplicity of gods to one 'True' divinity, thereby claiming exclusive access to absolute truth. The Moderns have inherited this idea of a supreme authority connected with truth, but instead of elevating one god above the others, knowledge of the laws of nature is regarded as absolute truth in contrast with all religions: "from the true God fulminating against all idols, we have moved to the true Nature fulminating against all the false gods."[35] Nowadays, appeals to Nature known by Science (as described before), or appeals to Laws of the Market known to Economics[36] colour political debates. However, in the New Climatic Regime, this is no longer tenable. Therefore, for Latour, politics in the New Climatic Regime consists of trying to find order without any higher arbiter or supreme authority.

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[33] Latour, *Facing Gaia*, 33

[34] Richard P. Feynman, "Cargo Cult Science," *Engineering and Science* 37, no. 7 (June 1974): 12. For a plot of some determined values for the charge of an electron through time, see https://hsm.stackexchange.com/questions/264/timeline-of-measurements-of-the-electrons-charge. In the cases where scientists fudged their data to make their experimentally determined value coincide with Milikan's, the established fact was overriding the actual experimental observations of scientists. Scientists were discarding the empirical for the theoretical, because it was established as fact.

[35] Latour, *Facing Gaia*, 157.

[36] For example, the constant pursuit of economic growth.

An important term in his theory is 'territory', which he does not define as a two-dimensional area on a map, but as "something on which an entity depends for its subsistence, something that can be made explicit or visualized, something that an entity is prepared to defend."[37] Politics, then, is the contestation and transformation of these territories. Not only humans have territories: Latour argues for a 'Parliament of Things', in which both humans and nonhumans are represented. Humans should give mute actors a voice in political discussions. This way, nonhuman actants are no longer deanimated and human actors are no longer overanimated, because the agency of nonhuman actants is recognized and their interests are taken into account in addition to human ones.

With respect to climate change, he argues that political negotiations need to stop focusing solely on reducing emissions to stay below the 2 or 1.5 °C limit, like the IPCC and the UNFCCC agreements suggest. Staying below this limit is unrealistic because global warming is a transversal problem and because the tragedy of the commons applies. A transversal problem is a problem that does not recognize political boundaries. Climate change is such a problem because emissions can cross national borders and cause problems in another country. The fact that there is no higher arbiter to end all disagreement (like a planetary government that can impose sanctions, a global Nature, a universal Science or an Economics with unbreakable laws) makes the 2 or 1.5 °C limit difficult to attain.[38] Furthermore, because the current political system is only occupied with human values, interests, and ambitions, it cannot adequately deal with transversal problems that fall outside the relationship between citizens and the state.[39] This gives rise to a tragedy of the commons, which is a prisoner's dilemma involving common resources, for example, in the context of climate change, the atmosphere. According to Latour, the tragedy of the commons does not arise because parties are unable to put their selfish interests aside, but because the interest of the individual can only be calculated by "placing the entity on a territory that belongs to it exclusively and over which it reigns with sovereignty, and by 'shunting' to the outside everything that must not be taken into account."[40] Thus, according to Latour, every time a transversal problem arises, the entities that were previously excluded like that should now be included into the discussion, "in order to oppose the others by making explicit what territory they occupy."[41] For example, pollution of the atmosphere is a transversal problem as those who emit affect those that do not, and thus, the Atmosphere should be represented as an actor so that its interests will be defended.[42]

[37] Latour, *Facing Gaia*, 263.
[38] Ibid, 259-60.
[39] De Vries, *Bruno Latour*, 136.
[40] Latour, *Facing Gaia*, 271.
[41] Ibid, 268.
[42] An example of this are the current North American Native American campaigns by self-appointed Sky Protectors against a carbon tax, whereby they argue that governments cannot sell shares of pollution, because the sky cannot be owned by anyone (or rather it is its own territory), and thus it is illegitimate to auction off rights to pollute to corporations. See www.skyprotector.org

The Role of Scientists in the New Climatic Regime

According to Latour, the role of scientists in the New Climatic Regime is threefold: tracing Gaian feedback loops, recognizing that the construction of a fact takes place through networks involving both social and non-social processes, and representing nonhuman actors.

First, in *Facing Gaia*, he describes that the Earthbound – the term coined by Latour for the people of Gaia, in contrast with the Anthropos that is completely separate from nature[43] – have to trace and retrace the feedback loops that connect actants, in order to become aware of the networks that constitute Gaia and the fact that our actions have an impact on the network.[44] In his later book, *Down to Earth*, he seems to suggest that this role is closely connected to science: "And there are those who seek, while keeping a firm grip on the sciences, to understand what is meant by distributing action, animation, the power to act, all along the causal chains in which they find themselves entangled."[45]

Furthermore, secondly, this does not only apply to the matter they are researching, but also to the scientists themselves. The world should no longer be taken as a Globe, as science tends to do when it profiles itself to have the 'view from nowhere' when doing research. In philosophy and science, this is the idea that findings are universalizable in time and generalizable in space. Scientists should recognize that the construction of a fact is also embedded in a network of actors (scientific instruments, other scientists, laboratories, universities, and so on), instead of this fact being a universal law of nature that can be used to settle issues, as described earlier. This also has political implications, as there can be no more appeals to nature as a higher arbiter – precisely because nature through space and time is interpreted by interested, value-laden human beings.

Thirdly, scientists play an important part in representing mute actors in political discussions, although this role is not limited to scientists. By doing experiments, they can detect previously unknown entities that should be included in the discussion of an issue. Furthermore, they can give these entities a 'voice' by investigating the characteristics and powers of these entities, and explaining them to the public in translation as it were, as admissible evidence in the collective conversation.[46] For example, in the context of climate change, scientists were the ones who initially put environmental problems like global warming on the political agenda through their public testimony of what they had found experimentally.[47]

[43] Latour, *Facing Gaia*, 247-8.
[44] Ibid, 276.
[45] Latour, Down to Earth, 77.
[46] De Vries, *Bruno Latour*, 143.
[47] Latour, *Facing Gaia*, 264.

Critics of Latour

Of course, Latour's theory can also be criticized. Several aspects of Latour's theory can be said to be unrealistic. For example, it can be argued that Latour's idea of a 'Parliament of Things' is untenable because the whole world order is based on its division into nation states and their sovereignty.[48] Changing this order by redistributing sovereignty and power to include other (non-human) actors will be extremely difficult and disruptive. As explained earlier, the role of science and politics in society and the way these are practiced will have to change radically. In addition, big corporations could well hinder the institution of Latour's new political system, as their primary objective is delivering profit for their shareholders (i.e. money), and therefore they have a clear vested interest in perpetuating the status quo. [49]

Even if it is possible to implement Latour's idea, he does not describe a process to move from the current situation to a Parliament of Things. In *We Have Never Been Modern*, where he discusses the Parliament of Things in the last chapter, he mentions that we do not have to start over but that we can start from the current situation:

> However, we do not have to create this Parliament out of whole cloth, by calling for yet another revolution. We simply have to ratify what we have always done, provided that we reconsider our past, provided that we understand retrospectively to what extent we have never been modern, and provided that we rejoin the two halves of the symbol broken by Hobbes and Boyle as a sign of recognition. Half of our politics is constructed in science and technology. The other half of Nature is constructed in societies. Let us patch the two back together, and the political task can begin again.[50]

However, this does not lay out a clear or practicable way forward. In *Politics of Nature*, he further elaborates upon his political theory, but it is rarely applied to real-world, political examples.[51] I thought the same about *Facing Gaia*, where he only gives one real-world example of representing mute actors within the current system – that of the Dutch water authorities (discussed in Part II of this thesis). Having only a single example makes it hard to propose a path to move towards a Parliament of Things.

More generally, it has been argued that Latour's framework is inadequate for addressing and critiquing power differentials and hierarchies.[52] The same has been said about *Facing Gaia*:

> What's missing in the book is any mention of ideology, of capitalism's global hegemony or of political economy in general. But this is in accord with Latour's commitment to actor-network theory, which posits a specious ontological flattening: it insists that there is no difference in the ability of 'actors'— whether they be human or non-human — to act. There is a distribution of agency to everything and hence an agential privileging of nothing, since nothing can exert more power than anything else. It ignores the disparities in agency and hierarchies of power that actually exist.[53]

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[48] Boris Pulskens, "Coping With the New Ecological Regime,"(Master's Thesis, Erasmus University Rotterdam, 2018), 46. http://hdl.handle.net/2105/43540

[49] Bart Mijland, "Bruno Latour's Political Ecology: Composing the Future We Want?," (Master's Thesis, University of Humanistic Studies, Utrecht, 2013), 74. http://hdl.handle.net/11439/106.

[50] Bruno Latour, *We Have Never Been Modern*, (Cambridge, MA: Harvard University Press, 1993), 144.

[51] John Law, "Politics of nature: A review of three recent works by Bruno Latour," *Capitalism Nature Socialism* 16, no. 1 (2005): 119.

[52] Srikanth Mallavarapu and Amit Prasad, "Facts, Fetishes, and the Parliament of Things: Is There any Space for Critique?", *Social Epistemology* 20, no. 2 (April-June 2006): 185-199.

[53] Alexandre Leskanich, "Book Review: Facing Gaia: Eight Lectures on the New Climatic Regime by Bruno Latour," LSE Review of Books, August 24, 2017, https://blogs.lse.ac.uk/lsereviewofbooks/2017/08/24/book-review-facing-gaia-eight-lectures-on-the-new-climatic-regime-by-bruno-latour/.

By not being able to address these disparities, Latour's theory cannot form the basis for a democratic politics and knowledge-making process. Critique is an important tool for inducing change.[54]

Latour's theory has also been criticized for being anthropocentric. In *Facing Gaia*, Latour emphasizes the importance of politics, but politics is a very human affair. This runs counter to his argument for a redistribution of agency to include nonhumans.[55] Furthermore, nonhumans might be represented in his idea of politics, but they only get a voice through human spokespersons.[56]

In spite of these criticisms, Latour's theory could provide a useful framework for science and politics in the Anthropocene. Firstly, the critique of anthropocentrism is a valid one, but it is also unavoidable if we want to deal with the current ecological crisis. As illustrated by issues such as pollution and deforestation, we fail to take nonhumans into account if they are not represented in a way that we will understand. As Latour puts it with respect to water: "the fiction resides not in giving water a voice but in believing that one could get along without representing it by a human voice capable of making itself understood by other humans."[57] Secondly, criticisms relating to the idea that changing the status quo will be difficult and disruptive are weak. Just because something might be hard to change does not mean that we should not do it. Furthermore, there are indeed examples that show that it is possible to redistribute power and sovereignty over other actors (such as the Dutch water authorities).[58] However, the criticism that Latour only discusses these examples sparingly is a problem that I ran into myself as well when reading *Facing Gaia*. This is why I have chosen to focus on finding a few practical examples for Latour's theory in the second part of this thesis, to which I will turn now.

[54] Mallavarapu and Prasad, "Facts, Fetishes, and the Parliament of Things: Is There any Space for Critique?", 197.
[55] McKenzie Wark, "Bruno Latour: Occupy Earth", Verso, October 5, 2017, https://www.versobooks.com/blogs/3425-bruno-latour-occupy-earth
[56] Hans Harbers, review of *We Have Never Been Modern*, by Bruno Latour, *Science, Technology, & Human Values* 20, no. 2 (1995), 274.
[57] Latour, *Facing Gaia*, 273.
[58] Other examples include the Embassy of the North Sea in the Netherlands, the granting of a "legal personality" to Te Urewera, Whanganui River and Mount Taranaki in New Zealand and Lake Erie in the U.S., or the Universal Declaration of the Rights of Mother Earth in Bolivia.

PART II

Examples of Science in the New Climatic Regime

Tracing Gaian Loops

Suzanne Simard is a professor of forest ecology at the University of British Columbia. In her research, Simard shows that there is communication and transfer of nutrients such as carbon between trees. I will first give an overview of her research, after which I will argue that it can be seen as an example for two roles of science in the New Climatic Regime: tracing the loops that are constitutive of Gaia and representing nonhuman actors (in this case, trees or forests).

In one of her experiments[59], Simard investigated interspecies communication between paper birch and Douglas fir. These two species were planted in the forest and covered with bags. Carbon dioxide gas with the radioactive isotope carbon-14 was injected into the bag with one species, whereas carbon dioxide gas with the stable isotope carbon-13 was injected into the bag with the other species. By analysing the carbon-14 and carbon-13 content in the trees, it was found that the two species were exchanging carbon through their root systems (the vast majority of naturally occurring carbon is carbon-12, whereas the other two isotopes only occur in small amounts). In fact, the birch tree was transferring more carbon to the fir tree in the growth season than vice versa. However, later in the year, the fir tree was transferring more carbon to the birch tree, because the birch had lost its leaves. Thus, the two species are interdependent, and engaged in a sort of mutualism.

It was found that the two species do not only exchange carbon, but also nitrogen, phosphorus, water, defence signals, allele chemicals, hormones, and so on.[60] It is thought that this exchange takes place through mycorrhizal networks: a mutualistic symbiotic system (a "living together" from which both partners benefit) of fungal networks connected to the root systems of plants. These fungi exchange nutrients with the plant in return for carbon, but they also connect individual plants, facilitating their communication and nutrient exchange.

In another experiment, a mycorrhizal network of Douglas fir and two fungi species was mapped using microsatellite DNA analysis.[61] The result of this mapping is shown in figure 1. In this map, the nodes correspond to the trees and the lines correspond to the fungi linking the trees together. The size of the nodes represents the size of the trees (the biggest circles are the biggest trees), and the colour of the nodes represents the age of the trees (the darkest circles are the oldest trees). As can be seen in the figure, the biggest, darkest nodes are the busiest nodes. Simard calls these 'hub trees' or 'mother trees'. The hub trees send their excess carbon to the understory seedlings. Furthermore, when the hub trees are ill or injured, they will receive carbon from and send defence signals to the other trees, making those more resilient. When they die, hub trees will transfer their carbon into the network.

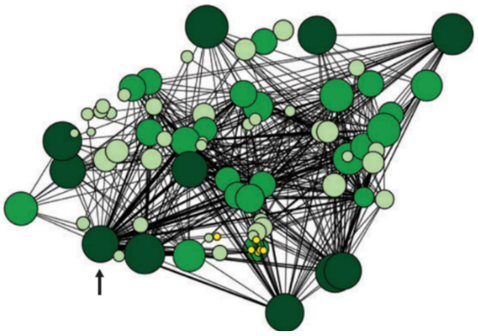

Fig. 1: a model of a mycorrhizal network consisting of Douglas fir and two species of fungi. The dots represent the trees and the lines represent the fungi. Reproduced from Kevin J. Beiler et al, "Architecture of the wood-wide web: *Rhizopogon* spp. genets link multiple Douglas-fir cohorts," *New Phytologist* 185, no. 2 (2009): 549, figure 2.

[59] Suzanne W. Simard et al., "Net Transfer of Carbon between Ectomycorrhizal Tree Species in the Field," *Nature* 388, no. 6642 (1 August 1997): 579-82.
[60] Suzanne Simard, "How trees talk to each other," June 2016, TED Video, video, 18:20, https://www.ted.com/talks/suzanne_simard_how_trees_talk_to_each_other.
[61] Kevin J. Beiler et al., "Architecture of the wood-wide web: *Rhizopogon* spp. genets link multiple Douglas-fir cohorts," *New Phytologist* 185, no. 2 (December 2009): 543–553.

Simard's research is a clear example of tracing the loops constitutive of Gaia, one of the roles of scientists in the New Climatic Regime. This role consists of detecting new entities and their territories by means of research and experiments, thereby shedding light on the Gaian network and our impact upon it. By mapping mycorrhizal networks and investigating communication between trees, she has shown that a forest is not simply a collection of trees, but a complicated network. Moreover, she has shown that the way we manage forests has a big impact on the network. For example, removing all birch trees from fir forests, as is common practice in order to increase wood production, increases disease in fir trees[62], partly because the lack of communication between the two species makes the forest less resilient.[63] Furthermore, high-grade logging and clear-cut logging severely damage the mycorrhizal networks by cutting the hub trees, and thereby decrease the resilience of the ecosystem. Instead, therefore, Simard pleads for patch cutting and retention of hub trees.[64]

Another aspect of her work is that by publishing her research in journals, giving TED Talks about it, and arguing for changes in forest management, she is literally, like the Lorax in Dr. Seuss' famed book and now movie, "speaking for the trees." She is exercising the role of representing nonhuman actors in the New Climatic Regime by researching previously unknown characteristics of trees (namely, their ability to communicate and exchange) and making these known to the public. Her research is political in the sense that it is changing the way we look at nature: from deanimate and inert, to animate, networked, and responsive. The current political system, however, does not yet recognize this view. British Columbia continues to practice clear-cut logging. Politics needs to stop excluding science and instead become more scientific. Nonhuman actors and scientists that represent them should be included. Simard is slowly achieving progress with this. She is leading a project called the 'Mother Tree Project'[65] which aims to develop more sustainable logging practices and more effective regeneration methods for the forest, for example by leaving a certain amount of hub trees on site or using specific seed mixtures with cooperating trees. Partners of the project include the B.C. Ministry of Forests, Lands and Natural Resource Operations and forestry companies, so different interests are represented. As a next step, however, scientists should also be included on the level of political decision-making. In the next section, I will discuss Latour's examples for this: 'Make It Work' and the Dutch water authorities.

[62] Karen E. Baleshta et al., "Reducing paper birch density increases Douglas-fir growth rate and Armillaria root disease incidence in southern interior British Columbia,"
[63] Simard, "How trees talk to each other," 2016.
[64] Ibid.
[65] See http://mothertree.forestry.ubc.ca/

Representing Nonhuman Actors

Make It Work

As for representing mute actors, Latour gives an example himself: 'Make It Work', a simulation of COP21 in May 2015 in the "Theatre of Negotiations" (Théâtre des Amandiers) at Nanterre-Amandiers, outside Paris. What Latour liked about this simulation was that mute actors were represented in the simulation. It did not only involve 24 delegations representing state actors, but also 18 delegations representing non-state actors. Among the non-state actors represented were actors such as the Atmosphere, Oceans, Indigenous Peoples, Cities, Non-Governmental Organizations and powers that are usually called 'lobbies', like Economic Powers or Stranded Petroleum Assets.[66] In order to have realistic negotiations, all acting powers should be included *inside* the negotiations rather than kept outside, and they should be given equal sovereignty. These actors were therefore given a similar voice to the conventional nation states: their delegations were formed in the same way, they spoke the same language, and they wore the same clothes. Everyone was addressed just as politely and straightforwardly.[67] Furthermore, Latour liked that the delegates did not focus on the 1.5 or 2 °C limit and the associated allocation of CO_2 quotas. They understood that this would be fruitless, since there is no sovereign arbiter to appeal to and end all disagreement, such as a world government, a 'global' or 'unified' Nature, a universal Science of Nature, or an Economics with unbreakable laws.[68]

Scientists were included in the negotiations, but they were not given an elevated position with respect to the others. They were distributed among the different delegations rather than separated from them, as is the case with the relation between the IPCC and COP21.[69] Thus, the delegates did without such a sovereign arbiter, and focused on 'the various ways of occupying territories'.[70] Latour defines a 'territory' not as an area on a map, but as "something on which an entity depends for its subsistence, something that can be made explicit or visualized, something that an entity is prepared to defend".[71] Every actor, then, in order to define its territory, "will have to introduce itself and state its interest, indicate its war aims, [and] specify its friends and its enemies"[72] Every time this happens, the other actors will have to recalculate their interests taking this new power and its territory into account[73], and thereby their territories are redefined.[74] For example, the delegation 'Ocean' opposed countries that are badly acidifying the oceans by saying: "We consider unacceptable for our sovereignty what you, the delegation representing 'United States' or 'Australia,' are inflicting on our domain. By opposing you, we are defining the limit of our territory and *we are redefining the shape of yours*".[75] In the traditional nation state model, the fact that (in this case) the territory of 'United States' or 'Australia' overlaps with the territory of 'Ocean' is denied. Thus, the national imaginary of nation states is revealed for what it is, an imposed fiction which has overstepped its boundaries onto the territory of other actors, such as the air, water, and earth. The New Climatic Regime requires nation states, polluting corporations, and other entities that have been abusing these actors to give up (some of) their power in favour of these actors.

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[66] Latour, *Facing Gaia*, 267-8.
[67] Ibid, 262-4.
[68] Ibid, 258-61.
[69] Ibid, 265.
[70] Ibid, 259.
[71] Ibid, 263.
[72] Ibid, 268.
[73] Ibid, 269.
[74] Ibid, 262.
[75] Ibid.

Dutch water authorities

There were two other goals of the simulation that the delegates would have had to reach in order to institute Gaia, but didn't. Firstly, they were to "find appropriate ways to visualize the new forms of overlapping sovereignty that they were exploring." Secondly, "during a final ceremony, the old nation-states were to have redefined their sovereignty in front of the other delegations."[76] Latour does give an example himself of the visualisation of the new forms of overlapping sovereignty, namely the Dutch water authorities.[77] These consist of *Rijkswaterstaat* on a national level, and elected water boards ('waterschappen') on a local level.[78] According to Latour, these institutions show that it is possible to represent nonhuman entities by a human voice on a political (and local) level. Scientists such as hydrologists and ecologists are included in these institutions in order to achieve an accurate representation of the characteristics, interests and powers of water. An example of a project that water boards have achieved is AquaReUse.[79] In this project, a cluster of farmers who grow their crops in greenhouses collectively clean their waste water at a waste water treatment plant in the area. Instead of disposing of their waste water (containing fertilizer and pesticides) into rivers, it can now be reused or stored for droughts.

Latour contrasts the situation in the Netherlands with that of almond growers in California's Central Valley, where there is no special authority for water management. He argues that the situation in the Netherlands is not simply a 'natural' one, resulting from its vulnerability against the power of water. The farmers in California also depend on water, but they continue pumping deeper and stealing water from their neighbours, even leading to subsidence.[80]

While the Dutch example represents the New Climactic Regime for Latour, the latter exemplifies the tragedy of commons that occurs when nonhuman actors such as water are denied an honoured place and voice in politics. In the case of the farmers in California, water is deanimated. Therefore, the farmers can lay claim to the territory exclusively and externalize everything else. In the case of the Dutch water authorities, water is animated: it is represented by humans on an elected water board. Therefore, the interests of water also have to be taken into account, and the farmers cannot just dispose of their polluted water into rivers. By means of a political process in which all actors are represented, the water cycle is closed, leading to a better situation for everyone.

[76] Latour, *Facing Gaia*, 270.
[77] Ibid, 272.
[78] "Waterbeheer in Nederland", Rijksoverheid, accessed June 17, 2019, https://www.rijksoverheid.nl/onderwerpen/water/waterbeheer-in-nederland.
[79] See http://www.aquareuse.nl/Home/.
[80] Latour, *Facing Gaia*, 272-3.

Recognizing that Scientists are in a Network

In Part I, I have described Latour's idea that the construction of scientific facts takes place through a complex network consisting of scientists, universities and academies, offices and laboratories, scientific instruments, funding, and so on, in which both social and non-social processes play a role. Latour's theory can be taken to imply that all knowledge is situated, which means that "all forms of knowledge reflect the particular conditions in which they are produced, and at some level reflect the social identities and social locations of knowledge producers."[81] Thus, in addition to factors like the institution at which research is performed or a scientist's relations to other inquirers, factors such as gender, race and class also influence the construction of scientific facts. For example, people with different social backgrounds will find different scientific problems important, or they will interpret the same data differently. In the New Climatic Regime, these factors in knowledge production should be recognized in order to adequately deal with them. For examples of how to do this, I will turn to feminist epistemology. Feminist epistemology studies the role of gender in knowledge production, though its ideas can be extended to include other social dimensions. I will first describe the 'gender data gap' as an example of how science can exclude and oppress women, after which I will discuss how two different branches of feminist epistemology want to deal with such problems.

Gender data gap

Most of the world's (scientific) data is based on men, because the male's body has always been taken as the standard human body. Since modern societies are very data-driven, this has negative consequences for women in a lot of situations. These can be life-threatening. In the medical world, for example, women are largely underrepresented in clinical drug trials. As a consequence, women are prescribed medicine that is either less effective for women than for men, causes more side effects, or is not the optimal dose.[82] Furthermore, women can have different symptoms than men for the same diseases, leading to frequent misdiagnosis and mistreatment. For example, when having a heart attack, women experience shortness of breath, nausea and fatigue, rather than pain on the chest.[83] There are many other examples: in a car crash, women are 47% more likely to be seriously injured, 71% more likely to be moderately injured, and 17% more likely to die, because of the design of the car and the shape of the crash dummies used for tests.[84] Many stab vests worn by police officers do not have enough room for women's breasts, which is not only uncomfortable, but also leaves parts of their body unprotected.[85] Exposure standards for chemicals are often too high for women because they have different immune systems and hormones than men, and on average a smaller body, thinner skin, and higher percentage of body fat.[86]

[81] Noel Castree, Rob Kitchin and Alisdair Rogers, *A Dictionary in Human Geography* (Oxford, UK: Oxford University Press, 2013), 464.
[82] Caroline Criado-Perez, *Invisible Women: Exposing Data Bias in a World Designed for Men* (New York, NY: Abrams Press, 2019), 195-215, EPUB.
[83] Criado-Perez, *Invisible Women*, 217-34
[84] Ibid, 185-91.
[85] Ibid, 126-7.
[86] Ibid, 115-6.

Feminist Epistemology

In her book *The Science Question in Feminism*, Sandra Harding describes three types of feminist epistemologies: feminist empiricism, feminist standpoint theory, and feminist postmodernism.[87] Here, I will discuss feminist empiricism and feminist standpoint theory.

Feminist empiricism focuses on the 'context of justification' of science, which consists of the testing of hypotheses and interpretation of evidence.[88] This theory therefore claims that androcentric bias (and other social biases) can be eliminated by stricter adherence to the methodological norms of science, but it does not question these norms. It also encourages the idea of more female scientists, since they are more likely to see androcentric bias.[89] This idea can be extended to other social biases, concluding that a diversity of scientists in general (regarding race, class, ability, etc.) will lead to the recognition of social bias.

According to feminist standpoint theory, the issue already lies in the 'context of discovery', which contains the selection of a scientific problem, the central concepts associated with it, a hypothesis, and a research design.[90] The problem is not that individuals are socially biased, but that society consists of conceptual frameworks and institutions that use socially biased assumptions.[91] Science is affected by these assumptions via the context of discovery, for example when scientists choose a research topic, or how a scientist conceptually frames a theory. In addition, via the context of discovery, these assumptions seep through to the context of justification, for example through the concept of a 'good' method of research.[92] This approach thus challenges science's claim to objectivity and value-neutrality. As a response to this problem, feminist standpoint theory argues that the subordinate position of women provides a 'privileged' standpoint over the dominant position of men – "a morally and scientifically preferable grounding for our interpretations and explanations of nature and social life".[93] This idea can be extended to include the standpoints of all marginal lives. Standpoints of marginal lives are 'privileged', because they are able to see the dominant conceptual frameworks, power structures and processes in society more clearly.[94] Being part of the 'ruling group' distorts and limits the understanding of these conceptual frameworks because you are inside of them, and tends to identify them as necessary. Subordinate positions stand outside these conceptual frameworks and the activities that generate them. Therefore, they can identify them as contingent and it is possible to have a better view of the interests and values associated with them.[95] The idea is, then, that scientists start off their research from the standpoint of these marginalized lives, with the goal of understanding the whole social order, not only marginalized lives.[96] This method should produce less false[97] and distorted results.[98]

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[87] Sandra Harding, *The Science Question in Feminism* (Ithaca, NY: Cornell University Press, 1986), 24-9.
[88] Ibid, 25.
[89] Ibid, 24-6.
[90] Sandra Harding, "'Strong Objectivity': A Response to the New Objectivity Question," *Synthese* 104, no. 3 (1995): 338.
[91] Ibid, 339.
[92] Ibid, 338.
[93] Harding, *The Science Question in Feminism*, 26.
[94] Elizabeth Anderson, "Feminist Epistemology and Philosophy of Science," Stanford Encyclopedia of Philosophy, last modified August 5, 2015, https://plato.stanford.edu/entries/feminism-epistemology/.
[95] Harding, "Strong Objectivity," 341-2.
[96] Ibid, 342.
[97] The concept of a 'less false' theory comes from the idea that we cannot know whether a theory is 'true', only whether it is 'consistent' with nature.
[98] Harding, "Strong Objectivity," 346.

In summary, Latour's actor-network theory applied to the institution of science shows that the construction of facts is influenced by both social and non-social processes. This also implies that factors such as gender, race and class play a role in this. As shown by the example of the gender data gap, problematic situations can arise if these factors remain unaddressed. Therefore, in the New Climatic Regime, rather than taking on a 'view from nowhere' and thereby claiming to be external to these kinds of factors, science should recognize them in order to be able to adequately deal with them. Two branches of feminist epistemology offer (different) ways to do this. Whereas feminist empiricism claims that social bias can be eliminated by stricter adherence to scientific norms and a more diverse group of scientists, feminist standpoint theory argues that socially biased assumptions are already present in the conceptual frameworks used in science. To combat this, scientists should take the perspectives of marginalized groups as a starting point, in order to generate more inclusive knowledge.

Conclusion

The aim of this thesis was to investigate the role of scientists in Latour's theory for the New Climatic Regime, that he develops in *Facing Gaia*, and to find practical examples for these roles. I have identified three roles. Firstly, by doing research, scientists should discover and describe the feedback loops that form Gaia in order to become aware of the networks that constitute Gaia and the fact that human actions have an impact on the network. As an example of this role, I have described Suzanne Simard's work. She has shown that trees exchange all sorts of chemical compounds through mycorrhizal networks and that these processes are vital for the health of the forest. Furthermore, by publishing in journals, giving Ted Talks about her work, and arguing for patch cutting and retention of 'hub trees', Simard has also started to exercise the second role I have described, namely, representing mute actors. Scientists can perform this role by doing experiments that detect all sorts of entities and their interests and powers, thereby making their territories visible. Simard is doing this by changing our view on forests and trees from deanimate and inert, to animate, networked, and responsive. Furthermore, she is leading the Mother Tree Project, which, together with the B.C. Ministry of Forests, Lands and Natural Resource Operations and forestry companies, aims to develop more sustainable logging practices. On a more political level, this role of representing mute actors entails that nonhuman actants should be included into political negotiations. Scientists should not be separated from politics, but included as spokespersons for these mute actors. Latour describes 'Make It Work', a simulation of COP21 that included nonhuman actors, and the Dutch water authorities as examples of this role. Finally, it should be recognized that the construction of scientific facts takes place through a complex network, in which both social and non-social processes play a role. Feminist epistemology offers ways to include these social processes into analyses of science and how to deal with them, especially regarding social bias towards women. I have described two branches of feminist epistemology. Feminist empiricism claims that social bias can be eliminated by a stricter adherence to scientific norms and by realizing a more diverse group of scientists. Feminist standpoint theory argues that scientists should take the perspectives of marginalized groups as a starting point, in order to generate more inclusive knowledge.

All of the examples mentioned above take the multiplicity of actors on the earth into account. Employing science as an external, higher arbiter for politics is fruitless; all the actants playing a role in science need to be made visible, like in feminist epistemology, as all these actants and processes only contribute to the robustness of scientific facts. Instead, employing science to trace Gaian feedback loops, like Suzanne Simard is doing, draws attention to the territories of nonhuman actors. These actors and their territories can then be represented on the level of political decisions, as in the example of 'Make It Work' and the Dutch Water Authorities, so that they have to be taken into account. This multiplying of actors is essential in the New Climatic Regime. We cannot continue deanimating actors like we have always done, as this is what has led us into the current era of climate catastrophe. It is urgently necessary to face Gaia, and as a student in natural science, I certainly hope to contribute.

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