# Towards a Spatially and Epistemically Just Earth System Boundary

Alyssa D. Delarosa
Master Thesis – MSc Philosophy of Science, Technology and Society - PSTS
University of Twente, Faculty of Behavioural, Management, and Social Sciences,
Enschede, the Netherlands
August 30, 2024

First supervisor: Dr. Katherine G. Sammler
Second reader: Dr. Casey R. Lynch

## Acknowledgements

I would like to extend my thanks to:

Dr. Katherine Sammler for supervision and guidance for this thesis. I am very grateful for the clear feedback provided during our collaboration together, and support as I worked to develop a focus and thesis scope within such a broad topic.

Dr. Casey Lynch for guidance, feedback, and orientating my approaches with different literature into coherent explanations.

Dr. Fran Meissner for supervision and guidance during the FRAME project and for the beginning foundational aspects of this thesis, such as suggesting the topic of spatial justice and whom I also credit with the continuous development of my writing and feedback skills.

Finally, I will not downplay the absolute grueling and trying weight of the academy and life on one's mental and physical health. Through these trying times, I was very fortunate to have a strong, solid foundation of advice and skills that carried me through the work and thesis year. I credit this foundation to my former colleague Jonny Grünsch, who before the start of the FRAME and thesis project year, provided guidance for keeping what I'll put nicely as "imposter syndrome" at bay, and led by example of how to organize, structure, and explain my research, during our work together in the Urban Environmental Ethics lab. I express my heartfelt gratitude for this foundation in making this thesis and other future endeavours possible.

# Abstract

Biodiversity and ecosystems are actively being harmed due to the sixth mass extinction event that is impacting the Earth system. In response to this event, the Earth Commission has proposed a biosphere functional integrity boundary which has designated 20-25% of every square kilometre of managed lands to be reserved for nature.

The proposed biosphere functional integrity boundary has been built off of the planetary boundaries and doughnut economic model frameworks and the implications of governance and scale drawn from the two frameworks. With developing the biosphere functional integrity boundary, the Earth Commission has acknowledged that the proposed metric may have to be modified based upon context of different areas, and has integrated both the "safe" operating space from the planetary boundaries framework, and the "just" operating space that the doughnut economic model framework added to the planetary boundaries framework.

The safe operating space is defined by eight proposed earth system boundaries from the Earth Commission and the just operating space is defined through a proposed earth system justice framework from the Earth Commission. This thesis will address and focus upon the conceptualisation of epistemic justice from the defined just operating space of the proposed biosphere functional integrity boundary.

By discussing the conceptualisation of epistemic injustice from Philosopher Miranda Fricker, and inferences drawn from a targeted review of the just urban greening literature, this thesis will identify overarching power dynamics that present a barrier to furthering epistemic justice with governance at both local and global scales. The overarching power dynamics can be a problem for the Earth Commission seeking to address the sixth mass extinction event with their proposed biosphere functional integrity boundary with governance at both local and global scales.

Feminist urban political ecology scholar Andrea Nightingale claims that overarching power dynamics within the selection and application of different knowledge sets call for research that identifies who has the power to make decisions while simultaneously being inclusive of everyone and all knowledges through spaces fostering deliberative democratic practises (Nightingale, 2023).

If epistemic justice is needed with the development and implementation of the proposed biosphere functional integrity boundary to address the sixth mass extinction event, then how can the overarching power dynamics within the selection and application of different knowledge sets be identified within different spaces?

This thesis will argue that by identifying the intertwinement of knowledge, space, and power production within spatial governance and scale, epistemic justice should be used together with spatial justice in order for power dynamics to be identified in different spaces with the proposed biosphere functional integrity boundary. Through both an epistemic and spatial justice lens, the Earth Commission can further its goal of addressing the sixth mass extinction event.



**Keywords:** Earth System Boundaries, Biosphere Functional Integrity Boundary, Epistemic Justice, Spatial Justice, Power

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# 1. Introduction

A global assessment from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has found that the climate emergency is a main factor in driving the rapid loss of biodiversity (IPBES, 2019). The climate emergency is also increasing the risk of species extinction in biodiversity hotspots (IPCC, 2022).

The increase in species extinction is not projected to decline or cease at anytime in the foreseeable future (UNEP, 2021). Throughout the history of the planet, there have been five mass extinction events on Earth. The current rapid and continuous loss of biodiversity is considered the sixth mass extinction event for Earth (Wollmuth et al., 2022). Unlike the previous five mass extinctions, this sixth mass extinction is largely driven by human carbon-emitting activities (Lewis & Maslin, 2015).

Since 2019, the Earth Commission, which is an initiative of the Future Earth and the Global Commons Alliance, has been working to address the sixth mass extinction event. Scientists from one of the five Earth Commission working groups, the biosphere interactions working group, have identified the *Biosphere functional integrity boundary*. This boundary proposes that 20-25% of every square kilometre of managed lands should be reserved for nature while acknowledging that the proposed metric may be modified based upon context of different areas (Rockström et al., 2023; Mohamed et al., 2024).

The proposed biosphere functional integrity boundary is one eight “safe” and “just” boundaries as part of the proposed earth system boundaries framework from the Earth Commission (see figure 1 appendix). The safe operating space of the proposed earth system boundaries framework (dark red in figure 1 appendix) has been built upon the planetary boundaries framework, developed in 2009 by environmental scientist Dr. Johan Rockström (who is currently a co-chair of the Earth Commission) along with 28 other scientists from the Global North (see figure 2 appendix).

The safe operating space is defined through Holocene-level measurements. The Holocene is succinctly described as the state of the Earth system before the sixth mass extinction event (Rockström et al., 2009). A 2015 update of the planetary boundaries framework (that includes Johan Rockström as a co-author) identified sub-global scales at regional and local levels and more control variables for the biodiversity planetary boundary (see figure 3 appendix).

The biodiversity planetary boundary has been identified as a core boundary and renamed the *biosphere integrity boundary* due to the fact that the boundary has direct influence on the Earth system. Because of this, the biodiversity planetary boundary also has major impact on urban landscapes (Steffen et al., 2015).

In addition to the defined safe operating space, the Earth Commission has simultaneously defined a “just” operating space. The just operating space has been built upon the doughnut economic model developed by economist Kate Raworth and published in 2012 from the international nongovernmental organisation Oxfam.

The doughnut economic model added the just operating space to the nine planetary boundaries with eleven social boundaries. The just operating space is the social foundation that lists what is needed to achieve global equity such as housing and education, addressing the relationship between social justice, global equity, and the Earth system (see figure 4 appendix).

The Earth Commission defines the just operating space in the proposed earth system boundaries framework through the proposed earth system justice framework. The earth system justice framework seeks to work within the safe operating space simultaneously with working in

the just operating space through its conceptualisations of justice (see figure 5 appendix). This thesis will focus upon the conceptualisation of epistemic justice within this proposed framework.

Researchers in the Earth Commission have conceptualised epistemic justice as "establishing equity between different forms of knowing" (Gupta et al., 2023, p. 632). The Earth Commission has conceptualised epistemic justice within the just operating space of the proposed biosphere functional integrity boundary due to the fact that both the planetary boundaries and doughnut economic model frameworks have been built with scientific knowledge that have been exclusionary of other knowledge sets.

This exclusionary aspect of other knowledge sets also includes governance and scale implications with both the planetary boundaries and doughnut economic model frameworks. With conceptualising epistemic justice when building upon the two boundary frameworks, the Earth Commission has specifically highlighted Indigenous and local knowledge sets within this conceptualisation of epistemic justice (Gupta et al., 2023).

This thesis will focus upon Indigenous knowledge within the context of both epistemic injustice and epistemic justice. Through the work of Philosopher Miranda Fricker, the power dynamics making up epistemic injustice and epistemic justice will be discussed and examined through governance and scale.

Additionally, this thesis will discuss the epistemic justice and power inferences drawn from a targeted review of the just urban greening literature that worked to examine the just operating space of the proposed biosphere functional integrity boundary and its implications in different urban areas. The literature review was from a Dutch Research Council (NWO) funded project led by a former co-chair of the Earth Commission, environmental scientist Dr. Joyeeta Gupta.

The overarching power dynamics within the selection and application of different knowledge sets was also highlighted within the targeted review of the just urban greening literature by Nightingale (2023). These overarching power dynamics can present a problem for the Earth Commission seeking to address the sixth mass extinction event with the proposed biosphere functional integrity.

Nightingale claims that these findings call for research that identifies who has the power to make decisions while simultaneously being inclusive of everyone and all knowledges (Nightingale, 2023). Nightingale remains optimistic in her writing, claiming that so long as the need for spaces that foster deliberative democratic practices are recognised, then these different knowledge sets can be brought further into the forefront (Nightingale, 2023).

If epistemic justice is needed with the development and implementation of the proposed biosphere functional integrity boundary to address the sixth mass extinction event, then how can the overarching power dynamics within the selection and application of different knowledge sets be identified within different spaces?

This thesis will argue that by identifying the intertwinement of knowledge, space, and power production within spatial governance and scale, epistemic justice should be used together with spatial justice in order for power dynamics to be identified in different spaces with the proposed biosphere functional integrity boundary.

# 2. Methodology

This thesis conducts a targeted literature review by using the keywords Earth System Boundaries, Biosphere Functional Integrity Boundary, Epistemic Justice, Spatial Justice and Power to pinpoint specific core articles that discuss these domains in-depth and locate scholars

that are experts within these literatures. Further sources are drawn from the citations within these articles and articles that referenced them.

Chapters 3-5 will work to situate the set-up for the main research question by defining epistemic injustice and epistemic justice, governance, scale, and the key boundary frameworks (planetary boundaries and doughnut economic model) that the proposed biosphere functional integrity is built upon. Chapter 6 will then use the work set-up in chapters 3-5 to answer the main research question.

Chapter 3 will explain epistemic justice by using philosopher Miranda Fricker's conceptualisation of epistemic injustice and power. By using Fricker's work, chapter 3 will define epistemic justice and the aspects of power that make-up epistemic injustice. Governance and scale will be defined and situated within the context of different power dynamics. By defining epistemic injustice, the work of environmental scholars will be mentioned to set-up discussion for how scholars are working to advance epistemic justice with the proposed biosphere functional integrity boundary.

Chapter 4 will examine the development of both the planetary boundaries and doughnut economic model frameworks by using the frameworks literature in order to show key aspects of how the proposed biosphere functional integrity boundary came to be. Governance and scale will also be discussed within both the frameworks and the biodiversity planetary boundary itself.

Chapter 5 will describe the proposed biosphere functional integrity boundary from the Earth Commission by providing a background context on the proposed earth system boundaries framework and its integrated safe and just operating spaces. Chapter 5 will furthermore shift the focus upon the just operating space of the proposed biosphere functional integrity boundary by describing key context of how the Earth Commission seeks to further epistemic justice with Indigenous knowledge.

Chapter 5 will lastly, discuss key inferences of epistemic justice from a targeted review of the just urban greening literature from a Dutch Research Council Project (NWO) led by a former co-chair of the Earth Commission. The inferences of overarching power dynamics within the selection and application of different knowledge sets will be used to identify the problem that the research question of this thesis seeks to address.

Chapter 6 will answer the main research question set-up by the previous chapters of this thesis by first defining space through Philosopher Michele Foucault's statement on the direct intertwinement of the production of knowledge, power, and space. After space is defined, spatialisation will also be explained to illustrate how the production of space, knowledge, and power is intertwined.

Through spatialisation, the work of critical geographers building on Foucault will be used to discuss and illustrate governance and scale, and the injustices that can occur through different scales. The discussion from critical geographers on the fact that injustice can occur on different scales will then be used to explain the conceptualisation of spatial justice. Chapter 6 will also draw from Political Feminist and Indigenous Feminist scholars on the use of both spatial and epistemic justice in different spaces.

# 3. Epistemic Justice

## Epistemic Injustice

Epistemology is defined as "the theory of knowledge" from the Greek "episteme" (knowledge and understanding) and "logos" (account or argument) (Steup & Ram, 2024). For the purpose of this thesis, there will be two main categories of epistemology: Dominant and non-dominant scientific knowledge sets.

The dominant scientific knowledge sets will be situated within the context of the boundaries development discussed in chapters 4 and 5, whilst the non-dominant scientific knowledge sets will be situated within the context of Indigenous knowledge and the proposed biosphere functional integrity boundary that will be introduced and discussed in chapters 5 and 6.

The concept of epistemic injustice was theorised by philosopher Miranda Fricker in 2007, who states that it is important to understand the "negative space" of epistemic injustice in order to understand epistemic justice (Fricker, 2007, p. viii). Fricker states how in philosophy, the assumption and focus tends to be on justice and furthering justice, which can lead to oversights in defining and identifying already existing injustices (Fricker, 2007, p. vii).

This "spatial" aspect of epistemic injustice and epistemic justice will be further expanded upon in chapter 6 as making up a key foundation of the argument of this thesis on the intertwinement of space, knowledge, and power production.

When exploring the "negative space" of epistemic injustice, Fricker focuses upon what she claims are two main forms of epistemic injustice: testimonial and hermeneutical injustice. Fricker claims that these are the two main forms of epistemic injustice because they specifically dismiss individuals as knowers (Fricker, 2007, p. 1).

Testimonial injustice occurs when a speaker receives more or less credibility than the speaker actually would have. Hermeneutical injustice occurs when some groups suffer a significant disadvantage over other groups due to a collective hermeneutical gap (Fricker, 2007). According to Fricker, the hermeneutical gap stems from an intentional societal gap in collective analytical tools (Fricker, 2007). This means that there is a marginalisation from members of a group in which certain wrongs that they experience are not recognised by society, such as dominant members of societal institutions.

Thus, just like with testimonial injustice, hermeneutical injustice harms the capacity of knowledge. The individual is experiencing a wrong that society has failed to identify. Because society has failed to identify the wrong, the individual also cannot identify the wrong being done to them but within their capacity of knowledge, they know that a wrong is being committed against them though the wrong is unidentified. With testimonial injustice, the individual is failed because of prejudice based upon their identity (Fricker, 2007).

Both testimonial and hermeneutical injustice occur due to aspects of prejudice and discrimination. As Fricker discusses quite a lot of psychological implications with both prejudice and discrimination, these aspects of prejudice and discrimination will not be a focus of this thesis.

Fricker also argues that these epistemological issues are justice issues due to the "virtue of truth" (Fricker, 2007, p. 6) with the knower. Meaning that, harming a knower with their capacity of knowledge is essentially harming the value of truth (Fricker, 2007). Thus, epistemic injustice is defined as harm to a knower that fails to recognise their capacity of knowledge.

Cases that illustrate both testimonial and hermeneutical injustice will be discussed in later

chapters of this thesis involving Indigenous knowledge. These cases will be discussed in order to show how society has failed to recognise Indigenous knowledge. The societal failure to recognise Indigenous knowledge has resulted in an exclusion of non-dominant scientific knowledge in favour of dominant scientific knowledge.

The exclusion of Indigenous knowledge in favour of dominant scientific knowledge has resulted in harm to Indigenous land. This harm to Indigenous land by overall exclusion within environmental science, including environmental policy, has been a motivating factor for the call for epistemic justice within global environmental science, including the Earth Commission with their proposed biosphere functional integrity boundary.

Both epistemic injustice and epistemic justice making up the motivation for the just operating space of the proposed biosphere functional integrity boundary will be further discussed in chapter 5 of this thesis.

Again, the aspects of prejudice and discrimination making-up both testimonial and hermeneutical injustice will not be a focus of this thesis given the plethora of psychological implications that Fricker discusses with both prejudice and discrimination. The aspects of both testimonial and hermeneutical injustice that will be a focus of this thesis is power.

The aspect of power is key to what both epistemic injustice and epistemic justice are intertwined with. Power is what presents the problem in applying epistemic justice with the proposed biosphere functional integrity boundary for addressing the sixth mass extinction event. Thus, by illustrating these power dynamics within both epistemic injustice and epistemic justice, the key aspects of space, governance, and scale, can situated within the main argument of this thesis.

## Power

Fricker discusses and situates power within the context of epistemic injustice. Fricker defines two main forms of power: social power and identity power. “social power” is defined as a “socially situated capacity to control others actions” (Fricker, 2007, p. 4). Social power can be both active and passive (Fricker, 2007). Essentially, Fricker is also building off of philosopher Michele Foucault on how power is upheld by different individuals (Fricker, 2007).

Identity power is a form of social power that is dependent upon societal conceptions of identities (Fricker, 2007). Identity power will be important in this thesis for illustrating how Indigenous knowledge (non-dominant scientific knowledge) has faced epistemic injustice by being discredited in favour of dominant scientific knowledge.

However, identity power also has aspects of prejudice and discrimination with corresponding psychological implications discussed by Fricker that are beyond the scope of this thesis. Thus, this thesis will focus upon these main aspects of power that make-up both hermeneutical and testimonial injustice, the components of epistemic injustice.

By understanding both social and identity power, it can be shown how epistemic injustice and epistemic justice are situated within the dynamics of power. The fact that power is upheld by different individuals is where the dynamics of power within governance and scale can be illustrated and understood.

For the purpose of this thesis, governance will be defined as individuals with decision-making power in different spaces. This decision-making power will be another key aspect of understanding both epistemic injustice and epistemic justice.

While social and identity power are aspects of power intertwined with both epistemic

injustice and epistemic justice, the power of decision-making with governance is also key to understanding the exclusion of different knowledge sets, such as Indigenous knowledge, in favour of other knowledge sets such as dominant scientific knowledge.

By understanding governance within this thesis, the intertwinement of space, knowledge, and power production can also be understood. This intertwinement will be clearly defined and discussed in chapter 6. Throughout this thesis, "scale" will be defined as different spatial areas that have been determined at levels (global and local) through governance within different contexts. This definition of scale will become clear as it will be showcased throughout this thesis.

## Furthering Epistemic Justice

Within the context of this thesis, epistemic injustice is defined as harm to a knower that fails to recognise their capacity of knowledge, and epistemic justice is defined through a knower being recognised for their capacity of knowledge. How to further this recognition is what scholars working to advance epistemic justice are aiming to answer, including scholars with the Earth Commission with their conceptualisation of epistemic justice.

As discussed, Fricker states that achieving epistemic justice is limited due to different power dynamics which she states is a "root cause" of epistemic injustice (Fricker, 2007). Furthermore, Fricker claims that collective social and political change is what can truly resolve epistemic injustice (Fricker, 2007).

Yet in the present time, Fricker claims that by exploring the space of epistemic injustice, inferences can be drawn for furthering epistemic justice which can be done through institutions adopting values of epistemic justice (Fricker, 2007). This can be done for instance, by legal institutions adopting laws that prohibit discrimination based upon identity.

Within the biodiversity and overall environmental context, there is the proposed biosphere functional integrity boundary from the Earth Commission, and other research initiatives aiming to further epistemic justice. Some of these different research initiatives include co-collaborative processes for decision-making.

Environmental scholar Sarah Cummings (2023) builds off of Fricker's work in order to conceptualise and situate epistemic injustice within the domain of environmental sustainability. Cummings et al., define epistemic injustice as "unfair treatment of individuals and groups in knowledge-related and communicative practices in which the voices, experiences, and problems of marginalised individuals, communities, and societies, are not being taken seriously" (Cummings et al., 2023, p. 1965).

Through this definition of epistemic injustice, Cummings et al., aim to develop a holistic framework of systemic epistemic justice within the domain of environmental sustainability. This proposed holistic framework within the environmental sustainability context would involve co-creation and direct collaboration with different knowledge sets of stakeholders and individuals who are not classified as scientific experts, such as Indigenous knowledge (Cummings et al., 2023).

These initiatives to further epistemic justice will be discussed and explored further in chapters 5 and 6. As epistemic injustice occurs when non-dominant scientific knowledge is excluded in favour of dominant of scientific knowledge, shifting these power dynamics that are the foundational conditions of epistemic injustice requires group political action for social change (Cummings et al., 2023; Byskov & Hyams, 2022).

This thesis will now turn to another descriptive chapter in order to provide important context for the background of the proposed biosphere functional integrity boundary through the

development of the two key boundary frameworks and their governance and scale implications: the planetary boundaries and doughnut economic model frameworks.

# 4. Boundary Frameworks of the Earth System

## Planetary Boundaries

In 2009, the planetary boundaries framework was developed by environmental scientist Dr. Johan Rockström (who is a co-chair of the Earth Commission), along with 28 other scientists from the Global North. The planetary boundaries framework aims to address the sixth mass extinction event by defining a safe operating space for the Earth system through Holocene-level measurements (Rockström, et al., 2009).

The Holocene is described as the state of the Earth system before the sixth mass extinction event (Rockström, et al., 2009). This safe operating space is defined through nine planetary boundaries of the Earth system (see figure 2 appendix).

These planetary boundaries were identified with quantifications proposed for seven of the nine boundaries (Rockström et al., 2009). These seven boundaries include metrics for climate change, ocean acidification, global freshwater use, land system change, and the rate which biodiversity is lost annually (Rockström et al., 2009).

For the purpose of this thesis, the biodiversity planetary boundary (rate of biodiversity loss) will be discussed and focused upon in this chapter while the other eight planetary boundaries will just be referenced for the purpose of providing background. This is in order to keep the focus upon the proposed biosphere functional integrity boundary from the Earth Commission in addressing the sixth mass extinction event.

While again, it is necessary to explain key aspects of the planetary boundaries framework in order to understand the proposed biosphere functional integrity boundary, the proposed biosphere functional integrity boundary is the biodiversity boundary from the Earth Commission that is seeking to address the sixth mass extinction event of biodiversity. Thus, that is why this thesis will focus upon the biodiversity boundary within these frameworks.

The importance of the planetary boundaries lies within the fact that the boundaries can provide a global perspective for understanding the Earth system in terms of where it is significant for sustainability (Rockström et al., 2009; Steffen et al., 2015; Biermann & Kim, 2020). The biodiversity planetary boundary especially has been discussed as a boundary that not only has been crossed already, but a boundary that has impact on the Earth system and other planetary boundaries through its different species and ecosystem functions (Rockström et al., 2009).

The crossing of the biodiversity boundary (seen in red on the left in figure 2 appendix) has been determined through the sole control variable for the boundary identified by Rockström et al., which is the biodiversity extinction rate (2009). With this sole control variable, there is a significant knowledge gap and uncertainty range. Furthermore, the biodiversity planetary boundary has already been determined to be “crossed” through this sole control variable. Meaning that, humanity has already reached a point of Earth system harm within biodiversity, determined by the biodiversity rate extinction control variable (Rosktröm et al., 2009).

Within the context of the biodiversity planetary boundary, the knowledge gaps especially lie with different regional and local scales. Since the planetary boundaries framework is developed to address the safe operating space at the global scale, there are unknown implications for biodiversity rates at local and regional scales.

Rockström et al., state that it is difficult to define biodiversity loss from regional to global scales (2009). Rockström et al., also state that the proposed boundaries should not be interpreted as targets for policymakers, regardless if the boundaries are accurate or not (2009).

In a 2015 update to the planetary boundaries framework (in which Rockström was a co-author) the knowledge gaps (zones of uncertainty) and scale were addressed for the nine planetary boundaries (see figure 3 appendix). Additionally, the biodiversity planetary boundary was identified as a "core" boundary (now called the biosphere integrity boundary) and more control variables were added for the boundary (Steffen et al., 2015).

The biosphere integrity planetary boundary has been identified as a core boundary due to the fact that the boundary has direct influence on the Earth system and the other planetary boundaries, as discussed by Rockström et al., (2009). "Biosphere" has been defined as the "totality of all ecosystems on Earth and their biota" (Steffen et al., 2015, p. 8). Because of this, the biosphere integrity planetary boundary also has major impact on urban landscapes (Steffen et al., 2015).

Biodiversity extinction rates being used as the only control variable for the biodiversity planetary boundary has been criticised due to the fact that some scientists have argued that extinction rates can vary over time (Steffen et al., 2015). Thus, within the 2015 proposed update to the planetary boundaries framework, there are more variables such as phylogenetic diversity, functional diversity, and biome integrity for the biosphere integrity planetary boundary (Steffen et al., 2015).

Additionally, while Rockström et al., (2009) focused upon global scales, Steffen et al., (2015) addressed sub-global scales for the planetary boundaries. They claim that addressing scales at the sub-global level for the planetary boundaries is necessary due to the fact that changes in the control variables, such as for the biosphere integrity planetary boundary, can impact the global scales.

Steffen et al., also claim that the identified sub-global scales is meant to add to a missing piece from the planetary boundaries framework, and that the planetary boundaries framework itself is not meant to override local and regional efforts to address the sixth mass extinction event (2015).

The assessments used to understand human activity impact on the Earth system were large-scale assessments from the Intergovernmental Panel on Climate Change (IPCC), the International Geosphere-Biosphere Programme synthesis, etc., in order to obtain understanding for the planetary boundaries at the local level (Steffen et al., 2015).

However, since the very design of the planetary boundaries framework is at the global scale, the applicability of the planetary boundaries framework is limited at sub-global scales (Steffen et al., 2015). There is also still a significant knowledge and overall uncertainty gap with the biodiversity extinction rates and the other proposed control variables for the biosphere integrity planetary boundary (Steffen et al., 2015). Overall, it is stressed that this update of the planetary boundary framework can inform and support sustainability goals through advancing global scientific knowledge in the long run (Steffen et al., 2015).

Steffen et al., also state that environmental policy is most implemented at sub-global scales and that there is a call for "planetary boundary thinking" at both local and global scales with the sustainable developmental goals (2015). Acknowledging both the local and global scales is important for realising differences in questions of justice, access, and inequality which are more visible within local scales than with global scales (Mohamed et al., 2024). The visibility of justice and injustice at different scales will be further expanded upon during the spatial justice analysis in chapter 6.

What is clear in this section, is that the planetary boundaries do have aspects of both governance and scale. Implications for governance and questions of epistemic justice can also be further examined. Who gets to make-up the spaces deciding different scales and has there been exclusion of non-dominant scientific knowledge sets? These questions will also become clear throughout chapters 5 and 6, in relation with the proposed biosphere functional integrity boundary.

A prominent response and build-on to the planetary boundaries framework is the doughnut economic model framework and its addition of a "just" operating space to the planetary boundaries (Biermann & Kim, 2020). This model will be explained in the next section, along with its implications of governance and scale.

## Just Boundaries

The doughnut economic model was developed in 2012 by economist Kate Raworth and published from the international nongovernmental organisation Oxfam. The doughnut economic model includes the nine planetary boundaries, with the addition of the just operating space to the planetary boundaries (see figure 4 appendix).

The just operating space is the social foundation comprised of eleven social boundaries listing what is needed to achieve global equity such as housing and education (Leach et al., 2013; Raworth, 2012). The doughnut economic model addresses the relationship between global equity and the Earth system.

The planetary boundaries framework did not address the relationship between global equity and the Earth system due to the fact that the planetary boundaries framework was formulated as both a biophysical and apolitical framework, which means that the framework excluded any discussion of global inequity or social justice (Biermann & Kim, 2020).

Through Oxfam's GROW campaign, the doughnut economic model has been presented as a discussion paper at the United Nations (UN) Conference on Sustainable Development (Rio+20) in 2012 to illustrate what following the planetary boundaries framework could look like with ending poverty and food insecurity (Raworth, 2012).

The doughnut economic model does not represent Oxfam policy, but Oxfam has published it with the intent of furthering discussion and debate with scientists, government, economists, etc (Raworth, 2012). Raworth claims that through quantifying both the planetary and social boundaries, the planetary boundaries framework becomes a "global-scale compass" through the doughnut economic model (Raworth, 2012, p. 5). Meaning that, the doughnut economic model can provide a global perspective on the Earth system and how close it is to being over-stressed (Raworth, 2012).

In 2017, Raworth presented an updated version of the doughnut economic model framework (see figure 6 appendix) in which the dimensions for both the social foundation and ecological ceiling are quantified based upon recent global social standards and earth-system science data, such as the 2015 update to the planetary boundaries framework from Steffen et al., (2015).

Raworth claims that the need to bring "all" of humanity into both a safe and just space is due to the fact that individuals below the social foundation can also live in a way that crosses the safe space in order to survive (Raworth, 2012). This is also due to policy that does not take context into account with both local and global scales.

Scholars in the Global South have critiqued the planetary boundaries for the fact that the boundaries could restrain economic growth and national sovereignty in the Global South as the

global scale is not designed to account for past and present contextual issues within different local scales (Biermann & Kim, 2020; Leach et al., 2013).

For governance, Raworth states that a "planetary perspective" is necessary for developing governance at local scales due to the fact that both the local and global scales are impacted by resource use and biodiversity (Raworth, 2012, p. 12). This is seen for example, with how deforestation and other biodiversity loss can be seen at the local scale before it impacts the global scale (Raworth, 2012).

The doughnut economic model also has implications for global policymaking. Raworth states that the challenge with global policymaking for the framework is that there are different management, context, and implications with resources such as biodiversity at both local and global scales (Raworth, 2012).

Despite these challenges, Raworth claims that agreeing to manage the Earth system at both local and global scales is "one of the most important issues of international law and governance" (Raworth, 2012, p. 14). Raworth states that the doughnut economic model can help with strategy for both economic and policymakers (Raworth, 2012). This strategy can be seen through both the incorporation of the planetary boundaries into the doughnut economic model (Raworth, 2012).

It is also important to note that both sets of boundaries making up the safe (planetary boundaries making up the environmental ceiling) and just (boundaries making up the social foundation) operating spaces of the doughnut economic model are normative in the sense that they are determined by social norms (Raworth, 2012).

Thus, there are both governance and scale implications with the doughnut economic model framework that Raworth states leaves questions such as, who gets to decide the boundaries? How can the framework be adapted at the local scale from the global scale? And what policy shifts are needed to bring humanity into both the safe and just space? (Raworth, 2012).

Other questions relevant to this thesis is which knowledge sets have been included and excluded within the development of both the planetary boundaries and doughnut economic model frameworks? In the next section, this thesis will discuss and examine the governance implications with both the doughnut economic model and the planetary boundaries frameworks. The governance implications with both the boundary frameworks is an aspect from which the Earth Commission has built the proposed biosphere functional integrity boundary with conceptualising epistemic justice.

## Boundary Governance

Both the planetary boundaries and doughnut economic model frameworks have governance implications. As discussed, both the planetary boundaries and doughnut economic model frameworks aim to address the sixth mass extinction event and overall advance the protection of the Earth system at the global scale through research and discussions with scientists, policymakers, and other experts.

While Rockström et al. (2009) aimed to develop a boundary framework that was not to be interpreted as targets for policymakers, the fact of the matter is that the planetary boundaries framework has shaped and influenced research into global sustainability and policy at the global scale (Biermann & Kim, 2020).

Indeed, the development of the doughnut economic model framework as a response and build-on to the planetary boundaries framework, with the goal to bring humanity into a safe and just space is an example in of and itself of shaping global sustainability discourse. The prominent

influence and use of both the planetary boundaries and doughnut economic frameworks in research and policy demonstrate that they have become dominant paradigms (Biermann & Kim, 2020).

The Earth Commission also building upon both the doughnut economic model and planetary boundary frameworks is indicative of the governance that both frameworks have. Because both these boundary frameworks have been labelled as "dominant paradigms," the scientific knowledge that developed these frameworks, and develops from these frameworks, is defined as dominant scientific knowledge within this thesis.

Because of the identified "dominant" scientific knowledge in the development of both the planetary boundaries and doughnut economic model frameworks, there is indication of other knowledge sets that have been excluded with the development of the boundary frameworks.

The planetary boundaries framework was developed without other stakeholders or public participation, meaning that the defined "safe" operating space for humanity within the planetary boundaries has been defined exclusively by a select group of scholars from the Global North (Biermann & Kim, 2020). And the doughnut economic model adding to the planetary boundaries framework by an economist from the Global North published by a large nongovernment institute also has exclusionary aspects.

Thus, decisions for global research and policy based off of the planetary boundaries and doughnut economic model frameworks is governance based upon frameworks that have been exclusionary of other scientific knowledge sets. These "other" scientific knowledge sets are defined within this thesis as non-dominant scientific knowledge sets that will be discussed as Indigenous knowledge within the context of both epistemic injustice and epistemic justice in chapter 5.

This is also why the Earth Commission seeks to incorporate epistemic justice with their proposed earth system boundaries framework and proposed biosphere functional integrity boundary. The Earth Commission recognises the governance implications from the planetary boundaries, doughnut economic model, and within their own framework and proposed biosphere functional integrity boundary. In addition to recognising the aspect of governance itself with the boundary frameworks, the Earth Commission also recognises that this governance that has been exclusionary. More background and governance with the proposed biosphere functional integrity boundary will be discussed in chapter 5.

Referring back to the biosphere integrity planetary boundary defined and discussed in this chapter with the planetary boundaries framework, the boundary itself has both governance and scale implications. Out of the nine planetary boundaries, the biosphere integrity planetary boundary has been identified as one of two "core" boundaries (Steffen et al., 2015). As discussed, the biosphere integrity planetary boundary has been identified as a "core" boundary because the biosphere integrity boundary can drive the earth system into a new state if the boundary is crossed (Steffen et al., 2015).

As also discussed, there are significant knowledge gaps with the control variables of the biosphere integrity planetary boundary (Steffen et al., 2015). These knowledge gaps are also an aspect of why the Earth Commission has merged together (integrated) both the safe and just operating spaces with their proposed earth system boundaries framework, which will be discussed further in chapter 5.

The fact that the biosphere integrity planetary boundary can operate at the entire earth system level that the other planetary boundaries can operate in is what Steffen et al., describes as a "hierarchy" of the biosphere integrity boundary over the planetary boundaries (2015).

Hierarchies within different spaces and scales will be explained further and discussed in chapter 6. For the next section, this thesis will further discuss and explore scale within governance of the planetary boundaries and doughnut economic model frameworks.

## Scale

While the Earth system and other literatures within the environmental context show that both the planetary boundaries and doughnut economic model frameworks have global Earth system governance implications within existing global institutions, there are additional questions of scale for both global and local levels (Biermann & Kim, 2020).

Despite the planetary boundaries framework claiming to be apolitical due to the fact that the framework is focused on biophysical boundaries of the Earth system, there are still political consequences and other implications drawn for global equity (Biermann & Kim, 2020).

For instance, the planetary boundaries framework suggests that no more than 15% of global land can be converted to cropland, along with the 2015 update that at least 75% of original forest should be maintained globally. Neither framework accounts for the imbalance between different areas in the Global North and Global South and their history of development which impacts how much they are forested or not (Biermann & Kim, 2020).

While the planetary boundaries framework was designed to address the Earth system at the global scale, and the 2015 update to the planetary boundaries framework accounted for sub-global scales at regional and local levels, there are still researchers who say that the planetary boundaries framework needs to be "downscaled" in order to align with decision-making at local scales (Biermann et al., 2020).

Some studies have found that attempts to downscale the planetary boundaries are not feasible due to the natural and biophysical sciences used to develop the framework. Such studies instead advocate for bottom-up approaches from identified key Earth system drivers such as biodiversity (Nilsson & Persson, 2012).

What researchers mean by downscaling the planetary boundaries framework is largely within a bottom-up context. The planetary boundaries framework is top-down in the sense that it is the global scales determining sub-global and local scales, rather than the reverse.

This is why Steffen et al., has stated that the planetary boundaries framework was not supposed to be downscaled due to the fact that both the local and global scales are intertwined with the Earth system and its impaction (2015).

Regardless, some researchers have employed a downscaling of the planetary boundaries to improve decision-making at the local level, for more equitable distribution of resources such as freshwater, agriculture, and other goods from natural resources (Biermann & Kim, 2020). However, it is still unclear how any earth system approach can address regional and national contexts (Biermann & Kim, 2020).

The fact of governance remains with research proposing that the planetary boundaries at different scales can be used to guide different national assessments and policies for environmental impacts (Biermann & Kim, 2020).

The planetary boundaries framework identifying different scales at both the local and global levels is important for understanding how other knowledge sets that are not dominant scientific knowledge sets, such as Indigenous knowledge, can be recognised as systems of governance. This recognition is important for furthering epistemic justice within power dynamics in different spaces, which will be further discussed in chapters 5 and 6.

While both the planetary boundary and doughnut economic model frameworks represent the safe and just operating spaces, these spaces are still represented with different boundaries (Rockström et al., 2023). With these biophysical, justice, governance, and scale implications, the Earth Commission builds upon the safe and just with their proposed earth system boundary framework and proposed biosphere functional integrity boundary.

# 5. Biosphere Functional Integrity Boundary

## Safe and Just Boundaries

Since 2019, the Earth Commission, which is an initiative of the Future Earth and the Global Commons Alliance, has been working to address the sixth mass extinction event. Dr. Johan Rockström, who lead the authorship of the planetary boundaries, is aware of the governance and scale implications regarding exclusion of knowledge and legitimacy (Biermann & Kim, 2020).

These implications are why the Earth Commission is comprised of both social and physical scientists from both the Global North and the Global South with five working groups (Biermann & Kim, 2020). The five working groups were part of "phase one" from the Earth Commission. Now at the time of writing this, the Earth Commission is in the next phase with a new "workstream" of four groups (Earth Commission, 2024).

Scientists from one of the five Earth Commission working groups in phase one, the biosphere interactions working group, have identified the *Biosphere functional integrity boundary*. This boundary proposes that 20-25% of every square kilometre of managed lands should be reserved for nature (Rockström et al., 2023; Mohamed et al., 2024).

What the Earth Commission seeks to do with their proposed earth system boundaries framework is to integrate both the safe and just operating spaces that have been defined by the planetary boundaries and doughnut economic model frameworks. (Rockström et al., 2021; Rockström et al., 2023). Thus, instead of separate social and planetary boundaries, the proposed earth system boundaries framework integrates the two boundary sets into one set of boundaries for the Earth system (see figure 1 appendix).

It is argued that the planetary boundaries are necessary from a justice perspective, in the sense that "just" requires a setting of targets for society to work towards for keeping a safe and just Earth system, which also motivates the integration of both the safe and just operating spaces of the proposed earth system boundaries (Gupta et al., 2021; Gupta et al., 2023).

The Earth Commission has recognised the call for governance with different scales so that the most marginalised and vulnerable are not harmed within the balance of both the safe and just operating spaces (Rockström et al., 2023; Gupta et al., 2023). Having both safe and just earth system boundaries is important for ensuring that both humans and the Earth system are protected, as the safe operating space of the boundaries can protect the Earth system but can still fail to protect current human life while the just operating space can protect humans but fail to protect the Earth system (Rockström et al., 2023; Gupta et al., 2023).

Thus, the Earth Commission also seeks to take contextual factors into account with different local and global scales (Rockström et al., 2023; Gupta et al., 2023). Furthermore, the Earth Commission has recognised the fact that non-dominant scientific knowledge sets have been excluded within the development of the planetary boundaries and doughnut economic model frameworks (Gupta et al., 2023). Resultingly, the Earth Commission has conceptualised epistemic

justice within their defined just operating space for the proposed earth system boundaries framework.

The Earth Commission conceptualises epistemic justice as "establishing equity between different forms of knowing" (Gupta et al., 2023, p. 632). The Earth Commission has specifically highlighted Indigenous and local knowledge sets within this conceptualisation of epistemic justice, and argue that dominant power dynamics need to be challenged in order for epistemic and other conceptualisations of justice to be realised (Gupta et al., 2023).

This chapter will also explain the epistemic injustice of the non-recognition and overall exclusion of Indigenous knowledge in the next sections for motivating the Earth Commission to highlight Indigenous knowledge specifically within their proposed earth system boundaries framework and biosphere functional integrity boundary.

This conceptualisation of epistemic justice is part of the proposed earth system justice framework from the Earth Commission (see figure 5 appendix). The proposed earth system justice framework is the defined just operating space for the earth system boundaries framework. The proposed earth system justice framework is built to integrate with the proposed earth system boundaries framework by situating justice within minimising significant harm from Earth system change (Rockström et al., 2023).

In addition to the doughnut economic model framework, these conceptualisations of justice within the proposed earth system justice framework were also built upon environmental and global justice scholarship (Gupta et al., 2023). Through examining the environmental and global justice scholarship, in conjunction with the planetary boundaries and doughnut economic model frameworks, the Earth Commission is able to analyse how the scholarship highlights a call "for all" (institutions, countries, peoples) to secure biodiversity (Gupta et al., 2023).

This call for all to secure biodiversity has also included more and more of a drive to integrate both Indigenous and local knowledge sets (Gupta et al., 2023). For the purpose of this thesis, epistemic justice will be the sole conceptualisation of focus from the proposed earth system justice framework from the Earth Commission (which is the defined just operating space of the proposed earth system boundaries). This thesis will now shift more focus to the proposed biosphere functional integrity boundary and epistemic justice.

## Biosphere Functional Integrity Boundary

The integration of both the safe and just operating spaces means that the proposed biosphere functional integrity boundary can incorporate both the biodiversity quantity and quality with the context that the spatial configuration of local scales takes into account (Mohamed et al., 2024). The local scales are still connected to the global scales in order to develop and implement the proposed biosphere functional integrity boundary in an epistemically just way that addresses the sixth mass extinction event. (Gupta et al., 2023).

As discussed, the Earth Commission has stated that the proposed earth system boundaries should be modified when needed for context with different local and global scales so that way the boundaries do not worsen already existing issues with both humans and the Earth system. This also includes the metric for the proposed biosphere functional integrity boundary (Rockström et al., 2023; Gupta et al., 2023; Mohamed et al., 2024).

This proposed metric for the biosphere functional integrity boundary (20-25% of every square kilometre of managed lands should be reserved for nature) was based upon an extensive literature review from *Nature's Contribution to People* (NCP) data that located six NCP to make-

up the proposed boundary that include control and regulation for pollination, pests disease, water, soil, natural hazards, and physical and psychological benefits (Mohamed et al., 2024).

"Functional integrity" is defined as the "capacity of an area to provide and sustain NCP based on habitat quantity, quality, and spatial configuration" (Mohamed et al., 2024). The quantity, quality and spatial configuration is dependent on local context, and can be different based upon NCP identified at different scales (Mohamed et al., 2024). Thus, biodiversity location is important as for instance, on waterways and reducing risk of natural disasters such as floods (Mohamed et al., 2024).

Seven of the eight earth system boundaries have already been crossed which also includes the proposed biosphere functional integrity boundary (see figure 1 appendix). The proposed biosphere functional integrity boundary already being crossed adds to the urgency and motivation of the Earth Commission to examine this boundary. While crossing the other planetary boundaries can lead to both Earth system and human harm, crossing the biosphere integrity boundary leads to again, an entire new state of the Earth system (Mohamed et al., 2024).

Thus, the classification of the biodiversity planetary boundary as a core boundary is also motivation for the Earth Commission to focus upon the boundary and its implications for urban landscapes. Within the development of the proposed biosphere functional integrity boundary, urban landscapes are recognised as important due to the fact that biodiversity is globally examined more within protected and natural areas (Mohamed et al., 2024). Urban areas provide crucial ecosystem services to inhabitants such as food and water (Mohamed et al., 2024).

If the biosphere functional integrity boundary is below the safe operating space then there would be loss of ecosystems and food production in the urban (Rockström et al., 2023). For the just operating space of the biosphere functional integrity boundary, there should be specific interventions with marginalised groups at local scales in the impacted areas being allowed the space to use their knowledge within the boundary procedures (Roskström et al., 2023). This includes Indigenous knowledge (Gupta et al., 2023).

## Addressing Epistemic Injustice

Because the Earth Commission has highlighted Indigenous knowledge specifically when seeking to address the sixth mass extinction event with epistemic justice of the proposed biosphere functional integrity boundary, this section will focus on epistemic injustice that has been experienced by Indigenous people in the US legal system.

By focusing on the epistemic injustice experienced by Indigenous people within the US legal system, the harm caused within the environmental context that has driven global environmental research groups such as the Earth Commission to work towards centring Indigenous knowledge can be better understood with the pursuit of epistemic justice in addressing the sixth mass extinction event.

This section will also approach defining and situating epistemic justice in line with how Fricker described epistemic injustice and epistemic justice, including the aspects of power. As discussed, the Earth Commission recognises the literature pointing to the governance and scale implications with both the planetary boundaries and doughnut economic model frameworks.

Because the proposed biosphere functional integrity boundary is for making space to maintain biodiversity, the Earth Commission states that local and Indigenous people should be involved in order to avoid disruption and harm to already existing epistemic knowledge sets, roles, and human habitation (Gupta et al., 2023).

What this means is that by identifying and situating epistemic injustices, such as the exclusion of marginalised and Indigenous people from scientific research, there can be work towards furthering solutions for epistemic justice to be applied within different spaces.

The scientific knowledge and governance systems that Indigenous people possess about their lands is conceptualised as separate from western scientific knowledge. Indigenous law scholar Professor Rebecca Tsosie states that epistemic injustice has occurred through the US legal system to Indigenous people through a "false dichotomy" of scientific interest opposed to Indigenous people (Tsosie, 2012, p. 1136).

What this means that Indigenous knowledge may not be seen as valid because Indigenous knowledge is not the dominant scientific knowledge, whereas the dominant scientific knowledge risks endangering the environment due to it being incomplete and not inclusive of Indigenous knowledge (Tsosie, 2012).

Thus, this is why this thesis will classify Indigenous knowledge as non-dominant scientific knowledge. Tsosie builds on Fricker's work in order to discuss the aspects of testimonial and hermeneutical injustice in relation to how science is used by US public policy for Indigenous health and environmental protection. To provide an example of testimonial injustice, Tsosie (2012) describes how the US legal system requires a witness to be qualified as such before they provide a testimony.

For Indigenous people, obtaining this qualification as a witness means that they must obtain "credible testimony" from an "expert witness" to prove they are an "Indian tribe" to receive political recognition (Tsosie, 2012, p. 1155). Furthermore, if an Indigenous group claims that a sacred place should be protected legally, then the group must provide qualified expert testimony to prove this (Tsosie, 2012).

Because the courts are unlikely to recognise tribal members as credible witnesses, an expert testimony would likely be produced by an academic to determine whether the group is in fact, an "Indian tribe" (Tsosie, 2012, p. 1155). This is because the categories and different epistemologies of knowledge that Indigenous groups possess are not recognised by the US legal system and academia, and is beyond the knowledge of these institutions (Tsosie, 2012).

As discussed by Fricker, the fact that the court does not recognise Indigenous knowledge as "credible" outside of academia and other systems is testimonial and epistemic injustice, as this is harm to the knower for not recognising their capacity of knowledge (Fricker, 2007).

This unrecognition of Indigenous knowledge by societal institutions is also a component of hermeneutical injustice. Hermeneutical injustice can be extremely hard to detect. Tsosie argues that it is more subtle than testimonial injustice and more covert (Tsosie, 2012). Tsosie also provides an example of hermeneutical injustice by describing how in a US court case, an Indigenous tribe claimed that the US government authorising timber harvesting from their lands was a constitutional violation. The court dismissed their claim and in their ruling, the court stated:

*Every American schoolboy knows that the savage tribes of this continent were deprived of their ancestral ranges by force and that, even when the Indians ceded millions of acres by treaty in return for blankets, food and trinkets, it was not a sale but the conqueror's will that deprived them of their land" (Tee-Hit-Ton V. Unites States, 1954).*

Thus, the fact that society does not recognise Indigenous knowledge is a hermeneutical injustice due to the fact that the way the society is structured is not inclusive or recognitional of Indigenous knowledge and outright dismisses Indigenous knowledge as not credible.

Both social and identity power can be seen with the fact that different individuals

are upholding the power structures within the court and legal system that does not recognise Indigenous knowledge. Identity power is seen through the fact that the Indigenous knowledge is also not recognised merely because it is Indigenous and identified as non-scientific knowledge.

Thus, both the described testimonial and hermeneutical injustice is epistemic injustice that Indigenous people have experienced with the US legal system and their lands. This has also been shown to impact environmental policy.

Environmental scientists Byskov and Hyams' work also uses Fricker's framing of epistemic injustice in order to argue that climate adaptation policies are epistemically unjust towards Indigenous people due to underrepresentation (2022). Byskov and Hyams also analyse whether epistemic injustice can conceptually be applied to climate adaption with such underrepresentation of Indigenous knowledge (2022).

Byskov and Hyams also discuss cases of epistemic injustice in which Indigenous people have been excluded from procedural decision-making in different climate technologies such as genetically modified crops (2022). This climate technology threatens biodiversity for Indigenous people as well as market access (Byskov & Hyams, 2022). Had Indigenous people been included within these decision-making processes, then these unforeseen negative consequences might have been avoided.

On the subject of policy, Tsosie describes another conflict with how science is used by public policy as a tool to focus upon a particular set of interests which in turn, then treats Indigenous people and Indigenous knowledge sets as "objects" of dominant scientific discovery (Tsosie, 2012, p. 1141). Because Indigenous knowledge is objectified in this way, Indigenous people and their knowledge is not seen as equal within the development of policy and scientific knowledge (Tsosie, 2012).

Furthermore, these scientific spaces will not outright use rhetoric that can be seen as racist and discriminatory. While overt scientific racism is largely rejected by the dominant scientific narrative, there is still covert scientific racism within different prejudices and discrimination that leads to the exclusion of epistemic knowledge in science (Tsosie, 2012).

These aspects of prejudice and discrimination will again, not be a focus of this thesis given their psychological implications as discussed by Fricker (2007), but it is important to understand both social and identity power upholding the structural discrimination of Indigenous knowledge through governance that makes decisions based off of dominant scientific knowledge whilst excluding non-dominant scientific knowledge.

The structural discrimination of Indigenous people and Indigenous knowledge has also led to the exploitation of Indigenous knowledge. For instance, the acknowledgement of scientists that Indigenous knowledge can be used to understand biodiversity management has led to pharmaceutical companies profiting off patenting products from Indigenous plant knowledge, without any US intellectual property laws protecting Indigenous knowledge from the exploitation (Tsosie, 2012).

This exploitation of Indigenous knowledge is demonstrated throughout large global institutes and their endeavours to "test" Indigenous knowledge under western scientific standards to determine whether it is "accurate," and can be adapted, such as with the IPCC and United Nations reports with the Sustainable Development Goals (Tsosie, 2012; Cummings et al., 2023; Byskov & Hyams, 2022).

Thus, this description of epistemic injustice now situates how the Earth Commission and Earth system and overall environmental research seeks to address the exclusion of Indigenous knowledge when addressing the sixth mass extinction event through epistemic justice. The next

section will describe how environmental science is working to further epistemic justice through the inclusion of Indigenous knowledge.

## Towards Epistemic Justice

Currently, scientists do largely agree in principle that an ideal future is one that establishes the basic human rights of all people, which includes Indigenous people (Byskov & Hyams, 2022). Furthermore, science can be used as a tool in shaping social policy and as such, science can be used to further Indigenous knowledge for Indigenous self-determination (Byskov & Hyams, 2022).

Indeed, global organisations such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) have found that biodiversity values are higher significantly on Indigenous-managed lands and have resultingly called for bridging and integrating both Indigenous epistemic knowledge with scientific knowledge together through co-creative processes (Cummings et al., 2023; Bush & Doyon, 2023).

This fact adds to the context of why environmental researchers are now working to advance epistemic justice through the inclusion of Indigenous knowledge, including the Earth Commission. Indeed, many social science scholars also see epistemic injustice as a barrier to research development and innovation, and how epistemic injustice is deeply intertwined with systemic power dynamics (Byskov, & Hyams, 2022; Cummings et al., 2023).

This is especially true within sustainable development, which requires new procedural practices that disrupt current unequal power relations as they relate to knowledge (Cummings et al., 2023). Indigenous knowledge should also be recognised for its own systems of governance (Tsosie, 2012). Indeed, Fricker argues that power is not in itself a bad thing, but it should be asked who has what power and why (Fricker, 2007, p. 14).

While power has been acknowledged within both epistemic justice and epistemic injustice, what work can be done to both address the power dynamics and further epistemic justice? Recognition of epistemic injustice is crucial for furthering epistemic justice. Tsosie describes how secular pluralism favours Western European (dominant scientific knowledge sets) understandings of science, economics, and technology as the appropriate constructs for domestic public policy over that of Indigenous knowledge (Tsosie, 2012).

Thus, in order for Indigenous knowledge (non-dominant scientific knowledge sets) to be included in climate policy, there must be recognition of how the current climate language is skewed towards Western scientific and technocratic approaches that limits the input of Indigenous knowledge (Byskov & Hyams, 2022).

The recognition and inclusion of Indigenous knowledge is intertwined with governance since it is dependent on decision-making power. Researchers from the Earth Commission have stated that for the just operating space of the biosphere functional integrity boundary, there should be specific interventions and policy at the local level (Rockström et al., 2023).

For addressing both the safe and just operating spaces of the proposed earth system boundaries framework, the Earth Commission has acknowledged the governance implications for local scales of the Earth system. Again, the Earth Commission has stated the marginalised groups in the impacted areas should be allowed the space to use their knowledge within the boundary procedures (Roskström et al., 2023).

The question lies in “how” Indigenous knowledge can be included both directly and impactfully, furthering overall epistemic justice. Who is making the decisions by how Indigenous knowledge is incorporated into what spaces?

A recent Dutch Research Council (NWO) funded project led by a co-chair of the Earth Commission sought to further examine the proposed biosphere functional integrity boundary and the implications with governance and scale in the just operating space. The next section will discuss the epistemic justice inferences from the literature review that the project was grounded in.

## Approaches From Just Urban Greening Literature

To further examine the proposed biosphere functional integrity boundary and the implications with the just operating space, Dr. Joyeeta Gupta, environmental scientist and former co-chair of the Earth Commission, led a Dutch Research Council (NWO) funded project called Fair global Research Agenda by Mutual Engagement (FRAME).

In collaboration with the University of Amsterdam, Erasmus University, Anchor University, the University of Twente, and Delft University of Technology, the goal of the FRAME project was to further examine the just operating space of the proposed biosphere functional integrity boundary through a targeted literature review of the just urban greening literature, policy and urban green space, and discussions with academic and local municipal stakeholders. This section will focus upon the epistemic justice, governance, and scale inferences drawn from the targeted review of the just urban greening literature.

The just urban greening literature review was conducted in 2023 by the author of this thesis under the supervision of Dr. Fran Meissner (Assistant Professor in Critical Geodata Studies and Geodata Ethics with the ITC Department of Urban and Regional Planning at the University of Twente). In order to be inclusive of different landscapes, the just urban greening literature was defined as literature that is concerned with increasing or redistributing the share of vegetation in built-up areas.

From this targeted review of the literature, inferences were drawn from a few cases centred in epistemic justice. One of the cases focused on a local community garden food initiative in Bangkok, Thailand. The second was on a policy to protect the corridor of the Yarra River that was developed and implemented by the Indigenous Wurundjeri people in Melbourne, Australia in their own original language.

In Bangkok, the City Farm Programme was comprised of collaborative urban farming networks that aimed to produce alternative food sources locally. The City Farm Programme includes local knowledge from residents about food and food systems within the city of Bangkok. One of the networks in the City Farm Programme, the Green Market Network, supports community-based agricultural systems that include gardening and farming on a small, local scale (Boossabong et al., 2018).

The Green Market Network also has urban spaces used for training centres with farming tools, social spaces for producer-customer relations called the Green Fair, and a Green Market Facebook page for information exchanges (Boossabong et al., 2018).

Boossabong, et al. (2018), emphasise that scale in the City Farm Programme, and more specifically, the scale at the local level, is more “workable” for actors such as the state, corporations, and people. Considering scale also brings to focus the aspects of collaborative local urban governance, which recognises the role of the people to bring about social change within institutions. For instance, furthering food security and social cohesion is possible at the community scale due to the fact that it is the community tending to the garden itself (Boossabong et al., 2018).

For these urban green spaces to be implemented, the City Farm Programme helped different communities in Bangkok create community gardens under different city infrastructural

spaces such as electric lines and airport rail links, in collaboration with the city infrastructural organisations. If there was no space available then the programme helped with the creation of floating community gardens such as on the river (Boossabong et al., 2018).

In this case, epistemic justice is realised through the implementation of knowledge by local community members in Bangkok for furthering urban green space at the local scale with governance that is collaborative. Farming is part of the cultural identity of Thailand and as such, many Thai people engage in growing their own food in their backyard and in collective gardens, including the city of Bangkok (Boossabong et al., 2018).

Within the second case in Melbourne, Australia, the Yarra River policy to protect the corridor of the Yarra River was developed and implemented by the Ministerial Advisory Committee that consisted of, and included, the Indigenous Wurundjeri people (Bush & Doyon, 2023).

The Ministerial Advisory Committee for the Yarra River was established in 2016 to both consult with and provide advice to stakeholders in the area. This included a recommended action plan for the management, promotion and protection of the river, with considerations for wider application and transferability (Bush & Doyon, 2023).

Traditional Owners of the river (the Indigenous Wurundjeri people) were not committee members at first, joining several months after the committee was established (Bush & Doyon, 2023). The committee identified key challenges such as population growth and climate change impacting the river waterway health and use. Additionally, the committee found that there was an overall lack of overarching governance on planning and alignment mechanisms with the river (Bush & Doyon, 2023).

The Yarra River policy was then implemented through the Ministerial Advisory Committee's final report that included 30 recommendations for governance reforms, establishment of a Community Vision and Yarra Strategic Plan, and establishment of a Birrarung Council to provide oversight and advice in the development and implementation of the Strategic Plan (Bush & Doyon, 2023). The policy was implemented in the Wurundjeri language by its co-title *(Wilip-gin Birrarung murron).* The policy recognises the river as its own living entity (Bush & Doyon, 2023).

The Yarra River policy act establishes 19 principles for the protection of the river and established the Birrarung Council to provide advocacy and advice as an independent body (Bush & Doyon, 2023). The Birrarung Council consists of Indigenous Wurundjeri people, environmental groups, water and landscape experts, Yarra River land bodies, local government, and community groups. This diverse council include many different epistemologies that the council works to address whilst centring the voices of the Wurundjeri people in the council (Bush & Doyon, 2023).

While the Yarra River Policy along with the Birrarung Council provide a new model of waterway governance and approach to planning and managing urban nature, there are still multiple limitations that include issues of which geographic scales are included and excluded from the policy (Bush & Doyon, 2023).

For instance, the Yarra River Policy focuses on the river corridor itself, but excludes other areas impacted by the river such as the most downstream section connected with the Port Phillip Bay. Port Phillip Bay is a major hub of commercial activity, with no public access to the river banks (Bush & Doyon, 2023). Furthermore, major transport projects (such as new freeway and motorway constructions) are also excluded from the Act (Bush & Doyon, 2023).

Despite these limitations, epistemic justice seems to have been furthered for this case. The Wurundjeri people were able to have decision-making power within the governance body through

co-collaboration of the Yarra River policy development and implementation at the local scale. Furthermore, because the policy is also bilingual in both English and Woi-wurrung (Wurundjeri language), the Yarra River is recognised as both part of the region's natural and cultural heritage (Bush & Doyon, 2023).

Because the river is part of the region's natural and cultural heritage, Parliament intends to keep the Yarra River alive and healthy for future generations, which is also in line with the Wuhrundjeri people protecting the river for future generations (Bush & Doyon, 2023).

Thus, both the Bangkok (City Farm Programme) and Melbourne (Yarra River Policy) cases can provide some useful information on how the proposed biosphere functional integrity boundary can incorporate epistemic justice with addressing the sixth mass extinction event.

However, as discussed by Fricker and in the previous section, there is social and identity power within epistemic justice, and the limitations discussed with the Yarra River Policy case indicate overarching power dynamics that cannot be ignored. These power dynamics are overarching within first, the formation of the Ministerial Advisory Committee for the Yarra River itself as the Wurundjeri people did not join the committee until months after its formation. Meaning that, the committee was formed without the Wurundjeri people.

Furthermore, the policy protecting only a very specific part of the river corridor means that the policy is quite limited in scale and governance for the rest of corridor. Meaning that, Indigenous knowledge can and should be implemented for the rest of the waterway and biodiversity management – but it is not (Bush & Doyon, 2023).

The Birrarung Council established by the Yarra River policy seems like the best approach to keep furthering epistemic justice through the Indigenous knowledge of the Wurundjeri people and the Yarra River. However, because the Birrarung Council consists of other groups, it is unclear how decisions are made and which knowledge sets are being included and excluded.

Despite the council claiming to centre the voices of the Wurundjeri people, it is unclear what this means in terms of decision-making power within governance. For instance, with both social and identity power, the dynamics of both social and identity power of different individuals making up the structures within the Birrarung Council is unknown for how the Indigenous knowledge of the Wurundjeri people is identified and thereby selected and applied with the council.

The limitations with the Yarra River policy case, and implications of overarching power dynamics in the selection and application of Indigenous knowledge, can also be used to scrutinise the City Farm Programme case. For instance, who, exactly, is making decisions and defining what the community and local scales of governance are within the City Farm Programme? Who and which knowledge sets, are being included and excluded with this decision-making?

These limitations are also in line with inferences drawn from feminist urban political ecology scholar Andrea Nightingale in the just urban greening literature review. Nightingale discusses the overarching power dynamics with the selection and application of different knowledge sets, including Indigenous knowledge (Nightingale, 2023).

To illustrate her argument, Nightingale discusses a water scheme case in rural Nepal and the Carbon Neutral City Alliance in major Global North cities. In both of these cases, Indigenous knowledge is intended to be included in the projects but due to overarching power dynamics, there is still exclusion within both the water and technology projects (Nightingale, 2023).

Nightingale claims that these findings call for research that can identify who has the power to make decisions with the need for spaces that foster deliberative democratic practises to be inclusive of all knowledge sets (Nightingale, 2023). Nightingale claims that as long as the need is

recognised for these spaces that foster deliberative democratic practises, then non-dominant knowledge sets can be brought further into the forefront (Nightingale, 2023).

Thus, these overarching power dynamics can present a problem for the Earth Commission attempting to address the sixth mass extinction event by incorporating epistemic justice with the proposed biosphere functional integrity boundary. While the Earth Commission intends to incorporate epistemic justice with the just operating space of the proposed biosphere integrity boundary, power dynamics can still determine how, and what, Indigenous knowledge gets selected and applied.

The deliberative democratic spaces that Nightingale mentions seem to be best illustrated within the Birrarung Council and its governance with the Yarra River at the local scale. However, as discussed, it is still unclear which knowledge sets are being included and excluded.

If epistemic justice is needed with the development and implementation of the proposed biosphere functional integrity boundary to address the sixth mass extinction event, then how can the overarching power dynamics with governance and scale in the selection and application of different knowledge sets be identified within different spaces?

The next chapter will define and situate space and spatialisation in order show how different power dynamics can be identified through the recognition of the intertwinement of space, knowledge, and power, through both a spatial justice and epistemic justice lens.

# 6. Spatial Justice

## Space, knowledge, and power production

For the purpose of this thesis, "space" will be defined within any aspect of "knowledge" (such as dominant and non-dominant scientific knowledge mainly discussed in this thesis) in line with work from philosopher Michele Foucault (1982) on the intertwinement of the production of space, knowledge, and power.

The intertwinement of knowledge, space, and power, means that, just as knowledge produces space, space produces knowledge and one cannot be produced without the other simultaneously with the production of power (Elden & Crampton, 2016). This rather broad definition of space is intentional for illustrating the power dynamics within governance and scale of different spaces that have already been mentioned throughout this thesis.

For example, while the proposed biosphere functional integrity boundary and the different boundary frameworks discussed in this thesis are inherently spatial, this definition of space also includes spaces such as the 29 global north scientists developing the planetary boundaries framework, the Oxfam institute (doughnut economic model), and the Earth Commission.

Also, other institutions discussed in this thesis within the context of epistemic injustice and epistemic justice, such as the IPCC and the United Nations. Additionally, this definition of space includes Indigenous spaces and governance at local scales, including the spaces fostering the local and Indigenous knowledge from the cases discussed in the just urban greening literature, and the deliberative democratic spaces that Nightingale (2023) mentions.

Miranda Fricker herself, also works to examine the "negative space" of epistemic injustice in order to understand epistemic justice (Fricker, 2007, p. vii). This already indicates that there is an intertwinement of both space and knowledge production. Knowledge is produced in space(s) whilst simultaneously, space(s) are produced with knowledge. Therefore, the production of knowledge, space, and power, are intertwined together.

How is the intertwinement of space, knowledge, and power production shown in these spaces? This intertwinement is shown through spatialisation. Spatialisation is defined as "the process of causing something to occupy space or assume some of the properties of space" (HarperCollins, n.d.).

An example of spatialisation is provided by Foucault in *Birth of the Clinic* (2002), Foucault examined the medical discourse where doctors would ask their patients, "What is the matter with you?", with its replacement question of "Where does it hurt?" (Foucault, 2002, p. xviii).

Thus, knowledge (in this example scientific medical knowledge) is produced by the space of the patient telling the doctor "where" it hurts. Spatialisation is therefore, important for understanding how space is defined and how the production of knowledge, space, and power are intertwined.

The medical doctor has power because of their identity as a medical doctor, intertwined with their medical knowledge. In the space of the hospital, the medical doctor has power over the patient. By the medical doctor asking the patient "where" it hurts means that they are drawing from their medical knowledge in asking for a specific space from the patient. When this space is identified, knowledge of the space is produced and the medical doctor has power over the patient with the medical knowledge produced by the space.

For helping to understand who has decision-making power within different space(s), Foucault also defined hierarchal power within space. Foucault writes about how designated hierarchal positions have more power over other positions designated as "less" in the hierarchy regardless of the knowledge standpoint within these positions (Flynn, 2016). For instance, while a nurse may have a better reading of the symptoms, it is the Medical Doctor alone who is legally empowered to make the diagnosis and prescribe the medication (Flynn, 2016).

It is important to understand hierarchy within the context of space and spatialisation due to the fact that different power positions in the hierarchy can be identified, which is important for identifying how different hierarchies in institutions have formed to both exclude and include Indigenous knowledge through both social and identity power, making up epistemic injustice.

Steffen et al., describe the biosphere integrity planetary boundary as having a "hierarchy" over the boundaries due to the fact that the boundary has major influence and impact within the Earth system (2015). The identity power of this hierarchical planetary boundary has spurred research and governance, such as with the Earth Commission and the proposed biosphere functional integrity boundary.

Thus, this is why Foucault examines the "right" to decision-making power based upon what is considered knowledge truth in a hierarchy (Flynn, 2016; Crampton & Elden, 2007). This is why dominant scientific knowledge sets are labelled as "dominant": because they have selected for use through both social and identity power.

Understanding this aspect of space and spatialisation is important for understanding power dynamics within different scales and the decision-making power of governance. Thus, spatialisation can be used to understand the intertwinement of knowledge, space, and power production with the proposed biosphere functional integrity boundary.

With the biosphere functional integrity boundary, the proposed metric (20-25% of every square kilometre of managed lands to be reserved for nature) is inherently spatial. The metric was identified by researchers at the Earth Commission with their scientific knowledge, within the space that is the Earth Commission with its working groups. Power is produced with the scientific knowledge identifying the proposed metric.

While the Earth Commission states that the metric with the proposed biosphere functional integrity can be modified depending on context, especially context at local scales, it is unclear which knowledge sets would produce the power to make these decisions and what power dynamics would produce different knowledge sets for the proposed metric in different spaces. In other words, who has the power to make decisions in these spaces?

When Foucault inquires about power and who has power, there are different answers that are dependent on the scale of social space (Moore, 2016a). As discussed, identifying different scales at the local and global level has been important for identifying different contexts that need to be taken into account with the proposed biosphere functional integrity boundary.

By defining space and spatialisation, these aspects of power can be better identified on different scales than they could be without defining space and spatialisation. For instance, it can be better understood which knowledge sets are simultaneously producing power and space on different scales with the proposed biosphere functional integrity boundary.

Power is distinguished by different scales and levels of analysis, which helps with avoiding conflating structures of power together into one whole unit (Moore, 2016b). Work at the local scale can bring about change that is more visible than larger regional or global scales.

Critical geographers Stuart Elden and Jeremy Crampton discuss how it is also on the smaller scale that power reveals itself (2007). To illustrate their claim, Elden and Crampton use the example of mapping and racial segregation, such as how eugenic scientists used their power to sterilise migrant communities that were visible in the cartography in Europe after World War I (Elden, & Crampton, 2007).

This injustice was committed on a local scale but it had consequences on a much larger scale as the maps influenced the work of eugenicists across the globe who committed mass sterilisations and other atrocities (Elden & Crampton, 2007). Thus, through space and spatialisation, it can be seen how injustices can occur within different scales.

The aspect of space and injustice has brought forth work from critical geographers to conceptualise and analyse spatial injustice and spatial justice. The next section will turn towards defining spatial injustice and spatial justice through different cases and examples in order to situate spatial justice with the proposed biosphere functional integrity boundary and epistemic justice.

## Spatial Justice

Critical Geographer Edward Soja defines both spatial injustice and spatial justice as “an intentional and focused emphasis on the spatial or geographical aspects of justice and injustice” (Soja, 2009, p. 2). Soja also states that spatial justice is not meant to replace other forms of justice (such as epistemic justice) but spatial justice is supposed to merely be another “way of looking at justice” (Soja, 2009, p. 2). Soja illustrates this by providing an example of a spatial injustice. The spatial injustice example that Soja provides is the Los Angeles Bus Riders Union civil rights case based upon arguments of spatial and locational discrimination within the mass transit.

This case consisted of the immigrant working-class population that relied upon the bus system versus the Metropolitan Transit Authority and their plans for a rail system that would work significantly more in favour of populations that were spatially located in wealthy suburban areas (Soja, 2009). The case was a civil rights court case and the arguments brought in regarding the spatial injustice of replacing the bus system with the railway added to the ongoing arguments of racial injustice which helped win the case (Soja, 2009).

As discussed with the definition of space and spatialisation, the marginalised group in the case were able to point to a specific discrimination because of the spatial location at the local scale.

The group claiming racial discrimination alone was not enough for the court to recognise the injustice.

While one could argue that the court not recognising the claim of racial discrimination from the immigrant working class population could be a case of epistemic injustice with either/or testimonial and hermeneutical injustice, the fact of the matter is that the court did recognise the claim of spatial injustice which indicates that there is future possibility for more work in the domain of epistemic justice to further its use with the use of spatial justice.

Within work furthering epistemic justice, there has been focus upon transport and mobility for marginalised groups in Chicago. Researchers have facilitated interviews with marginalised groups using public transport in Chicago, and call for more co-collaborative practices within urban planning and design for furthering epistemic justice (Lowe et al., 2023).

Thus, there is clearly room for both spatial and epistemic justice to come together within these initiatives as indeed, space and knowledge are already intertwined together. Just as the Earth Commission can recognise the intertwinement of space, knowledge, and power through spatialisation, they can also recognise that through this intertwinement, both a spatial and epistemic justice lens used together can identify power dynamics within different spaces.

An epistemic justice lens can help realise how the dynamics of social, identity, and governance power are clearly overarching the Los Angeles Bus Riders Union civil rights case discussed by Soja (2009). But with a spatial justice lens, power dynamics are able to be further identified within this space. To illustrate this, critical geography scholar Justin Williams uses the work of political scientist Clarissa Hayward discussing the relationship between states and citizens in the urban to argue that spatial justice can offer more robust insights into the theory and application of justice.

According to Williams, Hayward discusses how state policies create different identities such as race. For example, the space of the "black american ghetto" was created from both zoning and red-lining laws from which social inequalities emerged (Williams, 2013, p. 15). Williams claims that through a spatial justice analysis, the production of space can help better understand the relationship between space and politics (Williams, 2013).

It is the state then, that is able to be identified as having power with policy that defines identities making up different spaces of inequality. This is the intertwinement of space, knowledge, and power. Thus, for asking who holds the power in different spaces for the selection and application of different knowledge sets, a spatial justice lens can further show who holds this power.

Now that it has been shown how different power dynamics can be better identified in different spaces with both spatial and epistemic justice, what implications does this have for the deliberative democratic spaces that Nightingale (2023) proposed as a way forward for furthering epistemic justice under overarching power dynamics and what lessons can the Earth Commission draw from these implications with the proposed biosphere functional integrity boundary? This will be discussed in the next section.

## Furthering Spatial and Epistemic Justice

Just like with furthering epistemic justice, furthering spatial justice also has power dynamics involved. As the literature stated that epistemic injustice could not be truly resolved until there was collective political and social change that shifts power dynamics (Fricker, 2007; Cummings et al., 2023; Byskov & Hyams, 2022), urban planning scholar Peter Marcuse has stated

the same claim for spatial justice (2009). Despite this claim, Marcuse argues that a spatial justice lens is necessary for addressing injustice (Marcuse, 2009).

While Nightingale (2023) thinks that a deliberative democratic space would foster an environment for different epistemic knowledge sets to be at the forefront of decision-making processes, power dynamics are still intertwined within these spaces. Philosopher Susan Dieleman builds off of Fricker in *Epistemic Justice and Democratic Legitimacy* (2015) and argues that epistemic justice can be furthered within deliberative democratic spaces that are inclusive of different knowledge sets.

According to Dieleman, deliberative democracy is a legitimate government that is supposed to "embody the will of the people" (Dieleman, 2015, p. 796). Dieleman states that the government is only legitimate in deliberative democratic spaces if the deliberations are both fair and equal, and the decision-making processes are collective (Dieleman, 2015).

While Dieleman states that in theory, many feminist theorists would welcome an approach with deliberative democracy, there are still some feminist political theorists who claim that "deliberation" within these spaces is actually just more exclusion (Dieleman, 2015). This is seen with the overarching power dynamics within the decision-making governance of these spaces. Meaning that, who gets to decide what the deliberation is and what is deliberated (Dieleman, 2015)?

Thus, Dieleman claims that building on Fricker's work with epistemic injustice can help further identify the power dynamics within different spaces, such as with both social and identity power making up testimonial and hermeneutical injustice (Dieleman, 2015). Dieleman states that a way forward is to build deliberative democratic spaces with the awareness of these power dynamics and working to advance epistemic justice within the dynamics of power (Dieleman, 2015).

Urban planning scholar Susan Fainstein also discusses deliberative democratic spaces but focuses upon the spatial aspect itself with spatial justice. Fainstein also draws from political philosophy in writing about overarching power dynamics in different democratic spaces within the context of urban planning (Fainstein, 2009). Fainstein also addresses governance and scale by stating that justice itself, being a "demand" for policymakers also impacts different scales including local scales (Fainstein, 2009).

Fainstein seeks to address who will be included and excluded at these scales with policy and other decision-making impacting urban planning by claiming that with different urban planning projects, there should be consultation outside of the direct local scale such as with inhabitants that live outside of the area directly impacted by the project(s) (Fainstein, 2009).

Fainstein claims that there will always be exclusion, such as voluntary exclusion from people who do not wish to participate in deliberative democratic spaces such as with urban planning, and furthermore, there will always be disagreements with decision-making (Fainstein, 2009).

By using a spatial justice lens, Fainstein claims that what is important is that people are not excluded from deliberative democratic and other spaces based upon discrimination from their identity while simultaneously, people should not be forced to participate in these spaces for furthering a "cause" such as social justice (Fainstein, 2009).

More recent work in spatial justice has also stated the need for frameworks within urban planning and design that have a spatial justice lens and application with co-creative and collaborative processes with local residents (Manjeya, et al., 2023). Thus, the perspectives that both spatial and epistemic justice can provide within different spaces, including deliberative

democratic spaces, is valuable for furthering work seeking to identify power dynamics in different spaces.

As also shown, both epistemic and spatial justice can complement each other better when used together than alone. Dieleman (2015) seeks to advance deliberative democratic spaces that are aware of different power dynamics with furthering epistemic justice whilst Fainstein (2009) uses a spatial justice lens to identify power dynamics on different scales and specifically pinpoints urban planning projects as an illustration.

The Earth Commission can especially draw upon these urban implications with the biosphere functional integrity boundary as the proposed metric may require development of and/or shifting around of already existing urban planning projects in different areas.

Thus, while scholars working to further epistemic justice ask which knowledge sets are being included and excluded, scholars working to further spatial justice ask how the aspect of space itself can be just, and mean to complement (work with) already existing justice practises in different spaces as stated by Soja (2009).

As both epistemic and spatial justice scholars have stated, there is still overarching power dynamics regardless of what justice gets implemented. This section will now turn to the work of Indigenous feminist scholar Elspeth Iralu to demonstrate how Indigenous people are working with spatial justice.

Iralu (2021) used a spatial justice lens to criticise the "Map Your Indigenous Community Month" initiative in which Google Maps sought to have an "inclusive" space by recruiting individuals who were "affiliated" with "Indigenous communities" (p. 1488). Iralu criticises how Google Maps centres the initiative around the "underrepresentation" of Indigenous people in digital mapping which Iralu claims is a distortion that Indigenous spaces have no presence within digital mapping (Iralu, 2021).

This aspect then portrays Indigenous spaces as unpopulated that can be filled in with the initiative (Iralu, 2021). Furthermore, Iralu claims that within the context of this initiative and within Google Maps itself, it is portrayed that Indigenous people live in rural and isolated spaces while the urban spaces are already "filled in" (Iralu, 2021).

Iralu parallels this critique of the Google Maps initiative to critique of counter-mapping. Iralu claims that it is argued how counter-mapping is selective with whose knowledge is included, and works within power dynamics that overarch Indigenous knowledge (Iralu, 2021). In other words, counter-mapping favours what this thesis has described as "dominant" knowledge sets (in this case dominant cartographic knowledge sets) and excludes other non-dominant knowledge sets such as Indigenous knowledge with mapping.

Thus, while this initiative from Google Maps is seemingly trying to incorporate epistemic justice through the inclusion of Indigenous knowledge that was previously excluded, the overarching power dynamics in the initiative means that there is still exclusion of Indigenous knowledge. Iralu recognises this as a spatial injustice and discusses two main mapping concepts developed by Indigenous feminist scholars as initiatives seeking to further spatial justice: unmapping and remapping.

Iralu demonstrates both unmapping and remapping through examples of symbols that represented Zuni land and landscapes embedded in Zuni art and jewellery that could only be interpreted by Zuni Indigenous people (Iralu, 2021). Thus, according to Iralu, unmapping is a rejection of the dominant mapping methods, which means unmapping is a rejection of the land mapped over Zuni land (Iralu, 2021). Unmapping is instead, land mapped by the Zuni people for

Zuni land, and remapping is selecting these Indigenous and other Indigenous spatial methods over dominant mapping methods (Iralu, 2021).

Overall, both unmapping and remapping is an outright rejection of the dominant mapping methods in order to assert Zuni sovereignty (Iralu, 2021). In regards to power dynamics, Iralu states that initiatives such as the "Map Your Indigenous Community Month" from Google Maps try to provide mapping "for" Indigenous people whilst feminist Indigenous use of spatial justice focus upon which power dynamics are exclusionary and thereby, spatially unjust (Iralu, 2021).

Thus, this work by Iralu clearly demonstrates how both epistemic and spatial justice can be furthered within different power dynamics that also has the potential to "overcome" the barrier of power dynamics that has been presented by scholars as the problem in the first place through collective political and social change. (Marcuse, 2009; Fricker, 2007; Cummings et al., 2023; Byskov & Hyams, 2022).

There are lessons that the Earth Commission can draw from this scholarship from Iralu and other Indigenous feminist scholars when working to incorporate epistemic justice with the proposed biosphere functional integrity boundary in addressing the sixth mass extinction event. If the Earth Commission is seeking to further epistemic justice specifically for people that have and continue to experience epistemic injustice, such as Indigenous people, then perhaps more than deliberative democratic spaces are required.

While democratic deliberative spaces have the potential for identifying different power dynamics with both an epistemic and spatial justice lens, perhaps it is the already existing power and governance of Indigenous people that should be at the forefront of decision-making at the local scale with addressing the sixth mass extinction event.

In addition to the scholars working with spatial and epistemic justice declaring the need for social and political change, the Earth Commission has also stated that power dynamics need to be challenged in order for epistemic and other justice to be fully realised (Gupta et al., 2023). Thus, this scholarship from Iralu rooted in spatial justice demonstrates the direct challenge to power dynamics through the realisation of epistemic justice by Indigenous knowledge directly challenging dominant knowledge sets.

Furthermore, the proposed metric (20-25% of every square kilometre of managed lands to be reserved for nature) from the biosphere functional integrity boundary will likely be mapped and/or there will be mapping of already existing areas in order to help identify different biodiversity quantity, quality, and other contextual factors. The next section will discuss this aspect of mapping further with technology and spatial and epistemic justice.

## Furthering Spatial and Epistemic Justice: Technology

While the spatial justice scholarship discussed in this thesis can be helpful for the Earth Commission seeking to incorporate epistemic justice with the proposed biosphere functional integrity boundary, the implications for technology within this thesis discussion of spatial justice should not be ignored.

Thrift (2016) also discusses how there was much room for Foucault to expand upon the technological aspects of space. For one, technology is apparent throughout the discussed cases such as through the infrastructure of the biodiversity management and other spaces discussed which included spatial and epistemic injustice.

While to discuss and expand upon the aspects of both technology and space is beyond the

scope and focus of this thesis, this section will succinctly discuss some of the key implications that can be drawn from mapping technology and spatial justice in relation to the proposed biosphere functional integrity boundary and epistemic justice.

There is current research being conducted under a spatial justice lens within the digital space of urban planning and urban geography such as with data justice (Rivera, 2023) and within data collected from smart cities and GIS mapping (Tedeschi, 2024). Miriam Tedeschi (faculty of law and research fellow at the Department of Geography and Geology at the University of Turku) states that geographers have shifted focus from distribution to the role of oppression and domination within societies within spatial settings (Tedeschi, 2024).

This means that scholars are asking questions such as what data is being collected that makes up digital spaces and who has access to what data within these digital spaces? In other scholarship, Iralu also discusses State surveillance and collecting spatial data of Indigenous lands through ariel mapping technologies, such as GIS mapping technologies (Iralu, 2022).

Iralu argues how this power over Indigenous-managed lands from the state means that the state can practice policing and surveillance over Indigenous people (Iralu, 2022). If the state also categorises the surveillance data then the state can also determine who has access to the data (Iralu, 2022).

Thus, where this aspect of GIS technology could concern spatial justice is surveillance and captured data both within physical and digital spaces, with the governance of who has access to the data and who is making decisions for what scales.

Within the context of the proposed biosphere functional integrity boundary, what then does this mean for the data that will potentially be mapped and stored within digital spaces? Perhaps the Earth Commission can refer to the spatial justice scholarship with unmapping and remapping from Iralu (2021), to begin processing these questions and implications with mapping and the proposed biosphere functional integrity boundary.

This thesis will now move to the final concluding chapter to discuss other has moved to implications and recommendations for future work with both spatial and epistemic justice in relation to the proposed biosphere functional integrity boundary.

# 7. Conclusion

This thesis identified overarching power dynamics presenting a barrier for the Earth Commission seeking to address the sixth mass extinction event with the proposed biosphere functional integrity boundary with governance at both local and global scales.

This thesis asked, if epistemic justice is needed with the development and implementation of the proposed biosphere functional integrity boundary to address the sixth mass extinction event, then how can the overarching power dynamics within the selection and application of different knowledge sets be identified within different spaces?

This thesis has argued and shown that spatial justice can be used together with epistemic justice in order for the proposed biosphere functional integrity boundary to address the power dynamics within different spaces by identifying the intertwinement of knowledge, space, and power production, with spatial governance and scale.

This thesis reviewed the literature on epistemic justice and the development of the proposed biosphere functional integrity boundary. To answer the main research question, this thesis drew from conceptualisations of space from Foucault, spatial justice from critical geographers, and the

work of feminist political and feminist Indigenous scholars on deliberative democratic spaces and furthering both spatial and epistemic justice.

There are several limitations with this thesis, particularly revolving around the limited theoretical scope. While this thesis covered a variety of literature, it could have been explored in further depth. Future research can take a particular concept such as biodiversity, justice, or scale itself, and explore that concept more in depth with addressing a problem such as the sixth mass extinction event.

With the theoretical aspect, another main limitation is that this thesis is examining proposed boundaries and frameworks. While these proposed boundary frameworks have spurred much research, discussion, and debate globally, the fact of the matter is that they have not been applied. The proposed biosphere functional integrity boundary especially, is still in the developmental stage with current research from the Earth Commission continuing to examine the boundary with its proposed metric (20-25% of every square kilometre of managed lands to be reserved for nature) and how the metric can or cannot be implemented in different urban and other areas.

Despite these limitations, the fact that spatial justice can be used together with epistemic justice in order for the proposed biosphere functional integrity boundary to address the power dynamics within different spaces still remains. Additionally, this thesis did provide a foundation for future work seeking to take a particular concept such as justice or scale, and examine the concept in depth with the literature discussed in this thesis.

The fact that both epistemic and spatial justice are being seen in practise such as with the discussed urban planning initiatives, and by Indigenous people in directly challenging power dynamics, indicates that the Earth Commission would be able to theoretically incorporate spatial justice into the just operating space of the proposed biosphere functional integrity boundary and future research could further work into applying the boundary as a whole in practise.

The urgency with addressing the sixth mass extinction event is stressed time again with environmental researchers, including the researchers at the Earth Commission. However, the urgency to act is simultaneously recognised with the need to not worsen an already dire situation.

As scholars have discussed, it already is marginalised people, including Indigenous people, experiencing the worst effects and impacts of the sixth mass extinction event. Researchers and research groups such as the Earth Commission should be commended for their efforts to address the epistemic injustice experienced by Indigenous people by working to further epistemic justice through the inclusion of Indigenous knowledge within initiatives that address the sixth mass extinction event, including the proposed biosphere functional integrity boundary.

However, work to merely “include” Indigenous knowledge in of and itself is not enough to further epistemic justice. It is vital that the Earth Commission keeps the goal of challenging power dynamics in mind should they incorporate spatial with epistemic justice in the just operating space of the proposed biosphere functional integrity boundary.

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# Appendix

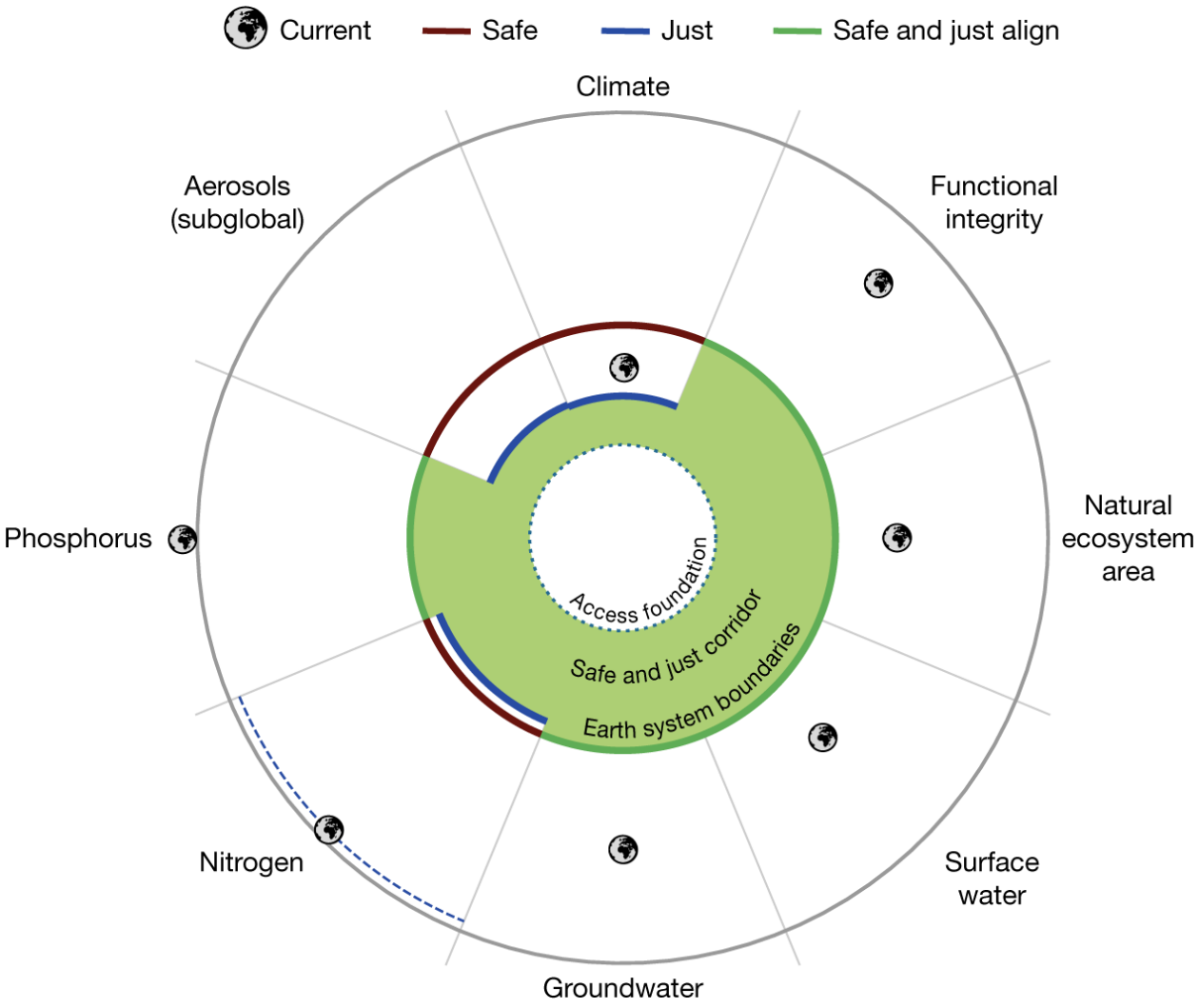


*Figure 1: Visualization of Earth System Boundaries model. Visualization of safe ESBs (dark red), just (NSH) ESBs (blue), cases where safe and just (NSH) boundaries align (green) and current global states (Earth icons). The biosphere functional integrity boundary (top right corner) is shown to be crossed outside of the safe and just operating space (corridor). (Image from: Rockström et al., 2023, p. 3).*

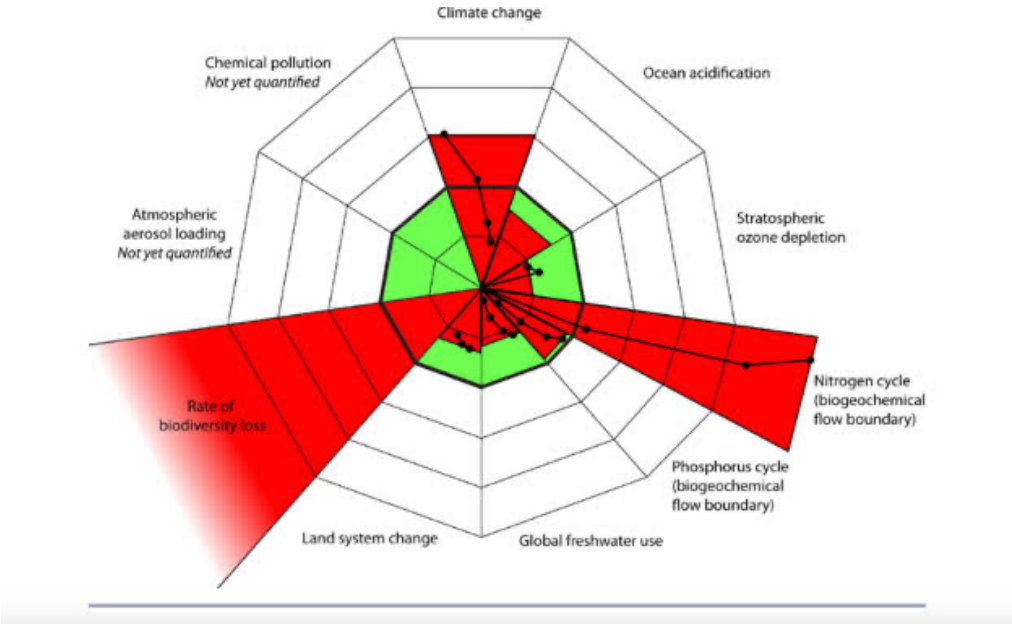


*Figure 2: Visualisation of the planetary boundaries. The safe operating space (green) with tipping points for the quantified dimensions (black dots) and quantified dimensions that have already been crossed (red). (Image from: Rockström et al., 2009).*

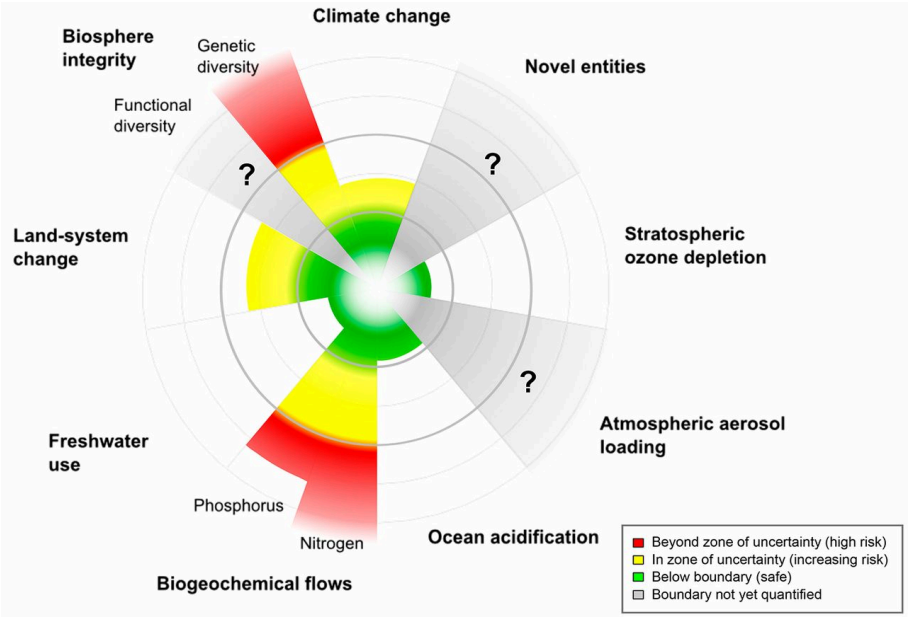


*Figure 3: Visualization of the revised Planetary Boundaries. The revision includes the zone of uncertainty (yellow) beyond the safe operating space (green) for which the crossed boundaries are beyond the zone of uncertainty (red). (Image from: Steffen et al., 2015, p. 736).*

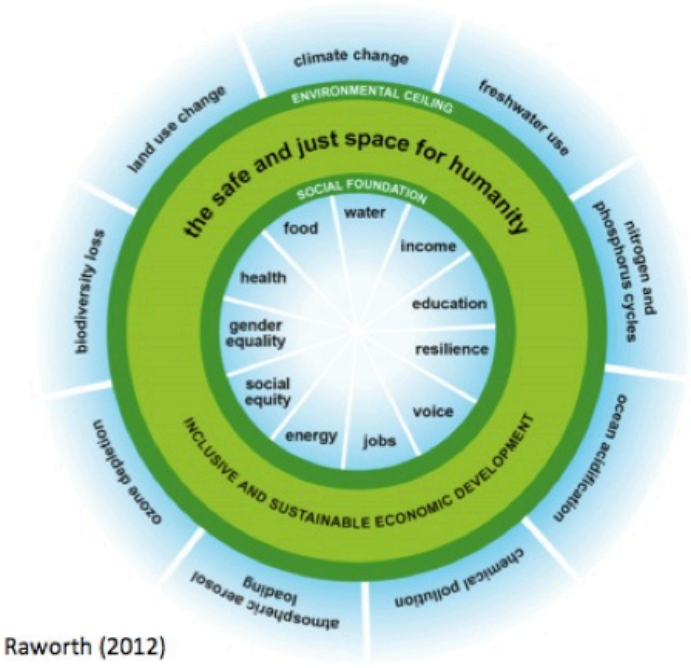


*Figure* 4*: Visualization of Doughnut Economic model. The safe and just space (light green) is between the social foundation and the environmental ceiling (dark green). The dimensions (blue) are based upon the Rio+20 goals comprised of eleven boundaries in the social foundation and the planetary boundaries in the environmental ceiling (Image from: Raworth, 2012, p. 15).*

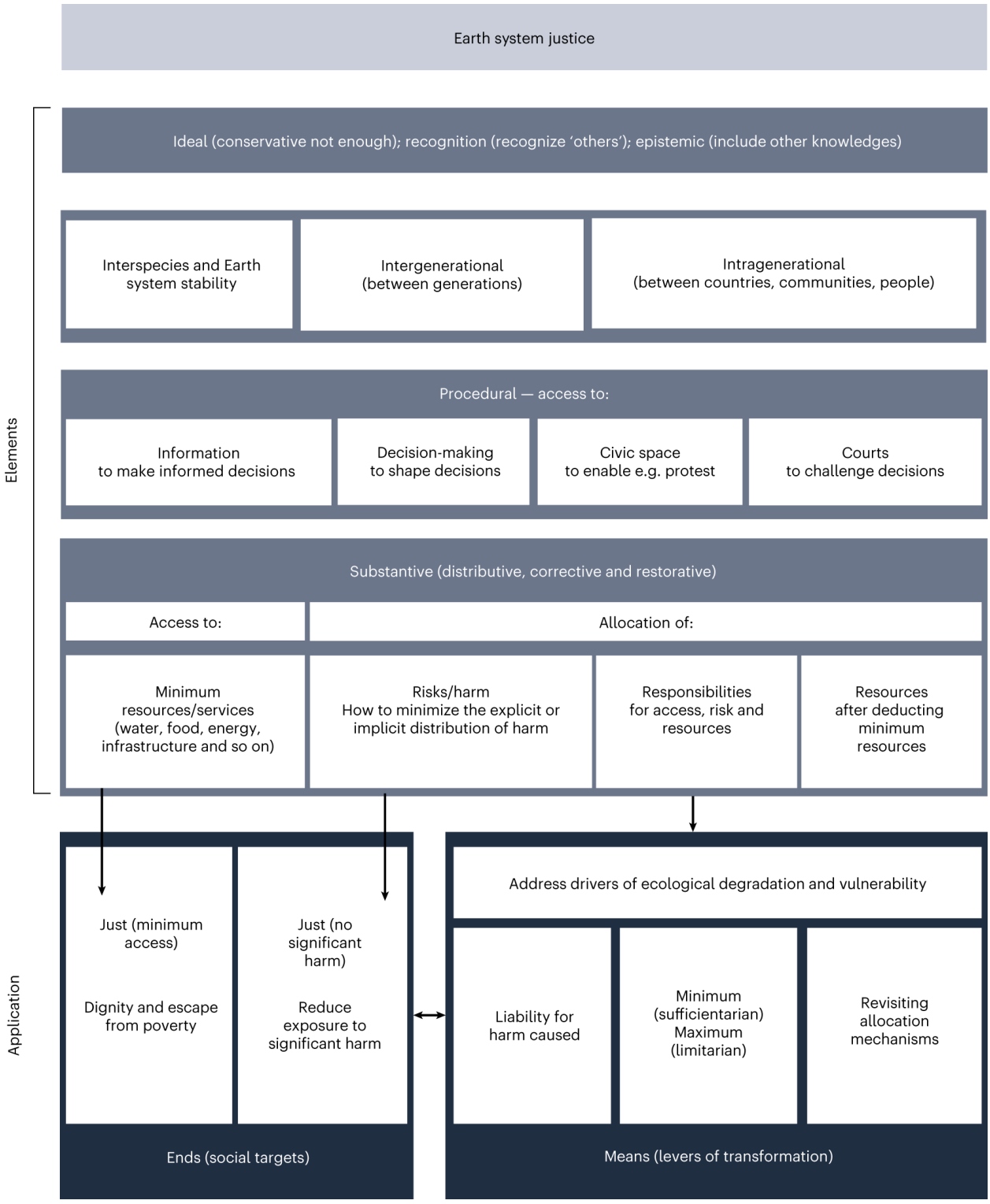


*Figure 5: Visualisation of Earth System Justice conceptualisation. The elements (ideal, recognition, epistemic, procedural, and substantive) operationalised as targets with just means (levers of transformation), in order to address the drivers of ecological degradation and vulnerability (Image from Gupta et al., 2023).*

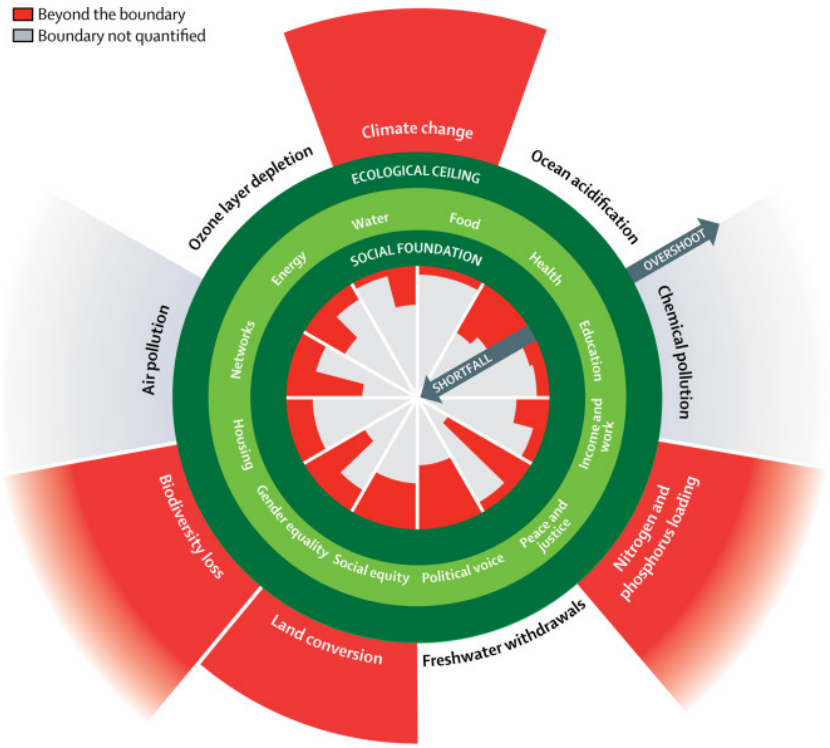


*Figure 6: Doughnut economic framework with quantified dimensions in the safe and just space (light green). Within the social foundation there are quantified shortfalls and quantified overshoots in the dimensions from the planetary boundaries in the ecological ceiling (red). The shortfalls (dark grey arrow) is where humanity falls short of living within the just operating space of the social foundation. The overshoots (dark grey arrow) is where human activity is crossing Holocene-defined levels from the planetary boundaries. (Image from: Raworth, 2017).*