

RESEARCH ARTICLE

Sufficiency as relations of enoughness

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Abstract

An expanding body of literature discusses the importance of sufficiency for sustainable development. However, conceptual vagueness stands in the way of the practical application of sufficiency as a sustainability strategy. The main contribution of this paper is the introduction of the concept of *relations of enoughness*, building on the general notion of ‘enough’, which is prevalent in sufficiency literature. Relations of enoughness will be explained based on the widespread use of sufficiency advocating for changes and reductions of individual consumption with the goal to reduce environmental impacts such as carbon dioxide emissions. Diverse uses and understandings of sufficiency can be united in a shared structure of ‘enough/too much/too little of X regarding Y’. Relations of enoughness can be connected to sustainability by expanding them into *chains of enoughness*, which serve as a conceptual foundation for the sustainable consumption corridor approach. Finally, the premises of sufficiency and potential for further research are discussed.

KEYWORDS

ecological limits, enough, human needs, relation, sufficiency, sustainability strategy, sustainable consumption

1 | INTRODUCTION

Sustainable development has been an ongoing international mission for more than 30 years. Starting with the Brundtland Report (WCED, 1987) and the Earth Summit in Rio de Janeiro in 1992, social and environmental challenges of modern times such as poverty, health, education, climate change and biodiversity loss have been combined into a joint perspective, both in science and practice. In 2015, this joint perspective inspired the formulation of the ambitious Sustainable Development Goals (SDGs) of the United Nations (UNGA, 2015), providing a promising international framework for tackling pressing sustainability challenges. However, 9 years later, the interim conclusion is devastating. A recent SDG report (DESA, 2023) states that

It is time to sound the alarm. [...] An assessment of the around 140 targets for which trend data is available

shows that about half of these targets are moderately or severely off track; and over 30 per cent have either seen no movement or regressed below the 2015 baseline. (DESA, 2023, p. 4)

The Agenda 2030 as the current framework of sustainable development is threatening to fail. Critiques argue that the hegemonic paradigm of green growth is responsible for insufficient achievements in sustainable development (Hickel & Kallis, 2020). Green growth pursues to reduce environmental impacts such as greenhouse gas emissions while continuing economic growth, therefore maintaining and even expanding production and individual consumption. This shall be reached by absolutely decoupling economic activities from environmental impacts through the use of innovation, technology and eco-efficiency. However, empirical evidence suggests that it is unlikely that absolute decoupling will happen strong and fast enough to tackle recent sustainability crises adequately (ibid.; Vadén et al., 2020;

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Haberl et al., 2020). As a result, alternative perspectives on sustainable development are strengthened, stressing the necessity to limit economic growth and individual consumption in the global north (Schmelzer & Vetter, 2021).

In this context, sufficiency as a sustainability strategy beyond efficiency and consistency receives increasing attention as a promising contender for tackling sustainability crises more adequately (Jungell-Michelsson & Heikkurinen, 2022). While there is an expanding body of scientific literature focusing on sufficiency, there is a variety of different uses of the term with strongly diverging content (ibid.; Spengler, 2016; Lage, 2022), which is due to a lack of conceptual work on its nature. Spengler (2016) states that sufficiency as a concept of sustainability sciences is rather undertheorized. The vagueness and lack of conceptual unity are summarized well in a recent systematic literature review:

[Sufficiency] is conceptualized as an idea, programme, doctrine, vision, worldview, paradigm, way of living, and strategy—among others. (Jungell-Michelsson & Heikkurinen, 2022, p. 3)

This statement demonstrates that the uses of sufficiency differ drastically. The authors identify a widespread, general notion of ‘enough’ in sufficiency literature and further analyse shared premises: (1) the complementarity of natural and manufactured capital, (2) the necessity to slow down the social metabolism, and (3) the existence of altruistic elements (Jungell-Michelsson & Heikkurinen, 2022). While this summary is an important contribution, it still doesn't provide a concise concept of sufficiency. Especially the shared notion of ‘enough’ identified by the authors is not further investigated. Since sufficiency aspires to accelerate the lack of progress in sustainable development, the present conceptual vagueness is not acceptable. Adequate practical application on pressing sustainability challenges is hardly possible without conceptual clarity (Schepelmann, 2023). How should sufficiency be effectively implemented if its meaning remains unclear?

The conceptual vagueness of sufficiency and the underlying notion of ‘enough’ motivates the research questions of this paper: How can the general notion of ‘enough’ prevalent in sufficiency literature be adequately conceptualized? How can different uses of sufficiency be systematically structured and united? To answer these questions, the paper starts with a short overview of the relevant sufficiency literature (Section 2). Recent literature reviews and insightful conceptual work will be used to distinguish four understandings of sufficiency. Based on this recapitulation of the debate, the concept of *relations of enoughness* will be introduced, which is the main contribution of this paper (Section 3). Relations of enoughness reconceptualize the general yet vague notion of ‘enough’ prevalent in sufficiency literature, building on the work of Princen (2005) and Spengler (2016). As an example, sufficiency understood as the reduction and change of individual consumption with the goal to reduce carbon dioxide emissions is reconceptualized as a relation of enoughness (Section 3.1). A central thesis of this paper is that the variety of different uses of sufficiency can be systematically structured and united by the concept of

relations of enoughness (Section 3.2). Furthermore, it shows how sufficiency is connected to sustainability, expanding single relations into *chains of enoughness* (Section 3.3), building a conceptual foundation for the sustainable consumption corridor approach (Di Giulio & Fuchs, 2014). Finally, the paper concludes with a discussion of contributions, premises of sufficiency, limitations, and possibilities for further research.

2 | SUFFICIENCY IN CURRENT LITERATURE

Recently, there have been several literature reviews (Jungell-Michelsson & Heikkurinen, 2022; Lage, 2022; Niessen & Bocken, 2021; Sandberg, 2021; Sorrell et al., 2020) and some conceptual debates on sufficiency (e.g. Di Giulio & Fuchs, 2014; Princen, 2005; Spengler, 2016). As the important literature is already summarised well, this article will not carry out yet another systematic literature review. Instead, two conceptual questions regarding sufficiency will be discussed in depth, which will be the foundation of the following conceptual work: (1) Is sufficiency conceptually about a certain level of ‘enough’ or about mere reductions? (2) What entities are addressed in the context of sufficiency? The discussed literature was found through keyword-based search in established databases (e.g. Scopus) and selected based on its conceptual contributions regarding sufficiency. Hereby, the already-mentioned literature reviews served as a general overview and starting point.

2.1 | Is sufficiency about ‘enough’ or about reductions?

In their literature review on energy sufficiency rebounds, Sorrell et al. (2020) make an important distinction:

Some authors interpret energy sufficiency as a goal or an outcome defined by a level of energy service consumption that is consistent with equity, well-being and environmental limits, while others interpret it as a set of actions or a strategy defined by intentional reductions in energy service consumption. (Sorrell et al., 2020, p. 3)

In the first interpretation of sufficiency identified by the authors, sufficiency is understood as a matter of defining and reaching a certain level, which is often labelled as ‘enough’. As Jungell-Michelsson and Heikkurinen (2022) state, this idea of sufficiency as ‘enough’ is widespread. An early use of sufficiency in this sense is found in the work of Daly (1992) on steady-state economics. The idea of ‘enough’ is also prevalent in Lamberton's (2005) work on sustainable sufficiency as an internally consistent version of sustainability, as he emphasizes the necessity to limit levels of consumption, economic growth and use of natural resources. In his seminal work ‘The Logic of Sufficiency’,

Princen (2005) characterizes sufficiency as ‘enough’ between ‘too much’ and ‘too little’, understanding it as a universally applicable idea. However, Princen's idea of sufficiency and its application to different phenomena is not conceptually standardized. Similarly, Spengler (2016) argues there are two different scientific debates using the term sufficiency. On the one hand, there is the debate on sufficiency as a maximum, with the goal to limit environmental impacts. On the other hand, Spengler summarizes the debate in the realm of moral philosophy and justice following Frankfurt (1987), using sufficiency to describe a certain social minimum that is necessary for people to live a decent life. She advocates combining both debates into a joint perspective, understanding sufficiency as a maximum and a minimum. An application of the notion of ‘enough’ to the realm of consumption can be found in the fruitful sustainable consumption corridors approach (Di Giulio & Fuchs, 2014; Fuchs et al., 2021; Lage, 2022).

In the second interpretation by Sorrell et al. (2020), sufficiency is not about ‘enough’, but about strategies and actions to allow reduction (e.g. of environmental impacts). In her literature review, Sandberg (2021) identifies four types of consumption changes and reductions which are seen as elements of sufficiency: absolute reduction, modal shifts, product longevity and sharing practices. Sachs (1993) focuses on reduction, too, but applies it to different dimensions, namely consumption, commercialization, spatial interconnectedness and temporal acceleration. Paech argues, that sufficiency should be understood exclusively as the opposite of consumption, as non-consumption (Folkers & Paech, 2020). He distinguishes three kinds of sufficiency: First self-limitation, which means the refusal to increase consumption, second reducing consumption, and third the general rejection of certain kinds of consumption like air travel. Therefore, he separates sufficiency from so-called sustainable consumption (ibid.).

In conclusion, there is no consensus on whether sufficiency should be conceptualized based on the idea of ‘enough’ or narrowly as actions and strategies of reduction.

2.2 | What entities are addressed by sufficiency?

In her literature review, Sandberg (2021) focuses on sufficiency as a contribution to sustainable consumption, handling consumption as the primary entity addressed by sufficiency. In this understanding, sufficiency strongly converges with the scientific literature on sustainable consumption (Geiger et al., 2017; Liu et al., 2017; Lorek & Spangenberg, 2014) as discussed by Spangenberg and Lorek (2019) and manifested in the sustainable consumption corridors (Di Giulio & Fuchs, 2014). However, sustainable consumption is an established debate and does not exclusively focus on reductions of consumption levels but includes all kinds of consumption with intent and/or impact on sustainability (Geiger et al., 2017). In sufficiency literature, also other entities than consumption are addressed. Paech's understanding of sufficiency is strongly focused on absolute reductions of consumption, but he investigates the consequences in other dimensions like work, time and mental health. He argues that increased consumption necessitates increased employment and may cause mental health

problems. In this context, Paech also tries to develop an economic theory of time use and consumption (Folkers & Paech, 2020; Paech, 2010, 2012). Sachs (1993) takes consumption as one dimension of sufficiency but also considers commercialization, spatial interconnectedness and temporal acceleration. Sufficiency is also seen as a matter of production (e.g. Jungell-Michelsson & Heikkurinen, 2022; Lage, 2022). Here, it is discussed how companies can and should contribute to sufficiency, not only by supporting changes in consumption but also by addressing production directly (e.g. Niessen & Bocken, 2021; Schneidewind, 2012). Similarly, Daly (1992) used the term sufficiency in his steady-state economics in the context of the size of stocks and the population in addition to consumption. Princen (2005) transfers the general idea of the sufficiency as ‘enough’ to many different entities such as complex systems like ecosystems, individual and social organization and management, harvest of natural resources, production, labour and consumption. By doing so, he broadens the meaning of sufficiency substantially.

As this short discussion shows, there is a strong focus on consumption in parts of the sufficiency literature. However, many authors address other entities using the term sufficiency, too.

2.3 | Four understandings of sufficiency

As demonstrated, there is a variety of different uses of sufficiency without a consensus on its meaning. Based on the two guiding questions discussed above, one can identify a narrow and a broad position regarding how each question is answered. Regarding the first question, the narrow position states that sufficiency is a matter of reduction, while the broad position states that sufficiency is based on the idea of ‘enough’. Regarding the second question, the narrow position is that sufficiency is merely a matter of consumption, while the broad position argues that sufficiency as a general idea can be applied to diverse entities. The resulting two-dimensional matrix (Figure 1) contains a narrow understanding of sufficiency as reductions and changes in individual consumption with the goal of reducing environmental impacts, as well as a broad understanding of sufficiency as the general idea of ‘enough’ that can be applied to diverse entities. Additionally, there are two mixed understandings, combining one narrow and one broad position. Generally speaking, the narrow understanding defines sufficiency in a quite exclusive way, rejecting many phenomena that are discussed using the term sufficiency. The broad understanding on the other hand includes the other understandings: If sufficiency can be applied to diverse entities, it can also be applied to consumption (e.g. Princen, 2005); Additionally, the focus on reductions (e.g. Sachs, 1993) can be seen as a consequence of humankind having left the area of ‘enough’ which necessitates actions and strategies for reductions of consumption and environmental pressures. Exemplarily, the articulation of the necessity to change and reduce individual consumption follows from the insight that current levels of consumption, at least in the global north, threaten the global carrying capacities (e.g. Sandberg, 2021; Spangenberg & Lorek, 2019). The provided overview (Figure 1) is the first contribution of this paper

		1) Is Sufficiency about Reductions or about 'Enough'?	
		Sufficiency as Reductions (Narrow Position)	Sufficiency as 'Enough' (Broad Position)
2) What Entities are Addressed by Sufficiency?	Primarily Consumption (Narrow Position)	Narrow Understanding: Sufficiency as Consumption Change with Ecological Intent (e.g. Sandberg 2021)	Mixed Understanding: Sufficiency as Sustainable Consumption Corridors (e.g. Di Giulio, Fuchs 2014)
	Many Different Entities (Broad Position)	Mixed Understanding: Sufficiency as Reductions in Several Different Dimensions (e.g. Sachs 1993)	Broad Understanding: Sufficiency as a General Idea of 'Enough' (e.g. Princen 2005)

FIGURE 1 Four understandings of sufficiency.

as it systematically structures different uses of sufficiency. The following conceptual work builds on the broad understanding, which includes the other understandings. Through the concept of relations of enoughness, it will be possible to unite diverse uses of sufficiency in a shared, general structure.

3 | RELATIONS OF ENOUGHNESS

3.1 | Sufficiency as relations of enoughness

The main cornerstone of this paper is that all uses and understandings of sufficiency conceptually are founded on a shared notion of 'enough' which is prevalent in sufficiency literature (Jungell-Michelsson & Heikkurinen, 2022). This notion of 'enough' is manifested in the broad understanding of sufficiency (Section 2), and is the foundation of the work of Princen (2005) and Spengler (2016). The goal of this section is to explicate this notion of 'enough' in a standardized way through the concept of relations of enoughness.

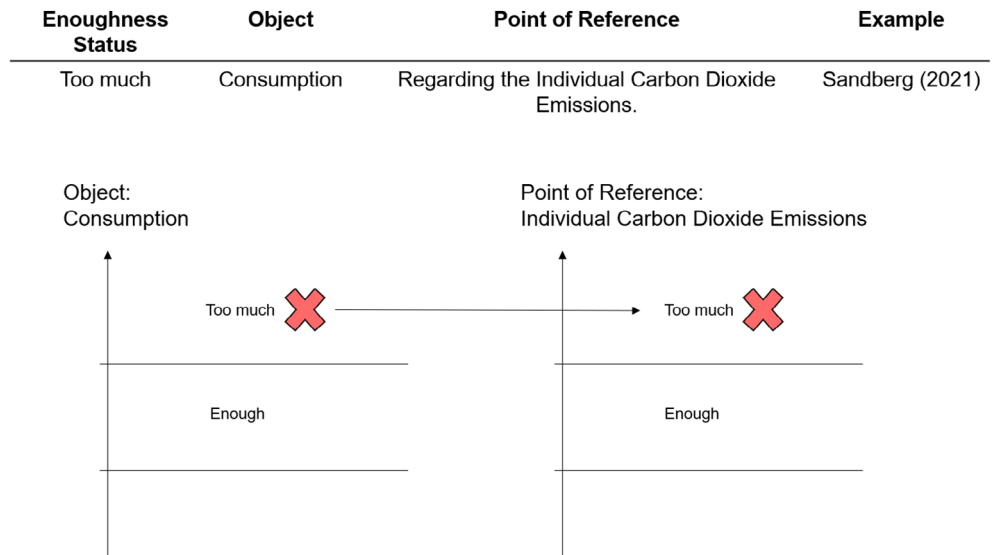
Spengler argues that the notion of 'enough' leads to two questions: 'Enough of what?' and 'enough for what?' (Spengler, 2016, p. 921). Therefore, 'enough' implies two entities that are connected in a specific way. Going beyond Spengler's argument, this connection, namely a relation of enoughness, can be expressed generally in the form 'enough of X regarding Y'. The first entity (X) is referred to as the object of the relation, and the second entity (Y) is the point of reference, as it represents the benchmark defining how much of X is enough or not enough. Hereby, 'entity' is a collective term for both objects and points of reference, including all diverse things that can be tossed into relations of enoughness. Speaking with Spengler (2016), the object is the answer to the question 'enough of what' while the point of reference is the answer to the question 'enough for what'.

Let us investigate climate change and the necessity to modify individual consumption as a concrete example. It is well-established that the emissions of greenhouse gases such as carbon dioxide must be drastically reduced to tackle climate change. The importance of climate change is emphasized in many different SDGs of the 2030 Agenda for Sustainable Development, most prominently in SDG 13 'climate action' (UNGA, 2015). On average, global yearly per capita lifestyle carbon footprint targets of 2.5 tCO₂e (tons of carbon dioxide equivalent) by 2030 and 0.7 tCO₂e by 2050 must be reached to

adequately face and limit climate change (IGES et al., 2019). Estimations for countries in the global north report average yearly per capita lifestyle carbon footprints of 17.6 tCO₂e in the USA (UNEP, 2021), 7.9 tCO₂e in the European Union and the United Kingdom together (UNEP, 2021), and 11.2 tCO₂e in Germany (Paar & Tsoutsouloupoulos, 2022). Thus, average lifestyle carbon footprints in the global north are way above the target of 2.5 tCO₂e by 2030. On the other hand, the average per capita carbon footprint in India is only 1.7 tCO₂e (UNEP, 2021). Countries in the global south often have low footprints, but would benefit from further economic development while being strongly exposed and vulnerable to the consequences of climate change (UNDP, 2019). Beyond averages, carbon footprints, consumption opportunities and the satisfaction of human needs are distributed unequally within countries (UNDP, 2019; UNEP, 2021). While '[t]he top 10 percent of emitters live on all continents' (UNDP, 2019, p. 179) today, even in wealthy countries such as Germany some persons still struggle with poverty (DESTATIS, 2023; Geißler, 2014).

In the exemplary case of Germany (11.2 tCO₂e), average per capita carbon footprints are way above the global targets (2.5 tCO₂e by 2030). Therefore, a way must be found to reduce the carbon footprints of an imagined average German person drastically and fast. Limiting carbon dioxide is a particular challenge as our modern ways of life and modes of production are based on fossil fuels. Daily activities such as driving to work, flying to a holiday location, or heating the flat with a gas boiler all produce greenhouse gas emissions. These actions are part of the way of life of many persons in Germany and are shaped by the mode of production, existing infrastructure and consumer culture. One way to reduce greenhouse gas emissions connected to individual consumption would be to increase eco-efficiency. This is the primary approach of the green growth paradigm, stating that environmental impacts such as greenhouse gas emissions can be decoupled from economic activities through innovation and technology. However, recent studies suggest that the absolute decoupling of greenhouse gas emissions from economic growth is unlikely to happen strong and fast enough (Haberl et al., 2020; Hickel & Kallis, 2020; Vadén et al., 2020). As increases in eco-efficiency are probably not sufficient to adequately reduce carbon footprints, reductions in the level of individual consumption seem necessary. Sufficiency as a sustainability strategy is often conceptualized in such a way, as reductions and changes in individual consumption with the goal to reduce environmental impacts (Sandberg, 2021). Exemplarily,

FIGURE 2 The first, undesirable occurrence of the relation of enoughness between consumption (object) and the individual carbon dioxide emissions (point of reference).



Sandberg discusses the reduction of air travel as an example of sufficiency in that sense (*ibid.*).

One can reconceptualize changes and reductions of consumption (such as reductions of air travel) to reduce carbon dioxide emissions as a relation of enoughness. Right now, for many people in Germany, there is too much consumption regarding carbon dioxide emissions in the form of an individual carbon budget. Consumption here serves as the object, the ‘enough of what’. The carbon dioxide emissions on the other side serve as the point of reference, the ‘enough for what’, the frame that defines how much consumption is acceptable and how much consumption is too much. If and only if the consumption of a person produces equal or less carbon dioxide emissions than the carbon footprint target (2.5 tons tCO₂e by 2030; IGES et al., 2019), one can speak of ‘enough’ consumption. If and only if the consumption of a person produces more carbon dioxide emissions than her individual carbon budget, one can speak of ‘too much’ consumption. Existing literature already discusses diverse kinds of reductions in different areas of consumption such as housing, nutrition and mobility that may be possible and effective to again reach ‘enough’ consumption depending on specific contexts (Sandberg, 2021). Note that the logical statements above only concern carbon dioxide emissions as a point of reference. Further implications of consumption on human needs are discussed later on (Sections 3.2 and 3.3).

This connection between consumption as the object and carbon dioxide emissions as the point of reference constitutes a relation of enoughness. The relation of enoughness between consumption (object) and individual carbon dioxide emissions (point of reference) has two different occurrences, as there are two relevant combinations of the object and the point of reference. In the first occurrence (Figure 2), too much consumption causes too many carbon dioxide emissions, which is undesirable. This is the case for many well-established consumption patterns leading to average carbon footprints of 11.2 tCO₂e in Germany today. However, by changing and reducing the consumption of the individual, exemplarily by reducing or even rejecting air travel (following Sandberg, 2021), carbon dioxide

emissions might be reduced and another, more desirable occurrence of this relation of enoughness be reached, in which enough (but not too much) consumption leads to enough (but not too many) carbon dioxide emissions (Figure 3). Therefore, we can understand sufficiency literature investigating measures and actions to change and reduce individual consumption with ecological intent as contributions to leave the first, undesirable occurrence of the examined relation of enoughness and to reach the second, desirable occurrence.

In summary, the use of sufficiency following Sandberg (2021) can be reconceptualized as a relation of enoughness between individual consumption (object) and the related individual carbon dioxide emissions (point of reference). The focus on lifestyle carbon footprints in Germany was chosen for demonstration purposes. Note that this does by no means imply that greenhouse gas emissions and their reduction are the sole responsibility of the individual. Individual consumption and resulting carbon footprints are strongly shaped by the mode of production, infrastructures and consumer culture which are beyond individual choice. Not just individuals, but also companies and political decision-makers can and must contribute to change and reduce individual consumption (e.g. Lage, 2022; Niessen & Bocken, 2021; Sandberg, 2021; Schneidewind & Zahrnt, 2014). For instance, sustainable change requires reductions in economic activities, including both decreased production of companies and reduced consumption of consumers, which should be promoted by businesses (Heikkurinen et al., 2019). Additionally, note that measures to reduce and change consumption can trigger rebound effects. Therefore, the effectiveness of sufficiency as reductions and changes in consumption can be limited and its evaluation must be performed empirically (Sorrell et al., 2020).

Let us distil the new conceptual insights provided by the given example and, by doing so, generally characterize the concept of relations of enoughness. The main idea of this paper is that all different uses and understandings prevalent in sufficiency literature can be reconceptualized as relations of enoughness (Section 3.2). Each relation of enoughness connects an object, answering the question

Enoughness Status	Object	Point of Reference	Example
Enough	Consumption	Regarding the Individual Carbon Dioxide Emissions.	Sandberg (2021)

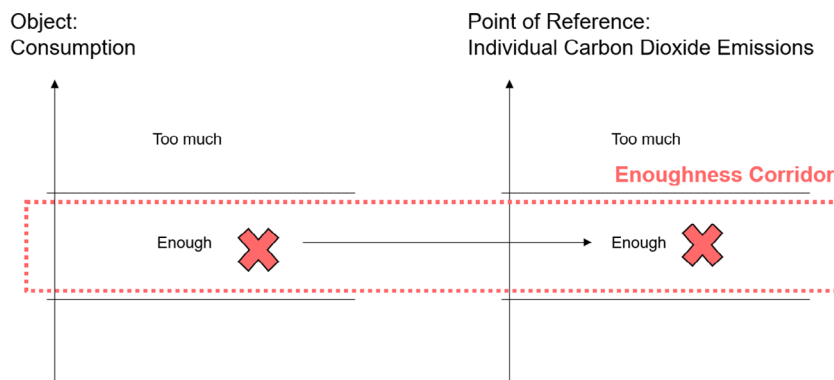


FIGURE 3 The second, desirable occurrence of the relation of enoughness between consumption (object) and the individual carbon dioxide emissions (point of reference).

Enoughness Status	Object	Point of Reference
Too much		
Enough	Of X	Regarding Y.
Too little		

FIGURE 4 The general structure of particular occurrences of relations of enoughness.

‘enough of what’, and a point of reference, answering the question ‘enough for what’, based on a defined scope. Generally, objects and points of reference are connected in a particular way. The object causally influences the point of reference: One can say that consumption causes carbon dioxide emissions, therefore too many emissions are a result of too much consumption. At the same time, the point of reference determines, how much of the object is ‘enough’: The mean person in Germany is consuming ‘too much’ with reference to the consumer’s carbon dioxide emissions. Both object and point of reference have a enoughness status, which generally can be in the states ‘enough’, ‘too much’ and ‘too little’ (inspired by Princen, 2005). However, it depends on the concrete relations examined which of these states appear. ‘Too little consumption’ might appear in other relations of enoughness (e.g. if one asks how much consumption a person needs to satisfy human needs; Section 3.2). But it is not important for the relation between consumption (object) and carbon dioxide emissions (point of reference). Each relation of enoughness has different occurrences. Usually, at least one such occurrence is undesirable, and exactly one occurrence is desirable. In the desirable occurrence, both object and point of reference are in the state ‘enough’. One can call this desirable occurrence the enoughness corridor, as it resembles a desirable corridor in which all entities are in the state ‘enough’. The different occurrences can be represented in a standardized structure (Figure 4) that is shared by all relations of enoughness. This structure will be used later on (Section 3.2) to reconceptualize diverse uses of sufficiency from the literature. Formally, one can define a

relation of enoughness as the set of all its occurrences. As long as only two entities are observed, the following logical proposition applies: The sufficiency status of the object is ‘enough’ (not ‘enough’) if and only if the sufficiency status of the point of reference is ‘enough’ (not ‘enough’). This embodies both, causality as well as determination.

Critics could argue that the states ‘enough’, ‘too little’ and ‘too much’ might be the result of subjective judgment and arbitrary attribution, being inappropriate as the foundation of scientific analysis. However, this objection can be faced as there are at least three dimensions to be considered to define the thresholds between these states: First the factual, second the analytical, and third the political dimension. The factual dimension refers to the way our world functions. Sandberg (2021) argues in such a way, explicating the impact of consumption on environmental degradation. The factual limits can usually only be determined with certainty in or after the moment of their transgression which should be prevented for good reason. Hence, the analytical dimension becomes important. Scientists are studying diverse environmental and social phenomena and trying to understand their internal mechanisms. They try to understand what limits exist and which transgressions would lead to fundamental problems. The planetary boundaries framework is a central contribution to this endeavour as it defines limits in nine dimensions that should not be crossed to ensure the functioning of the planetary system and to remain inside a safe operating space for humankind (Richardson et al., 2023; Rockström et al., 2009). Additionally, the work from philosophy and development economics on defining just institutions, human needs, human rights, and central capabilities can be seen as an attempt to define social limits from a scientific perspective (Nussbaum, 2011; Rawls, 1971; Raworth, 2018; Sen, 1988; Stewart, 2019). Systems thinking contributes to the identification of areas of ‘enough’ and central limits by understanding them as results of peculiar system dynamics (Monat & Gannon, 2015; Princen, 2005). Third, there is the political dimension, which consists of political and societal agreements on what thresholds are seen as important and shall not be crossed. The Paris Agreement on the limitation of

TABLE 1 Examples of uses of sufficiency in the literature, rephrased as occurrences of relations of enoughness.

Enoughness status	Object	Point of reference	Example
Too much	Energy (heat)	Regarding the functioning of complex adaptive systems (like the climate system).	Princen (2005); Kay and Schneider (1995)
Too much	Harvest of natural resources (wood)	Regarding the stability of local ecosystems (forest).	Princen (2005)
Too much	Consumption	Regarding limited individual time and mental health.	Paech (2010, 2012); Folkers and Paech (2020)
Too much	Consumption	Regarding the stability and desirability of the natural environment.	Sandberg (2021); Spengler (2016); Di Giulio & Fuchs (2014)
Too little	Consumption	Regarding the fulfilment of basic human needs.	Frankfurt (1987); Spengler (2016); Di Giulio & Fuchs (2014)
Too much	Production	Regarding the stability and desirability of the natural environment.	Jungell-Michelsson and Heikkurinen (2022)
Too much	Consumption, commodification, acceleration and interconnectedness	Regarding the goal to build a nature-friendly society.	Sachs (1993)
Too much	Work	Regarding the 'natural' rhythm of work and regarding the stability and desirability of the natural environment.	Princen (2005)

climate change is such an agreement, explicitly defining certain temperature limits and implying carbon budgets (UNFCCC, 2015). The Declaration of Human Rights (UNGA, 1948), the Millennium Development Goals (UN, 2015) and the Sustainable Development Goals (UNGA, 2015) by the United Nations serve as international political agreements including social aspects. In some areas, there might be no formal agreements of such kind. In these cases, there might be some kind of societal common sense, or there is still ongoing societal and political negotiation or dispute on what is considered 'enough'. While the factual and analytical dimension leans towards a limits model of sufficiency, the political dimension leans more towards individual preferences and societal processes (Lehtonen & Heikkurinen, 2022). Therefore, what is considered 'enough' strongly depends on the nature of the sustainability topic in question, the societal circumstances as well as the perspectives of involved actors.

Finally, it is insightful to consider further literature using the term relation. Recently, relations have become more important in different disciplines such as sociology and the humanities (Dépelteau, 2018). West et al. (2020) as well as Walsh et al. (2021) testify an emerging interest and untapped potential of relational thinking in sustainability science, founded in systems thinking and inspired by the relational turn in the humanities. As Monat and Gannon (2015) argue, relations between entities are an essential part of systems thinking. As will be shown (Section 3.2), systems thinking and the concept of relations of enoughness can be connected through the seminal work of Princen (2005). In philosophy (MacBride, 2020), relations are distinguished from properties: One can say that a cat is black, describing a property of the cat. One can also say that the cat is on top of the mat, describing a specific relation between the cat and the mat. In fact, relations of enoughness are relations in this philosophical sense (ibid.), which allows us to characterize relations of enoughness as binary, asymmetric and internal relations. Relations of enoughness in this article are

treated as binary relations, connecting always two entities. Note that relations of enoughness might be applied to more than two entities (e.g. in a case where two objects both causally influence one point of reference). However, this is not covered in this paper. In general, all relations of enoughness are asymmetric and have a direction, meaning that object and point of reference cannot switch places. This is due to the already introduced, directional properties of causality and determination (see above). Additionally, relations of enoughness are internal relations as they necessarily exist due to the (combined) nature of their entities.

3.2 | Application to further sufficiency literature

The general thesis of this paper is that diverse uses of sufficiency can be reconceptualized by relations of enoughness, as shown in Table 1. Note that all investigated uses are in line with the three premises of sufficiency literature identified by Jungell-Michelsson and Heikkurinen (2022). This connection between the concept of relations of enoughness and the shared premises of sufficiency will be further discussed later (Section 4). For demonstration purposes, two further cases will be examined in detail. They are selected to prove the ability of relations of enoughness to deal with uses of sufficiency with entirely different content.

Princen (2005) connects sufficiency to the functioning of complex adaptive systems. Following Kay and Schneider (1995), Princen argues that these systems have to maintain a certain amount of energy regarding self-organization and internal structure. As Kay and Schneider argue, self-organizing systems

exist in a situation where they get enough energy, but not too much. If they do not get sufficient energy of

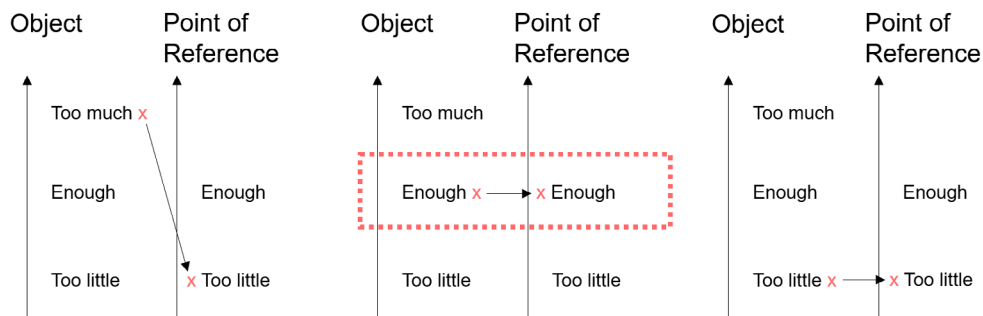


FIGURE 5 The shared structure of two relations of enoughness with entirely different content.

high enough quality (beyond a minimum threshold level), organized structures cannot be supported and self-organization does not occur. If too much energy is supplied, chaos ensues in the system, as the energy overwhelms the dissipative ability of the organized structures and they fall apart. So self-organizing systems exist in a middle-ground of enough, but not too much. (Kay & Schneider, 1995, p. 52).

The functioning of complex adaptive systems can be understood as a relation of enoughness between energy (object) and self-organization of complex adaptive systems (point of reference). A certain level of 'enough' energy is necessary to allow self-organization, while 'too much' and 'too little' energy will threaten its existence. This relation of enoughness can be visualized in Figure 5. As Kay and Schneider (1995) as well as Princen (2005) conclude, complex adaptive systems have internal mechanisms to stay within the area of 'enough' and to maintain their functioning. However, if a certain threshold is crossed, the system might move to a new yet unpredictable state. Management of human interactions with these systems must therefore be structured by the logic of 'enough', 'too little' and 'too much'. By including this perspective in his work, Princen (2005) builds a much more ambitious foundation for sufficiency, connecting it to ecology and systems thinking (Kay & Schneider, 1995; Monat & Gannon, 2015).

Another application of sufficiency can be found in debates of moral philosophy on questions of justice based on the work of Frankfurt (1987), as elaborated by Spengler (2016). From this perspective, a decent amount of access to resources and goods is necessary to allow the satisfaction of basic human needs. This use of sufficiency can be reconceptualized as a relation of enoughness between consumption (object) and the fulfilment of basic human needs (point of reference). Spengler provides insights on what the enoughness corridor might look like and how a lack of money and consumption leads to a lack of satisfaction with basic human needs. Thus, she makes a strong case for sufficiency as a social minimum (ibid.). However, other authors such as Paech (2012) argue that there can be too much consumption in a social sense, which may lead to a lack of basic human needs such as mental health. As too much consumption can lead to 'consumption blockage' [own translation; 'Konsumverstopfung'] (Folkers & Paech, 2020, p. 170), reducing individual consumption may be seen as liberation (Paech, 2012). Considering both Spengler's and Paech's

arguments, the resulting relation of enoughness has three occurrences, which are visualized in Figure 5.

As a result, Figure 5 can adequately represent two relations of enoughness with entirely different content but the same structure: first the relation between energy and the self-organization of complex adaptive systems following Kay and Schneider (1995) and Princen (2005), and second the relation between consumption and the fulfilment of human needs following Spengler (2016) and Paech (2012). This stresses the power of the concept of relations of enoughness to systematically structure and unite different uses of sufficiency with entirely different contents.

3.3 | Sufficiency, enoughness and sustainability

Above, relations of enoughness were introduced and utilized to reconceptualize diverse uses of sufficiency. As a sustainability strategy, sufficiency must possess a strong connection to sustainability. However, this connection has not yet been discussed and will be investigated now.

As different authors have argued (e.g. Grunwald & Kopfmüller, 2022; Ott & Döring, 2008), sustainability as a concept is about intergenerational and intragenerational justice. Ott and Döring (2008) emphasize this connection to justice as they base their theory of strong sustainability on a discussion of John Rawls' 'A Theory of Justice' (1971). Rawls understands the concept of justice as the necessity to have a 'set of principles for assigning basic rights and duties and for determining what [...] to be the proper distribution of the benefits and burdens of social cooperation' (Rawls, 1971, p. 5). Just societal institutions are based on principles that do not arbitrarily distinguish between persons and allow a 'proper balance' (ibid.) of different interests. However, different persons can have different conceptions of justice, which are different ideas on what set of such principles should be chosen. Based on this perspective, one can understand the concept of sustainability as the expansion of the concept of justice into the future, including both inter and intragenerational claims. Different approaches to sustainability articulated in the scientific and public debate (Hopwood et al., 2005) represent different conceptions of sustainability.

The concept of relations of enoughness has a strong connection to the concept of sustainability. Spengler (2016) already argued that the debates on sufficiency as an environmental maximum and a social

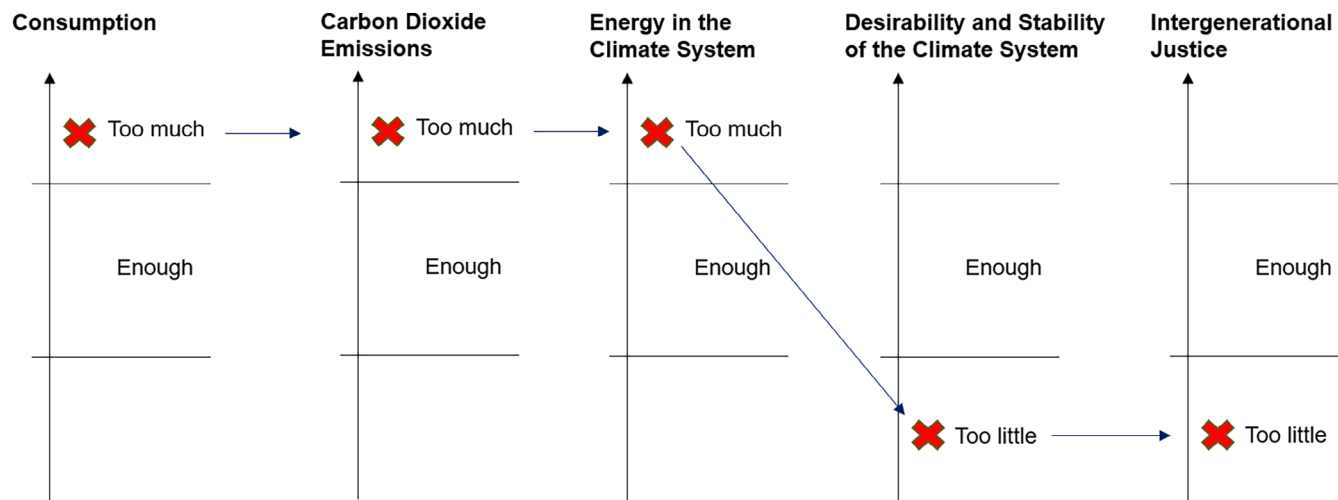


FIGURE 6 The chain of enoughness of consumption and climate change.

minimum should be united as both target sustainability. Transferring this idea, all relations of enoughness assessed in this paper are connected to sustainability, as their point of reference is always connectable to the intergenerational or intragenerational dimension of justice. This idea will now be further elaborated, based on two examples.

In Section 3.1, the relation of enoughness between consumption (object) and carbon dioxide emissions (point of reference) has been introduced. It states that today for most persons in the global north, there is too much consumption regarding carbon dioxide emissions in relation to individual lifestyle carbon footprint targets (2.5 tCO₂ by 2030). What is the connection of this relation to sustainability? Climate change is a fundamental threat to human existence and therefore a matter of intergenerational justice, as explicated in the SDGs. This connection allows us to reconstruct not just a relation of enoughness between consumption and carbon dioxide emissions, but a whole chain of enoughness that connects individual consumption to intergenerational justice (Figure 6). Chains of enoughness are the result of combining relations of enoughness in a consecutive order. In the resulting chains, the point of reference of the first relation is simultaneously the object of the second relation of enoughness, and so on. By connecting matters of consumption to intergenerational justice, the resulting chain explicates the normative content of sufficiency in the sense of reductions and changes of consumption with environmental intent. Note that climate change not only affects intergenerational justice and future generations but already influences the human needs of persons currently living on earth (e.g. through extreme weather events; IPCC, 2023). Therefore, as time moves on, matters of intergenerational justice unfold their threatening potential ever more strongly in the present if not faced effectively.

In the chain of enoughness of consumption and climate change, too much consumption causes too many carbon dioxide emissions, leading to amounts of energy in the form of temperature rises that destabilize the climate system. Fundamental changes in the climate system however have drastic consequences and therefore threaten intergenerational justice, which is one of the two key dimensions of

sustainability. If one reads the chain in this way, from left to right, the chain presents itself as a sequence of causality. Sufficiency, here understood as a change and reduction of consumption following Sandberg (2021), targets the first link in the chain, with the goal to reduce environmental impacts, therefore to maintain the stability and desirability of the climate system and to stop threats on intergenerational justice. The result of a successful practical use of sufficiency in this sense would be to reach the enoughness corridor of the whole chain, in which all its links are in the state of 'enough', contributing to intergenerational justice and sustainability (Figure 7).

However, if one reads the chain from right to left, one follows the path of determination. The conception of strong sustainability states that certain natural foundations like a stable and functioning climate system must be maintained (Ott & Döring, 2008). The internal mechanisms of the climate system then determine, how much energy in the climate system is 'enough'. This can be seen as an application of Princen's idea that complex adaptive systems need enough but not too much energy to continue functioning and being stable (Princen, 2005). The planetary boundary framework (Richardson et al., 2023) states that more than +1.0 W m⁻² total anthropogenic radiative forcing at top-of-atmosphere can be seen as a central threshold for climate change that should not be crossed. A transgression of this threshold of energy may represent 'too much' energy in the climate system, possibly triggering fundamental yet unpredictable change. From another perspective, these energy limits can be expressed in the form of temperature targets as politically agreed upon in the Paris Agreement as the 1.5°C and 2°C targets (UNFCCC, 2015). Unfortunately, the limit of radiative forcing defined by the planetary boundaries approach has already been transgressed (Richardson et al., 2023) and it is likely that the 1.5°C limit will be exceeded during the 21st century (IPCC, 2023). Based on certain amounts of energy in the atmosphere and defined temperature targets, corresponding global carbon budgets can be calculated. Exemplarily, the latest IPCC report estimated the remaining carbon budget from the beginning of 2020 for limiting warming to 1.5°C with 50% likelihood to be 500 GtCO₂ (ibid.). These

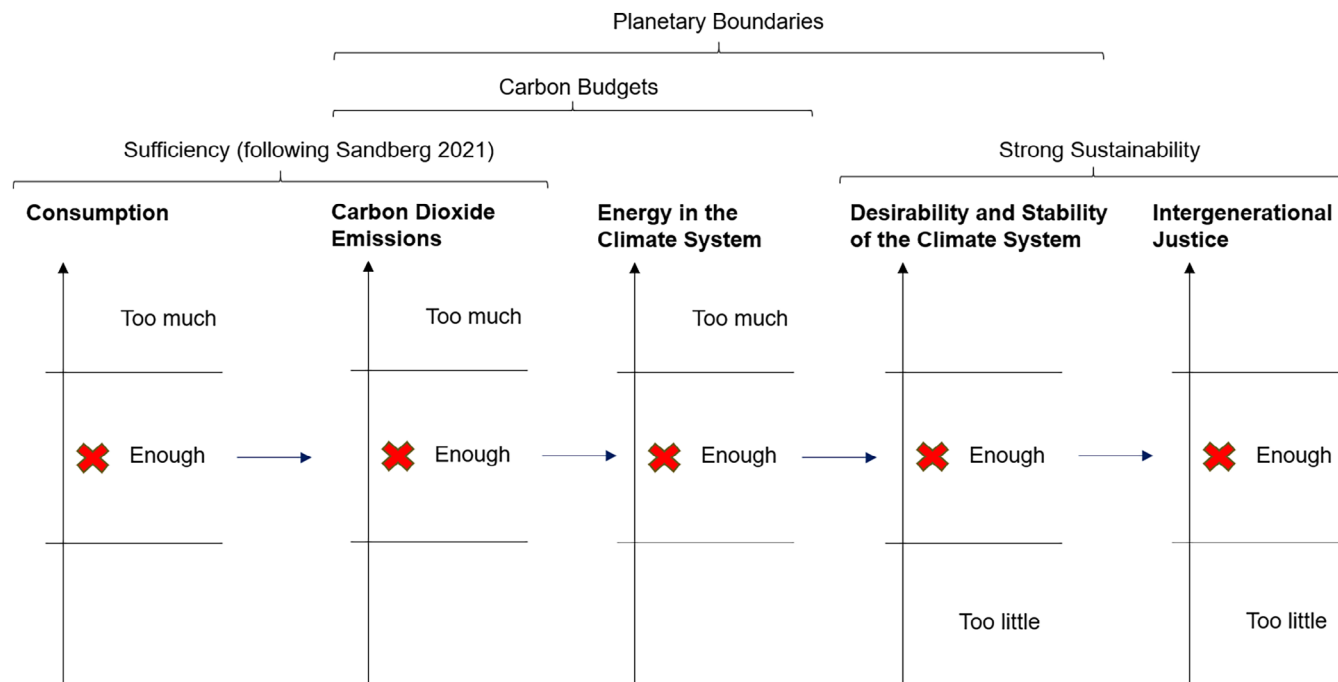


FIGURE 7 The enoughness corridor and diverse concepts of climate and sustainability science in the chain of enoughness of consumption and climate change.

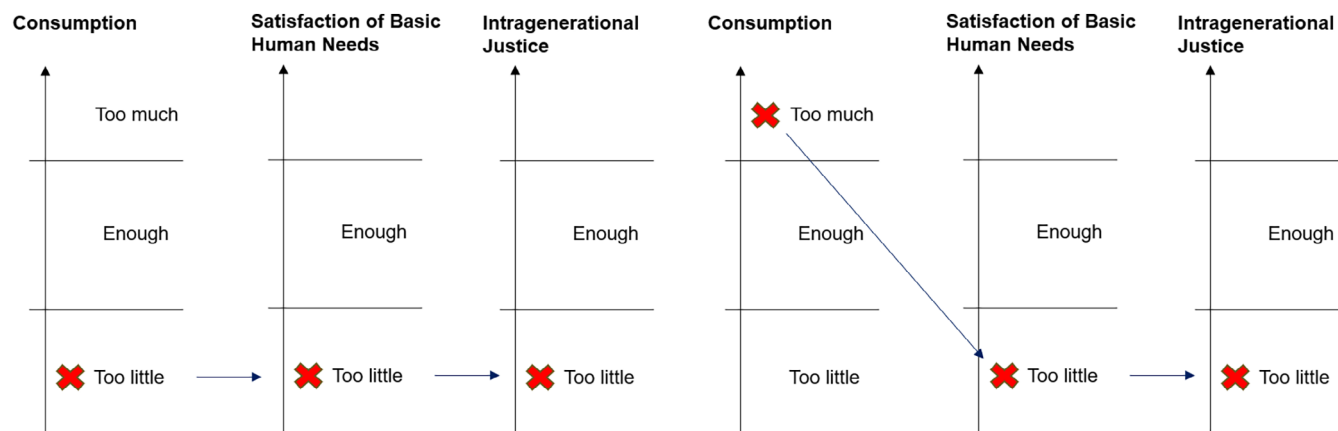


FIGURE 8 Two undesirable occurrences of the chain of enoughness of consumption and basic human needs.

carbon budgets then can be individualized, finally determining how much individual consumption is 'enough' or 'too much'. Here, we come back to the average per capita lifestyle carbon footprints of 11.2 tCO₂e in Germany (Paar & Tsoutsouloupoulos, 2022), and the necessity of strong and fast reductions of such carbon footprints targeting 2.5 tCO₂e by 2030 (IGES et al., 2019). Sufficiency as a change and reduction of individual consumption with the goal to reduce carbon dioxide emissions then is necessary as the individual carbon budget is threatening to be exceeded. Therefore, the need of sufficiency is determined by the chain of enoughness, founded in intergenerational justice. As shown in Figure 7, diverse concepts of climate and sustainability science discussed above target different parts of this chain of enoughness.

In Section 3.2, the relation of enoughness between consumption (object) and human needs (point of reference) has been introduced. It states that all persons need a certain amount of consumption to satisfy basic human needs (e.g. nutrition, health or shelter). Spengler (2016), who inspired the construction of this relation of enoughness, already discussed it as a matter of justice in the context of sufficientarianism. Therefore, the link from consumption to intragenerational justice as a key dimension of sustainability is already established. One can explicate the connection of consumption to intragenerational justice through the chain of enoughness of consumption and basic human needs (Figure 8).

In the first undesirable occurrence of the chain of enoughness (left side in Figure 8), too little individual consumption causes a lack of

satisfaction of basic human needs. Exemplarily, too little individual consumption of adequate amounts of diverse food causes insufficient nutrition. Lacking basic human needs such as nutrition on the individual level then lead to intragenerational injustice. Again, the chain of enoughness represents causality if it is read from left to right. The determination of enoughness status on the other hand happens from right to left, starting with intragenerational justice: Intragenerational justice necessitates the adequate satisfaction of basic human needs such as nutrition for all persons, therefore criteria of adequate nutrition define how much individual consumption of food is 'enough'. This first undesirable occurrence is particularly a challenge of human development, as many persons in the global south lack opportunities to consume adequately and satisfy their basic human needs. The necessity to guarantee a fundamental minimum of consumption is stressed in the Agenda 2030, exemplarily in the form of SDG 1 'no poverty', SDG 2 'zero hunger', SDG 3 'good health and well-being' and SDG 6 'clean water and sanitation'.

The second undesirable occurrence (right side in Figure 8) conceptualizes the already discussed argument of Paech (2012) that too much consumption can cause individual problems of consumption blockage, reducing mental health and dissatisfying basic human needs. This occurrence of the chain of enoughness is primarily a problem in (over-)developed countries in the global north in which material needs are satisfied and (over-)consumption can cause harmful mental stress (*ibid.*). The goal of sufficiency in this sense is again to reach the corridor of enoughness, in which all entities are in the state 'enough'. Note that the chain of enoughness of consumption and basic human needs may necessitate reductions of consumption (in the global north) but also expansions of consumption (in the global south).

The two reconstructed chains of enoughness are well in line with Spengler's (2016) idea of sufficiency as maximum and minimum. The chain of enoughness of consumption and climate change explicates how too much consumption damages the climate systems and threatens intergenerational justice. The chain of enoughness of consumption and human needs explicates how too much and too little consumption lead to the dissatisfaction of basic human needs and threatens intragenerational justice. This result has remarkable similarities to the sustainable consumption corridors presented by Di Giulio and Fuchs (2014), in which sustainable consumption is limited by a maximum defined by environmental means and a minimum defined by means of well-being, human needs and equity. Therefore, one can understand the presented chains of enoughness as a conceptual foundation of sustainable consumption corridors, connecting sufficiency as changes and reductions of consumption to sustainability. The presented conceptual foundation is of importance as it is able to reveal both factual and normative assumptions that lead to the definition of sustainable consumption corridors. Such assumptions might address the size of carbon budgets, the considered kinds of environmental impacts and planetary boundaries, as well as the mostly implicit yet central conception of sustainability followed. Additionally, it becomes apparent that enoughness and sufficiency are strongly connected to challenges of sustainable development in practice as put on the agenda by the SDGs.

4 | DISCUSSION

Relations and chains of enoughness allow to conceptually explicate the notion of 'enough'. However, sufficiency is more than that. Jungell-Michelsson and Heikkurinen (2022) show this by identifying three shared premises of the sufficiency debate: (1) the complementarity of natural and manufactured capital, (2) the necessity to slow down the social metabolism and (3) the existence of altruistic elements. This emphasizes that sufficiency as a sustainability strategy is not neutral regarding diverse conceptions of sustainability, but has a strong alliance with strong sustainability (Ott & Döring, 2008) as articulated by the first premise, and with the degrowth perspective (Lage, 2022; Schmelzer & Vetter, 2021) as articulated by the second premise. While using relations and chains of enoughness to explicate diverse uses and understandings of sufficiency, it is of great importance to make sure that the results are still compatible with these shared premises. Exemplarily, advocates of green growth could state that there simply is too little technology, innovation and eco-efficiency, leading to too little absolute decoupling. However, they would continue, by increasing eco-efficiency, which they expect to be successful, fast and strong enough absolute decoupling shall be accomplished. By doing so, so they would argue, intergenerational justice could be reached. This example shows that green growth can be reformulated in terms of enoughness, albeit this perspective is not compatible with sufficiency. The very insight that eco-efficiency will most likely not suffice to limit environmental impacts adequately necessitates sufficiency. In conclusion, conceivable entities can be tossed into chains and relations of enoughness, allowing to reflect on all kinds of sustainability conceptions and issues. In the context of sufficiency, only such relations and chains of enoughness should be constructed that are compatible with the shared premises of the sufficiency debate. Therefore, in relation to recent macroeconomic debates on the role of growth in sustainable development (e.g. Harangozo et al., 2018; Hickel & Kallis, 2020; Schmelzer & Vetter, 2021; Urhammer & Røpke, 2013), sufficiency is a clear ally of degrowth, while relations of enoughness seem conceptually open to different streams.

Beyond the scope of sufficiency, it might be fruitful to use relations and chains of enoughness to reflect more generally on climate change and sustainability. This potential has already been sketched (Section 3.3). The 1.5°C and 2°C temperature targets of the Paris Agreement (UNFCCC, 2015), the carbon budget approach (IPCC, 2023) as well as the planetary boundaries framework (Richardson et al., 2023) all represent attempts to define what is 'enough' and which limits should not be transgressed. The same is true for the SDGs as a political framework that, in addition to environmental goals, contain social goals, defining poverty, hunger and lacking health (among others) as fundamental transgressions of the social minimum (UNGA, 2015). All this work is not strongly founded in the sufficiency perspective, but in a more general interest in sustainability. While the notion of 'enough' is strongly advocated by sufficiency literature, relations and chains of enoughness can be insightful for sustainability research and practice in general.

Additionally, further investigation of external aspects interacting with examined relations and chains of enoughness seems necessary. In this paper, relations and chains of enoughness have been introduced under the assumption of *ceteris paribus* conditions for the sake of clarity. However, in reality, interactions between external aspects and investigated relations and chains of enoughness are common. Exemplarily, this is true for the relation between consumption (object) and carbon dioxide emissions (point of reference) introduced above (Section 3.1). An increase of eco-efficiency in the production and use of goods is expected to increase the area of 'enough' consumption as the same goods cause less emissions. The presented approach does not claim that sufficiency is the only effective way to reduce environmental impacts. Though, the interaction between different sustainability strategies (Huber, 2000) is not considered conclusively, yet. The same is true for properties of the carbon cycle like carbon sinks that interact with carbon budgets (IPCC, 2023). Increased carbon sink capacity allows for higher carbon dioxide emissions relative to defined temperature targets. As a consequence, carbon sinks increase the amount of consumption to be considered 'enough'.

In this paper, diverse actors that are influencing sustainability have not been discussed in depth. However, there is an expanding body of literature reflecting the role of different actors, including individual consumers but also companies and governments (Lage, 2022; Niessen & Bocken, 2021; Sandberg, 2021; Schneidewind & Zahrt, 2014). The same is true for questions of scope, e.g. through a focus on individual persons, nation states, or the global north and global south. Further research would benefit from connecting relations and chains of enoughness to different groups of actors and scopes. Which actors have the power to change relations and chains of enoughness from an undesirable occurrence into the corridor of enoughness? Some actors like political decision makers might even be able to transform the very structure of chains of enoughness by changing the fundamental socio-economic foundation (e.g. Jackson, 2009; Laws, 2015).

Finally, relations and chains of enoughness have been developed through conceptual discussion of existing literature. The concept would strongly benefit from empirical application in sustainability research to demonstrate its merit. This includes empirical work on how areas of 'enough' are constituted in different contexts and through perspectives of diverse actors involved.

5 | CONCLUSION

Based on a short overview of sufficiency literature, the main contribution of this paper is the introduction of the concept of *relations of enoughness*. This article tries to demonstrate two achievements of the concept: First, it is able to reconceptualize existing uses of sufficiency, independent of their specific content. Second, relations of enoughness can be connected to sustainability, forming *chains of enoughness*, able to explicate implicit factual and normative assumptions. The two constructed chains of enoughness serve as a conceptual foundation for the well-established sustainable consumption corridor approach.

Scientists and practitioners are enabled to construct and discuss the relations and chains of enoughness relevant for their particular interests. This may contribute to a consolidation, to more conceptual conciseness and to an explicit handling of normative assumptions in the sufficiency debate and sustainability science and practice. However, further research is necessary to prove the merit of the concept empirically, including handling diverse contexts and the role of different actors. More conceptual clarity regarding sufficiency as a sustainability strategy is of particular importance to enable practical implementation. Practitioners now can ground sufficiency policy and practice on concise definitions, identify areas of 'enough', and transform the core idea of 'enoughness' into measures in central areas like climate action.

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[Correction added on 25 June 2024, after first online publication: Projekt DEAL funding statement has been added.]

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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