Received: 22 March 2022 | Revised: 24 June 2022 | Accepted: 7 July 2022

DOI: 10.1002/sd.2371

RESEARCH ARTICLE

Sustainable Development WILEY

Biosphere-based sustainability in local governments: Sustainable development goal interactions and indicators for policymaking

Rita Nerland[1,2] | Heidi Rapp Nilsen[3] | Bjørn Andersen[1]

[1]Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Trondheim, Norway

[2]Municipality of Molde, Molde, Norway

[3]Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway

Correspondence
Rita Nerland, Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, Trondheim 7491, Norway.
Email: ritagn@stud.ntnu.no

Funding information
Norges Forskningsråd, Grant/Award Number: 327222

Abstract

Knowledge on sustainable development goals (SDGs) interactions has a bias toward global perspectives and lacks regional or country-specific differentiation. This paper takes a biosphere-based sustainability approach and assesses SDG interactions in a local governmental context. We start by addressing how the SDGs promote a biosphere-based sustainability. Here, we find a range of opinions and we settle on a set of SDGs. Second, we explore how a set of sustainability indicators are connected to the SDGs and biosphere-based sustainability. We conduct a case study and develop an SDG interaction model, and further compare global and local level interactions. We find that the local level has some differences compared to global level findings. However, the distribution among synergies and trade-offs was found to be quite coherent. Our SDG interaction model connects sectors both within a single government and between governmental levels and can as such facilitate policy coherence. The main contribution of this study is our unique approach of conducting a local level assessment which aligns an existing sustainability measurement system with interaction research.

KEYWORDS

biosphere-based sustainability, indicators, interactions, local governments, policy coherence, SDG implementation, synergy, trade-off

1 | INTRODUCTION

Local governments play a vital role in the execution of the 2030 Agenda, which provided the 17 sustainable development goals (SDGs) (UCLG, 2019; United Nations, 2015b). They lay the groundwork for the necessary social transformations and provide services that about two-thirds of the SDGs depend on (UCLG, 2019). There is a broad span in the challenges, priorities, and constraints facing local governments throughout the world. The SDGs can help local governments prioritize and set the bar for development, but implementing the SDGs successfully is not by any means a plug-and-play exercise. Nilsson et al. (2016) state that if countries ignore the overlaps of the SDGs and start trying to tick off targets one by one, perverse outcomes might surface. This paper aims to find how SDG achievement in local governments can influence the Earth system, our biosphere.

Even though the 2030 Agenda has received harsh criticism, the overall reaction to its release was overwhelmingly positive (Spangenberg, 2017). One of the main strengths of the agenda is its principle of indivisibility, also characterized as the interlinkage principle or integration principle (Blanc, 2015; Breuer et al., 2019; United Nations, 2015b). As Amina Mohammed, special adviser to the UN Secretary-General stated in the post-2015 development planning:

"Every goal is inextricably linked to the rest" (Maurice, 2015). The goals call for a new era of partnership, where silos are broken down and governments are restructured to ensure policy coherence (Horvath et al., 2022; Maurice, 2015; Tremblay et al., 2020). No wonder why Mohammed further underpinned that the indivisibility principle would prove to be the toughest challenge in the coming years (Maurice, 2015).

Despite the excessive focus on the indivisibility principle, the 2030 Agenda does not state how the various goals or targets are interlinked, and in the aftermath of the SDG release a new field of sustainability research emerged, namely SDG interaction research. There is, according to Nilsson et al. (2018), a large and diverse knowledge base on interactions and an almost indefinite number of ad hoc examples can be found. Weitz et al. (2018) express that numerous efforts have been made to conceptualize and assess interactions amongst the SDGs but that the policy-relevance has been limited. Pham-Truffert et al. (2020) found that the available knowledge on interactions has an inherent bias toward global perspectives and generally lacks regional or country-specific differentiation.

The growing focus on SDG integration in governments calls for a well-grounded implementation strategy. However, the implementation strategy needs to build on a solid theoretical base, and be visible in order to assess what is accounted for and what is not. According to Masuda et al. (2021), numerous challenges relating to the SDG mainstreaming (the inclusion of relevant concerns about the SDGs into policy-related decision making) at the local level have been identified. They found that these challenges include a lack of coordination in the implementation of the 2030 Agenda at international, national, and local levels; fragmented responsibility and ambiguous accountability; weak motivation; limited data sets for conducting monitoring and evaluation activities, including setting indicators; insufficient human and financial resources; and a lack of multi-stakeholder partnerships and consideration of synergies and trade-offs (Masuda et al., 2021).

This paper will particularly address the challenges related to the consideration of synergies and trade-offs and furthermore relate this to the debate on how sustainability should be defined. In "Our Common Future" (WCED, 1987) the Brundtland Commission set the direction for sustainable development. Folke et al. (2016) argue that the Brundtland Commission gave equal weight to the three dimensions of sustainability. This interpretation is also evident in the SDGs which are said to "balance" the three dimensions of sustainable development (United Nations, 2015b, n.d.).

The increasing knowledge on how a functioning Earth System is a prerequisite for a thriving global society (Griggs et al., 2013), has led the sustainability research community in the direction of what we can call a biosphere-based approach to sustainability. Griggs et al. (2013) argue that "we need to reframe the UN paradigm of three pillars of sustainable development—economic, social and environmental—and instead view it as a nested concept. The global economy services society, which lies within Earth's life-support system." (Griggs et al., 2013, p.306). This is in line with many other contributions as, amongst others, Folke et al. (2016) who advocate for a biosphere-based sustainability where the economy and society are embedded within the biosphere.

Against this backdrop, we address the following research questions in this paper: (1) Do the SDGs promote a biosphere-based understanding of sustainability and if so, how? (2) How do global level SDG entity interactions relate to local level SDG entity interactions? The two research questions are answered by synthesizing the literature on biosphere-based sustainability and SDG interactions, and furthermore through a case study, examining a likely scenario of SDG operationalization in a set of Norwegian local governments. We first take an explanatory approach, evaluating and comparing established concepts and theories. Second, by making an interaction model, biosphere-based sustainability and the SDGs are evaluated from various angles. We compare global level results with the case study's local level results and discuss their differences. Our study responds to the calls for assessing SDG interactions at the local scale, as well as taking an indicator-to-indicator approach in the evaluation (Bennich et al., 2020; Pham-Truffert et al., 2020; Weitz et al., 2018).

The remaining part of the paper is structured as follows. First, we present our literature review. Second, we present the case study, including research design and data analysis. Third, we provide the research results followed by a discussion on the findings of the interaction assessment. Finally, we conclude and make recommendations for further research.

2 | LITERATURE REVIEW

Research within the field of sustainability is multi- and interdisciplinary, making conflicting arguments evident among the various schools of thought. As part of this study, we undertook an explanatory literature review, using a simple snowballing approach to find relevant literature on biosphere-based sustainability and the SDGs. Through the literature review, we gained insights regarding the first research question, namely, if (and how) the SDGs promote a biosphere-based understanding of sustainability.

2.1 | SDG interactions

Due to the integrated and overarching nature of the SDGs, a principle of indivisibility should guide their implementation (Bennich et al., 2020; Nilsen, 2020). The 2030 Agenda itself does not state how the goals relate to each other or how these relationships should be addressed. Thus, an international debate along with research efforts of what could be referred to as SDG interaction studies is a fast-emerging field (Bennich et al., 2020; Miola et al., 2019). Horvath et al. (2022) defines SDG entity interactions to include interactions between goals, targets, indicators, policies, and external entities. This is how SDG entity interactions will be defined in this paper as well, henceforth addressed as simply SDG interactions.

Over the recent years, scholarly literature has produced different proposals for categorizing the SDGs, systematically mapping the linkages between them, and identifying the nature of their interdependencies (Breuer et al., 2019). Despite having the same research objective, SDG interaction studies differ considerably regarding their methodological approaches (Linnerud et al., 2021, p.739) and there is no general agreement on what defines an integrated approach, or how science can best approach SDG interactions in policy-relevant ways (Bennich et al., 2020; Breuer et al., 2019). This paper will not go into detail about the myriad of existing methodological approaches to assess SDG interactions, as this has been thoroughly done by other scholars (Bennich et al., 2020; Breuer et al., 2019; Di Lucia et al., 2022; Horvath et al., 2022; Nilsen, 2020). In essence, previous literature studies highlight the need to use the correct method for the correct purpose (Horvath et al., 2022), hence the popular statement "one size fits none" seems appropriate as the main takeaway.

The interaction assessment conducted in this paper used the work of Pham-Truffert et al. (2020) as a baseline and for comparison of results. They undertook an extensive literature review where data about negative and positive interactions among the SDG goals and targets were collected, synthesized, and analysed. The target level interactions were assessed whenever possible, and at a more generic SDG level otherwise, considering all the 126 outcome-related SDG targets. The interactions were scored according to the SDG interactions framework developed by Nilsson et al. (2016) and furthermore aggregated to weighted synergies and trade-offs. A synergistic interaction indicates that achievements on one entity contribute towards progress on another, while a trade-off interaction indicates that progress achieved on one entity produces effects detrimental to another (or parts of thereof) (Breuer et al., 2019).

As Bennich et al. (2020) point out, few have studied SDG interactions at the indicator-to-indicator level (Bennich et al., 2020, p.11). The case study of this paper fills this gap by evaluating how the United for Smart Sustainable Cities (U4SSC) Key Performance Indicators (KPIs) (U4SSC, 2017) could be coupled to SDG targets, and furthermore to SDG interactions. The U4SSC KPIs provide a standardized method to measure performance in regard to achieving the SDGs and becoming a smarter and more sustainable city (ITU, 2021). This set of indicators was chosen due to the novel regional usage of the indicators in the case study municipalities and because of its global application. This is a unique approach, aligning an existing performance management system with interaction research.

The Nilsson et al. (2016) framework has been implemented in several studies, using both qualitative and quantitative methods, and has been proven to be suited for supporting various objectives (Breu et al., 2021; Hernández-Orozco et al., 2021; International Council for Science, 2017; McCollum et al., 2018; Nilsen, 2020; Nilsson et al., 2018; Pham-Truffert et al., 2020; Weitz et al., 2018). The framework consists of a seven-point typology and scoring scale. The scale ranges from cancelling (−3), counteracting (−2), and constraining (−1) on the negative side, consistent (0) when there is no significant interaction, to enabling (+1), reinforcing (+2), and indivisible (+3) on the positive side. According to Nilsson et al. (2016), the scale can be applied at any level—among goals and targets, to individual policies or actions.

2.2 | Biosphere-based sustainability in the SDGs

The world is currently facing both a climate and a biodiversity crisis (IPCC, 2022, p. 7–9). Through the Paris Agreement, the United Nations Framework Convention on Climate Change put forward a goal to limit global warming to well below 2, preferably to 1.5°C, compared to pre-industrial levels (United Nations, 2015a). The nationally determined contributions (NDCs) after the 2021 United Nations Climate Change Conference accumulate to a temperature rise of 2.4°C by the end of the century (Climate Action Tracker, 2021). Unfortunately, goals are not always reached. van Soest (2022) found that there is a considerable emissions gap. Both the ambitions and the implementation of policies to meet the ambitions need to the strengthened.

Furthermore, the IPCC now clearly recognizes the interdependence of climate, ecosystems and biodiversity, and human societies (IPCC, 2022). IPBES (2019) states that "The biosphere, upon which humanity as a whole depends, is being altered to an unparalleled degree across all spatial scales" (IPBES, 2019, p.10). For instance, an average of around 25% of species assessed in the latest global assessment of IPBES were found to be threatened (IPBES, 2019). Against this backdrop, a biosphere-based approach to sustainability is perhaps the only plausible approach for ensuring a viable future for humans and nature as we know it.

We found that the literature generally agrees on what biosphere-based sustainability is. It is not proposed a specific definition, but the work by Folke et al. (2016) seems to be the most cited in this regard, stating that in a biosphere-based sustainability perspective, the economy and society are seen as embedded within the biosphere and the biosphere serves as the foundation upon which prosperity and development ultimately rest. This is in line with Griggs et al. (2013) proposed redefinition of sustainable development, namely, "development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends" (Griggs et al., 2013, p.306).

A biosphere-based sustainability perspective is evident in the work of many scholars in a diverse range of fields, for instance, environmental science (Rockström et al., 2009), social science (Westley et al., 2011), economics (Raworth, 2018), and systems theory (Skene, 2020). The planetary boundaries was first defined in Rockström et al. (2009), proposing a safe operating space for humanity with respect to the Earth system. Nine boundaries associated with the planet's biophysical subsystems or processes were defined. The Safe and Just Space (SJS) framework combines the planetary boundaries with theories of human needs, adding up to a holistic model where both humans and nature can prosper (Raworth, 2018). According to Spangenberg (2017), criticism of earlier draft versions of Agenda 2030 was largely ignored. Hajer et al. (2015) demanded, among others, the inclusion of the planetary boundaries and the SJS framework, but these are neither mentioned nor implicitly implemented in the final agenda.

We found that there are two main challenges when pursuing biosphere-based sustainability through the operationalization of the SDGs: The first is related to cherry-picking of SDGs (Forestier &

Kim, 2020) and lack of systems perspective (Skene, 2020). Forestier and Kim (2020) found that many governments choose to prioritize certain SDGs over others based on their national or economic interests. Even though goal prioritization may not be entirely avoidable, excessive and prejudicial goal prioritization goes against the "integrated and indivisible" attribute of the SDGs and can limit the accomplishment of the agenda (Forestier & Kim, 2020). Skene (2020) states that the very idea of setting goals comes under significant scrutiny within systems theory and further explains that the SDGs need to be addressed with an emphasis on fundamental issues related to systems theory and how the Earth system functions (The conflict between goal setting and systems theory comes from not including path-thinking and other inherent attributes of complex systems sufficiently. See Skene (2020) for more in-depth reasoning on this).

The second challenge is the fact that some of the targets are to some extent directly dangerous to our biosphere (Jain & Jain, 2020; Nature., 2020; O'Neill et al., 2018). SDG 11 (Sustainable Cities and Communities) is one of the goals that reflect this property (Morton et al., 2017). For instance, the urban development target 11.2, on sustainable transport systems, represents potentially a mutual trade-off with coastal conservation efforts (International Council for Science (2017) in Pham-Truffert et al. (2019)) and expanding roads are one of the main drivers of forest degradation (IPCC (2018) in Pham-Truffert et al. (2019)).

Spangenberg (2017) states that the SDG targets reveal two opposing and mutually exclusive world views. Long before the launching of the SDGs, the mutually exclusive world views within sustainability have been framed in the debate of weak versus strong sustainability (Neumayer, 2003; Nilsen, 2008). Weak sustainability is rooted in neoclassical economics and characterized by the goal to sustain a constant level of consumption or utility, whereas strong sustainability requires that there must be restrictions on the substitution between the economy and nature (Neumayer, 2003; Nilsen, 2010a). The debate between weak and strong sustainability has been conducted mainly on the continuum of environmental versus economic issues rather than taking account of social consequences (Hopwood et al., 2005; Nilsen & Ellingsen, 2015). In recent years, the debate has to a stronger extent included the social dimension. The conflict line is now more often drawn between the social and environmental goals on one side and the economic goals on the other (O'Neill et al., 2018; Skene, 2020). Mutually exclusive world views and paradigms obviously constitute conflict lines (Kallio et al., 2007), although there are developments along what these world views consists of. Another way forward is to not treat them as paradigms but, as different but overlapping discourses, which then can actually be debated (Nilsen, 2010b, 2010c).

Purvis et al. (2019) state that the three dimensions of sustainability do not explicitly form any part of the framework of the SDGs. However, since their release in 2015, many have argued for various thematic arrangements of the goals as Morton et al. (2017), Stockholm Resilience Centre (2016), UNDP (2015), and Waage et al. (2015). United Nations (2015b) presents five areas of critical importance; people, planet, prosperity, peace, and partnerships (often abbreviated the 5Ps). Morton et al. (2017) claim SDG 13 (Climate Action), 14 (Life below Water), and 15 (Life on Land) to be in the "planet" area, while UNDP (2015) also includes SDG 6 (Clean Water and Sanitation) and 12 (Responsible Consumption and Production) (UNDP, 2015). In addition to the 5Ps, we found that the so-called "SDG wedding cake" is a familiar arrangement, dividing the goals into the three well-known dimensions of sustainability. This model states that SDG 6, 13, 14, and 15 are in the biosphere dimension, making the foundation which the rest of the SDGs build upon and within.

Quite contrary to this, Jain and Jain (2020) argue that achieving the SDGs is synonymous with ecological deterioration. Zeng et al. (2020) found that the SDG indicators do not sufficiently measure biosphere-based attributes and that progress on the environmental SDGs, has little relationship with actual biodiversity conservation, and instead better represents socioeconomic development. Furthermore, in their report to the Club of Rome, Randers et al. (2018) state that "Nowhere, however, is it admitted in the 2030 Agenda that the successes in reaching the eleven social and economic goals (goals 1–11), if done based on conventional growth policies, would make it virtually impossible to reduce the speed of global warming, to stop overfishing in the oceans or to stop land degradation, let alone to halt biodiversity loss." (Randers et al., 2018, p.6).

Given these findings, there is no doubt that answering the first research question of this paper on how the SDGs promote a biosphere-based understanding of sustainability is a challenging task. Our literature review established that SDG 13, 14 and 15 were included in the planet/biosphere area in all evaluated literature that had a thematic approach (for instance Folke et al. (2016), Morton et al. (2017), and UNDP (2015)). Moreover, we found that pursuing biosphere-based sustainability through the SDGs faces two main challenges: Cherry-picking and lack of systems perspective, and further that some of the targets can threaten the biosphere. Some scholars even claim that achieving the SDGs leads to a deterioration of the biosphere. The SDGs have tremendous momentum in both public and private sectors and will indeed be directing sustainability strategies in the years ahead. Thus, as an answer to the first research question, we argue that SDG 13, 14 and 15 constitute the foundation of a biosphere-based sustainability approach through the SDGs. Additionally, given the challenges stated previously, ensuring a biosphere-based approach through the SDGs becomes a methodological choice and responsibility. We argue that this is the responsibility of both the SDG research community and policymakers. This is the approach developed in the rest of this paper.

3 | METHODS

Given the importance of pursuing biosphere-based sustainability, this study seeks to find answers to how biosphere-based sustainability can take centre stage in the operationalization of the SDGs. A case study was conducted as part of finding these answers. In the following sections, the research design will be outlined followed by a description of the case study. Lastly, the data analysis methodology will be presented.

3.1 | Research design

We undertook a mixed-methods approach, utilizing both qualitative and quantitative methods. The research process was divided into two consecutive steps. First, we did a mapping process, finding how the U4SSC indicator set relates to biosphere-based sustainability represented by SDG 13, 14 and 15, as concluded in the literature review. This step is elaborated in sub-section 3.3.1. Second, KPI level SDG interactions from target 11.2 to the biosphere-based targets were assessed. Target 11.2 was chosen due to the overweight of trade-off interactions to SDG 13, 14 and 15 in Pham-Truffert et al. (2019), and because transport systems is an area of attention in the case municipalities.

We made an interaction model consisting of global and local level interactions. The interactions were assessed qualitatively and quantitatively, using both the reported U4SSC KPI results from the case municipalities and the interaction scoring reported by Pham-Truffert et al. (2019), as well as subjectively evaluating the case-specific context. These steps are elaborated in Section 3.3.2. In order to limit the scope of this paper, we chose to hold recommendations on indicator improvement to a minimum.

3.2 | Case study

The case studied in this paper was a set of municipalities localized in the northwest region of Norway. Norway consists of 11 administrative regions, called counties, and this case study incorporated the municipalities localized in Møre and Romsdal (M&R) county. The county has initiated a sustainability program, aiming to make the county the "sustainability county number one". As part of this program, all the municipalities in the county have conducted sustainability reporting in accordance with the U4SSC indicator set as the first whole county in the world (Møre og Romsdal fylkeskommune, 2021b). Related to transport, the county has formulated a "zero-growth target". This means that public transport, mobility solutions, cycling, and walking should be able to handle the growth in the demands for personal transport – leading to a zero-growth in the use of personal vehicles (Møre og Romsdal fylkeskommune, 2021-2024).

The U4SSC is a UN initiative that enables cities to measure their performance through a set of KPIs and is used in over 100 cities around the world (ITU, 2021). The indicator set consists of 91 indicators evaluating how "smart and sustainable" a city is and is developed by the International Telecommunication Union (ITU). According to their concept note, the U4SSC implementation program is open to all cities, projects, stakeholders, and activities related to Smart and Sustainable Cities, that can contribute to the achievement of the SDGs and especially SDG 11 (ITU, 2019).

The final results from a U4SSC assessment are often visualized as a "rose", using a four coloured scale to reflect the score according to a defined target value of the KPI (Møre og Romsdal fylkeskommune, 2021a, p.8). The results for M&R county can be found in the project report (Møre og Romsdal fylkeskommune, 2021a) (Norwegian only) and the results for each municipality can be explored at ITU's official site (ITU, n.d.). The total aggregated score for the M&R county is at 66%, a score which is barely within the light green area (66%–95% of target value), according to the four-coloured scale.

When assessing the target and KPI level interactions, the contextual dimensions, geography, governance, technology, and timescale, highlighted by Nilsson et al. (2016) were incorporated. The geographical context is the municipalities in M&R county. More specifically, the average municipality, represented by the population-adjusted average score, was evaluated. This geographical scope also reflects the governance system in context, i.e., governance at the municipal level. Governance depending on other levels, such as national environmental policies, was also taken into account in the evaluation of interactions. Concerning technology and timescale, the best-practice technology known today was assumed provided as well as taking the predictions of future development during the scope of the SDGs, into account. Thus, the timescale evaluated was the period from 2022 till 2030.

3.3 | Data analysis

In determining how the U4SSC indicators handled biosphere-based sustainability, a manual mapping process was conducted. Getting an understanding of SDG interactions at the global level and then assessing them with regard to the case study was done in a systematic manner using different assessment techniques. In the following subsections, the various data analysis methods are elaborated.

3.3.1 | Mapping process

In the mapping process, our focus was to find how the U4SSC documents described SDG coverage in the KPIs. The U4SSC Collection Methodology (U4SSC, 2017) was used as input for the mapping procedure. The Collection Methodology describes the U4SSC KPI framework and provides detailed information for all the KPIs. We found that each KPI was mapped against one, two, or three SDGs, at the indicator, target, and/or goal level.

The mapping was conducted in spreadsheets and was a somewhat manual procedure where all KPIs were inspected in regard to their SDG representation. A table was created, with one KPI for each row and columns for the KPI name and the target level coverage. All KPIs and SDGs were assessed in this mapping process. Some KPIs had coverage at the SDG indicator level. In such cases, we mapped towards the corresponding SDG target. Table 1 illustrates how the table was built up. Based on the

TABLE 1 Table illustrating how the mapping process was conducted.

KPI name	Factsheet	Collection methodology
Protected natural areas	SDG 11	SDG 14, SDG 15
Recreational facilities	SDG 11	SDG 11

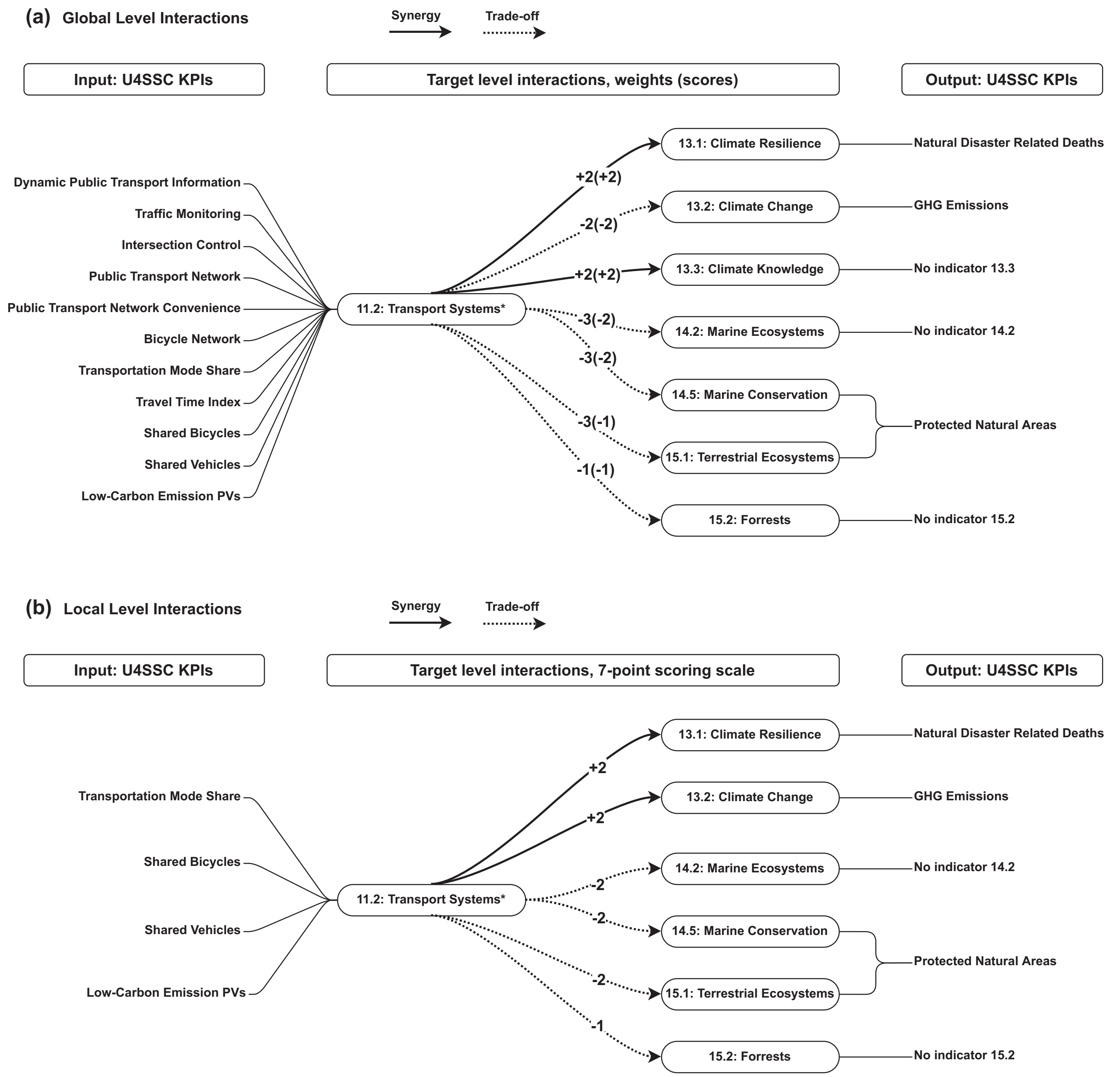

FIGURE 1 Interaction model comparing global and local level KPI interactions. The figure is built on a combination of mind map and flowchart principles and should be read from left to right, using the boxes at the top as guidance. The left-hand side of the figure illustrates the U4SSC KPIs that were mapped against target 11.2: Transport systems. The asterisk (*) reflects that all the targets are termed with short names. The appendices provide the full names of the SDG targets. Further, the middle part of the figure illustrates the target level interactions. The arrows illustrate the direction and weight of the interactions (from target 11.2 to a selection of the biosphere-based targets). Dotted arrows represent trade-offs and solid arrows represent synergies. In Figure 1a the interactions are incorporated as given in Pham-Truffert et al. (2019), with the weight and in parenthesis; the seven-point score contribution with the highest absolute value. In Figure 1b, the interactions are simply the seven-point score as concluded in the case study interaction assessment. Finally, on the right side of the figure, we have the "output" U4SSC KPIs. These are the U4SSC KPIs that were mapped against the biosphere-based targets that are visible in the figure.

target coverage findings, a simple coverage assessment was conducted, as presented in Table 2, in the results chapter.

3.3.2 | Interaction assessment

We conducted a two-step SDG entity interaction assessment. Pham-Truffert et al. (2020) was used as a basis for the assessment, as they present a unique SDG interaction dataset drawing on an extensive literature review, complemented by an interactive repository of SDG interactions (Pham-Truffert et al., 2019). Pham-Truffert et al. (2020) present the distribution between trade-offs and synergies (sum of the two equals 100), as well as a weight for the interaction. The interactions were assessed at the target-to-target level and in an aggregated form at the goal level. The magnitude of the interaction is given in a weighted value which is built on contributions from the inspected literature, according to the seven-point scale proposed by Nilsson et al. (2016). Each weight is an aggregated form of the scoring scale contributions where the absolute numbers of the scores are summed up (see the "Data formatting" section in [Pham-Truffert et al., 2020, p.1240] for further description).

The first step of the assessment was at the global level. We studied the interactions from target 11.2 (Sustainable Transport Systems) to SDG 13, 14 and 15, using the weighted scores, as well as the underlying seven-point scale contributions, documented in Pham-Truffert et al. (2019). By using the results from the KPI mapping process, we connected the KPIs to their respective SDG targets and constructed a model, bringing the KPIs and target level interactions together. This model is illustrated in Figure 1a.

Second, we undertook a local level assessment, with respect to the case study context. In this step, we assessed the same interaction paths as in Figure 1a, but now only using the seven-point scoring scale. The contextual dimensions presented in Section 3.2 was incorporated. The output from this assessment was a model, reflecting how the KPIs are interlinked in the context of the case municipalities and is presented in Figure 1b. The mapping process and the interaction assessment, made several findings surface. These findings are elaborated on in the next chapter, the results chapter.

4 | RESULTS

In this chapter, our research findings are presented. The first section presents the findings regarding biosphere-based sustainability in the U4SSC indicator set. After this, the interaction assessment is presented and elaborated.

4.1 | Biosphere-based sustainability in the U4SSC KPIs

The U4SSC KPI mapping procedure led to the following important findings. We found that SDG 11 has the highest coverage of all the SDGs, with a representation in almost half of the U4SSC KPIs. The biosphere-based SDGs have low coverage. SDG 13 was found to have a coverage of 2% (two U4SSC KPIs) while SDG 14 and 15 had 1% (one U4SSC KPI).

It was of interest to study how the KPIs were distributed among the targets of the assessed SDGs. The Collection Methodology describes "SDG Reference(s)" for each KPI, and refers to SDG goal(s), target(s) and/or indicator(s). In Appendices A–D, tables presenting the detailed KPI coverage at the target level of the selected SDGs can be found, along with the full title of each SDG target. Quantitatively inspecting the appendix tables gave some interesting findings as presented in Table 2. The table states the number of targets (both outcome and means of implementation targets) related to each SDG and the number of targets that are covered in the KPIs according to U4SSC (2017). The third column "Target coverage" is the percentage of targets with KPI coverage.

TABLE 2 Table illustrating the U4SSC KPI target coverage for SDG 11, 13, 14 and 15

SDG	Total number of targets	Number of targets with KPI(s)	Target coverage
11: Sustainable Cities and Communities	10	9	90%
13: Climate Action	5	2	40%
14: Life below Water	10	1	10%
15: Life on Land	12	2	17%

We found, not surprisingly, that the large number of KPIs representing SDG 11 gives high target coverage (90%) for this SDG. For the biosphere-based SDGs, the table enables a more balanced understanding. SDG 13 has five targets, where two of them have KPI representation. This gives a target coverage of 40%. Thus, a low number of KPIs (two in this case) does not necessarily mean a low target coverage. On the other hand, high target coverage does not imply that the indicators measure the target progress sufficiently. The high number of targets (10 and 12) related to SDG 14 and 15, respectively, combined with their low KPI representation (one KPI), resulted in a low target coverage for these SDGs.

4.2 | Comparing global and local SDG entity interactions

In this section, we present the findings from our interaction assessment. We will present the global level results presented in Pham-Truffert et al. (2019) and argue to what extent these results can apply to the case study context. The basic properties of the case study were presented in the methods chapter. We assessed all the interaction paths from target 11.2 to the targets of SDG 13 (climate action), 14 (life below water), and 15 (life on land) that were expressed in Pham-Truffert et al., 2019. The full title of target 11.2 is "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (United Nations, 2015b).

We found that seven out of the 11 KPIs related to target 11.2 got a yellow or red score in the county. These KPIs and their corresponding population-adjusted average score are as follows: "dynamic public transport information" (yellow), "traffic monitoring" (red), "intersection control" (yellow), "transportation mode share" (yellow), "shared bicycles" (red), "shared vehicles" (red), low-carbon emission PVs" (yellow). Since it is the KPIs with poor performance that are most likely to be acted upon, we chose to assess these KPIs in the case study interaction assessment. Further, we found that the technical KPIs, "dynamic public transport information", "traffic monitoring" and "intersection control", were not likely to have any critical effect on the influenced biosphere-based KPIs and these were therefore excluded from the assessment. This led to a final set of influencing U4SSC KPIs, included in the case study assessment, namely, "transportation mode share", "shared bicycles", "shared vehicles" and "low-carbon emission PVs".

When assessing the local level interactions, some boundaries had to be established. We assessed the U4SSC KPIs "as is" and when assessing a given interaction, we used the following guiding question: "How would an increase in the performance of the KPIs related to SDG target 11.2 influence this biosphere-based target and (if any) their corresponding U4SSC KPI?". We paid special attention to the areas where we came to a different conclusion than Pham-Truffert et al. (2019).

Pham-Truffert et al. (2019) found five trade-off interactions and two synergistic interactions from target 11.2 to the biosphere-based SDGs. In the following sections, we present the global and local level findings for each of the biosphere-based SDGs.

4.2.1 | SDG 13 - Climate action

Target 11.2 has synergistic interactions with target 13.1 (strengthen resilience and adaptive capacity to climate related disasters) and 13.3 (build knowledge and capacity to meet climate change) (Pham-Truffert et al., 2019). Pham-Truffert et al. (2019) evaluated the interaction from target 11.2 to target 13.1 to have a weight of (+2) and a (+2) score according to the seven-point scoring scale. This origins from United Nations (2016) who state that the literature has focused on how the quality, design, distribution, interrelation, and operation of infrastructure affect its resilience to natural disasters, which in turn influences people's resilience to shocks. For the case study context, we found that the transportation infrastructure is an important part of the resilience to climate-related hazards and natural disasters. This is presented in the transportation contingency plan for M&R county which states that the Ministry of Transport and the counties should arrange for transportation contingency in major crises (Møre og Romsdal fylkeskommune, 2020). Climate change is stated to increase the probability of several of the risks evaluated in the plan (Møre og Romsdal fylkeskommune, 2020). Thus, the interaction score of (+2) was found to apply to the case study context as well. Further, we found that it was hard to find a clear link between target 11.2 and 13.3 in the case study context, and we chose to disregard this interaction from the case study interaction model.

The path from 11.2 to 13.2 (Integrate climate change measures into policies and planning) was demanding to assess. This comes from the fact that increasing the performance of the U4SSC transportation KPIs could be done by various measures, which in turn, will have a different effect on the U4SSC KPI related to target 13.2, namely, "GHG Emissions". The reported value of the "GHG Emissions" KPI in M&R county captures the direct local GHG emissions (Miljødirektoratet, n.d.). Pham-Truffert et al. (2019) quote International Council for Science (2017) in rating this interaction a counteracting (−2) interaction. They state that "Providing more access to transport today (target 11.2) is likely to lead to higher greenhouse gas emissions (target 13.2), thus exacerbating climate change, while measures taken to reduce greenhouse gas emissions can constrain transport access" (International Council for Science, 2017, p.26–27).

Some conflicting arguments came evident in this interaction evaluation. First, an increase in the performance of the "Transportation Mode Share", "Shared Bicycles" and "Shared Vehicles" KPIs mean a shift from private vehicles to more public transport, walking, and cycling, as well as increasing the amount of sharing services related to private vehicles. This shift is likely to lead to lower local GHG emissions, and as such, a strengthening of the performance of the "GHG emissions" KPI. An increase in the performance of the "low-carbon emission passenger vehicles" KPI will also lead to lower local GHG emissions. However, these shifts could require investments that produce GHG emissions, both directly (locally) and indirectly (goods and services produced elsewhere than the given municipality). In the current "Climate Plan", the Norwegian government presents ambitious transport-related climate policies for the coming decade (Meld. St. 13, 2020-2021). An example is the ambition of having fossil-free construction sites in the transportation sector by 2025 (Meld. St. 13, 2020-2021). The current definition of the "GHG Emissions" KPI in M&R county implies that policy improvements that influence the local emissions will influence the "GHG Emissions" KPI. Since this study has a long-term holistic approach, and there are reasons for believing that the investment-related emissions will drop as the climate policies evolve, this interaction was found to contradict (Pham-Truffert et al., 2019), and to be synergistic, with a reinforcing (+2) score, as the achievement of the transport-related U4SSC KPIs aids the achievement of the "GHG Emissions" U4SSC KPI. The synergistic result is in line with the conclusion of Weitz et al. (2018) who found this interaction to be synergistic with a score of (+3).

4.2.2 | SDG 14 and SDG 15 - Life below water and life on land

Regarding policy development on land, coast, and ocean areas, we did not find the same desirable development as with climate laws and policies. The four-year research project EVAPLAN found that nature often loses priority in favour of physical development and business development (Simensen et al., 2022). Brendehaug et al. (2021) state that governmental policies for climate change adaptation and protection of biodiversity are lacing priority in favour of focusing on the reduction of GHG emissions and the energy transition.

Target 14.2 (protect and restore marine and coastal ecosystems), 14.5 (conserve coastal and marine areas), 15.1 (conserve and restore terrestrial and freshwater ecosystems), and 15.2 (end deforestation and restore degraded forests) were included in the assessment. Even though these targets represent different perspectives, we chose to present their case study results collectively since the arguments relevant for the interaction scoring are to a large extent the same arguments.

Pham-Truffert et al. (2019) gave the interaction from target 11.2 to target 14.2 a (−3) weight, which originated from a (−1) and (−2) score, documented in International Council for Science (2017). They state that "Fostering sustainable coastal zone management and increased protection efforts for coastal ecosystems may result in constraints for or even counteract the achievement of several SDG11 targets, depending on the strength of integration of approaches and policies. Interactions may also work in the opposite direction" (International Council for Science, 2017, p.196). Target 14.5 and 15.1 are related to the same KPI, namely, "Protected Natural Areas" and both got an influence of weight (−3) from target 11.2 (Pham-Truffert et al., 2019). Detailed information on the interaction from target 11.2 to target 14.5 states that this interaction is constraining or counteracting and that there is a conflict between increased conservation efforts in the coastal zone on one side and transportation systems on the other (International Council for Science, 2017). Concerning the interaction from target 11.2 to 15.1, Pham-Truffert et al. (2019) found two contributions, IPBES (2019) and IPCC (2018). IPBES (2019) states that nature managed by indigenous peoples and local communities is under increasing pressure and, furthermore, that transport infrastructure is one of the contributing factors (IPBES, 2019, p.14). Lastly, for the interaction from target 11.2 to target 15.2, Pham-Truffert et al. (2019) quote IPCC (2018), stating that expanding road networks is one of the main drivers of deforesting and forest degradation (IPCC, 2018, p.509). This contributed to both a weight and score of (−1) for this interaction.

Assessing what influence increasing the performance of the transport-related U4SSC KPIs could pose on the nature-based targets and (if any) the U4SSC KPIs related to them, was an interesting exercise. M&R county has a long coastline, and the transport system is heavily dependent on bridges, undersea tunnels, ferries, and boats. Further, the county is one of Norway's longest, implying that the roads connecting the county span through rural areas and land-based ecosystems such as forests. One could argue that reaching target 11.2 demands infrastructure investments (i.e., building more roads), and since some roads will utilize natural areas, this is a cancelling (−3) interaction towards the related SDG 14 and 15 targets. However, the various KPIs related to target 11.2 represent different perspectives relevant to this specific interaction assessment. If for instance the performance of the public transport part of the "Transportation Mode Share" KPI is increased in such a way that it leads to less private transport, this could lead to a release of road areas that could be utilized for cycling and walking or be transformed back to their natural state. The same reasoning could for instance be used for the "Shared Vehicles" KPI. This aspect is mentioned in, Brendehaug et al. (2021), stating that a good public transport system will make it easier to reduce the total road areas, and thus protect blue and green zones (Brendehaug et al., 2021, p.60).

Another contribution to these interactions is the threat posed by the release of microplastic from vehicle tires, as well as the release of other hazardous substances from the traffic system (Tamis et al., 2021). Reducing the total amount of vehicle-based traffic could lead to less air dispersal and rainwater runoff of such hazardous substances. Of the targets included in our assessment, this will particularly influence target 14.2 (marine ecosystems). One of the transport-related KPIs represents a possible trade-off influence due to these arguments, namely "low-emission passenger vehicles". Only focusing on increasing the performance of this KPI can undermine the synergistic arguments.

In sum, these findings led to the following case study scores: For the interactions to target 14.2, 14.5, and 15.1, we settled on a counteracting (−2) score, as this was found to represent the "middle way" of our findings regarding possible developments for the influencing U4SSC KPIs. Regarding the interaction to target 15.2, we found that the constraining (−1), trade-off conclusion of Pham-Truffert et al. (2019) was valid for the case context as well.

4.3 | Main findings

The findings of the interaction assessment were summarized in Figure 1. Figure 1b illustrates that target 11.2 exerts a positive influence on target 13.2 for the case study context. The municipalities' work towards better performance on the transport-related KPIs, is likely to pose a positive influence on the "GHG Emissions"-KPI. Target 11.2 was found to have a negative influence on target 14.2, 14.5, 15.1 and 15.2, where the three first interactions were found to be counteracting (−2) and the last was found to be coherent with the constraining (−1) score of Pham-Truffert et al. (2019). We found that the net influence of increasing the performance of the transport-related KPIs for the case study context was negative on the biosphere-based SDGs.

With regards to answering the second research question on how global level SDG entity interactions relate to local level SDG entity interactions, we found the following: Even though our local level findings led to some adjusted scores, compared to the global level findings of Pham-Truffert et al. (2019), the main distribution among synergies and trade-offs was found to be quite coherent (only one interaction changed sign). This implies that global SDG interaction models seem to be a good starting point for assessing interactions at the local level as well, at least for the interactions from target 11.2 to the influenced biosphere-based targets. This is an important and relevant finding for local governments, as their capacity to perform comprehensive assessments on their own, are often limited.

In our KPI mapping process, we found that SDG 13, 14, and 15 had relatively low coverage and that SDG 11 could be said to be the "main SDG", in this indicator set, being covered by almost 50% of the KPIs. The interaction assessment progressed these findings, highlighting that target 14.2 and 15.2 lacked KPIs. Furthermore, the targets of SDG 13, 14, and 15 that had KPI coverage, were found to have insufficient coverage. This could have implications for the possibility to monitor the influence pursuing sector-specific SDG initiatives could pose on the biosphere.

The final interaction model is not by any means an "answer" to how pursuing better performance on target 11.2 will influence the biosphere. Nonetheless, the model can function as an indicative foundation of how a transport-related SDG initiative could influence the biosphere. In the following chapter, we discuss the implications of the findings of the interaction assessment.

5 | DISCUSSION

This study adds further knowledge on SDG interactions by taking the perspective of biosphere-based sustainability in a local governmental context as a starting point and furthermore by evaluating interactions at the U4SSC KPI level. In this chapter, the results are discussed in light of relevant literature and further evaluated in the context of the case study.

Regardless of having KPIs to guide their sustainability efforts or not, local governments often implement sustainability measures in a case by case way, without taking the possible influence one measure could have on other areas into account (Forestier & Kim, 2020; Masuda et al., 2021). As stated in the results chapter, the final interaction model can function as an indicative foundation. This means that such models can guide the decisions in municipalities toward a more holistic sustainability practice. As stated by Horvath et al. (2022), systemic research and policy advice, especially on the development of policies and measures to achieve the SDGs, is urgently needed. An SDG interaction model like the one constructed in this paper can contribute to connecting sectors both within a single government and between governmental levels, and can as such facilitate policy coherence.

Further, as recognizing trade-offs in SDG processes has been found to be one of the main governance challenges influencing SDG implementation (Bowen et al., 2017), perspectives of sub-optimality should be included. Sub-optimality in the form of trade-offs, can be found throughout the biosphere; these trade-offs are not a sign of failure but are indicative of a properly functioning system (Skene, 2020). The trade-off output from one sub-system could be another sub-system's input, leading to a synergistic system as a whole. For instance, the trade-off interaction from target 11.2 to target 15.1 reflects a possible negative influence on life on land. An example of such influence could be the process of building road infrastructure in terrestrial areas. The tradeoff output could, for instance, be biomass (as trees) and biodiversity losses. If the biomass is used as input materials to buildings, and the biodiversity loss is compensated for by protecting at least as much qualitative terrestrial area elsewhere in the municipality, this trade-off interaction has led to synergistic interactions to SDG 12 (Responsible consumption and production) and a synergistic loop back to SDG 15. An important point when using a general interaction model is therefore to adapt the initiative in question such that synergies are accelerated, and the trade-offs are redesigned to become another initiative's synergistic fuel. This is in line with the recent study by Kostetckaia and Hametner (2022), who found that it is crucial to tackle the question of how trade-offs can be overcome and ideally turned into synergies in order to ensure the achievement of the SDGs in their entirety.

Research on global versus local SDG entity interactions is scarce. Warchold et al. (2021) assessed similarities and differences in SDG interactions among four regional groups. They found both similarities and differences in the SDG pairs of relevance to this study (SDG 11 to SDG 13, 14 and 15). Hernández-Orozco et al. (2021) state that many authors argue that the nature of SDG interactions will vary significantly based on local contexts and realities. Thus, our local level findings must be interpreted in light of their context, and generalization of findings should be done with caution.

We also found that the U4SSC indicator set is lacking in its coverage of the biosphere-based SDGs. On one hand, this results in an unbalanced and insufficient coverage of the targets related to these SDGs and, on the other hand, a downgrade of the biosphere. This is in line with the findings of Zeng et al. (2020) on the global SDG indicators. The famous saying "what gets measured gets managed" (cited in for instance Klaus (2015)) has proved to be a fact in many organizations and gives an accurate picture of the consequences absence of indicators could lead to. Since we have found several trade-off interactions to the biosphere-based SDGs, we would argue that the lack of accurate biosphere-based indicators can pose damaging consequences for the biosphere.

6 | CONCLUSION

This study contributes to both research and practice by assessing how biosphere-based sustainability can be achieved through the SDGs in a local governmental context. The research questions of the paper were as follows: (1) Do the SDGs promote a biosphere-based understanding of sustainability and if so, how? (2) How do global level SDG entity interactions relate to local level SDG entity interactions? The research questions have been answered in a stepwise manner, firstly through a literature review, and subsequently assessing KPI coverage, global level KPI interactions, and interactions in the context of the case study. The main contribution of this study is our unique approach of conducting a local level assessment which aligns an existing sustainability measurement system with interaction research.

The first research question relates to how the SDGs promote a biosphere-based understanding of sustainability. By conducting a literature review using a snowballing approach, we found that there is no clear and definite answer to this question. We found that some argue for a thematic arrangement (Morton et al., 2017; Stockholm Resilience Centre, 2016; United Nations, 2015b; Waage et al., 2015), specifying a set of goals that cover the biosphere. Furthermore, some scholars critique the SDGs for being in contrast with the planetary boundaries (O'Neill et al., 2018; Randers et al., 2018), and their achievement for being ecologically unjustifiable (Jain & Jain, 2020). Our literature review did not aim to conclude on a final set of biosphere-based SDGs as the indivisible attribute of the goals as well as the characteristics of a biosphere-based sustainability makes such a view too simple. We did, however, settle on assessing SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land) in our SDG interaction study, thus being able to ascertain how pursuing SDG-rooted initiatives could influence some components of the biosphere. Our second research question deals with the relation between global and local level interactions. By conducting a case study and utilizing the interaction study conducted by Pham-Truffert et al. (2020), we constructed a KPI-level interaction model, illustrating how target 11.2 (sustainable transport systems) influences SDG 13, 14, and 15 for the average municipality in M&R county. We found that using the seven-point scoring scale presented in Nilsson et al. (2016) provided good guidance in evaluating the influence posed by the various interactions. Our methodological approach provides transferability and scalability for the benefit of other local and regional governments and is the main strength of this study. Figure 1 presents our interaction model for the global and local levels. The local level interaction scores were, in most cases, found to be consistent with Pham-Truffert et al. (2019) underlying findings.

This research contributes to the call for adapting the initiative such that synergies are accelerated and trade-offs are redesigned to promote biosphere-based sustainability solutions (Skene, 2020). This study has explored a highly important territory and we have gained valuable insights that can be implemented in the daily activities of local governments. The statement saying that the indivisibility principle of the SDGs will prove to be the toughest challenge in the coming years (Maurice, 2015), is certainly an aspect that this study reflects.

Limitations of this study are related to the framing of biosphere-based sustainability and the interaction framework. Assessing biosphere-based sustainability from the perspective of SDG 13, 14 and 15 represent a limitation in the choice of SDGs; it also makes it difficult to incorporate the indivisibility principle sufficiently. With regards to the interaction framework, there is a possibility of bias since this study used the work by Pham-Truffert et al. (2020) as a basis for evaluating interactions. This also implied that targets without documented interactions in Pham-Truffert et al. (2020) were not evaluated. Furthermore, the data reported by the municipalities could have errors, which could influence the results. The findings are case-specific, thus the limited regional scope makes the study inappropriate for generalization of findings.

This study contributes to filling the knowledge gap within SDG interactions at the local governance level. However, knowledge of interactions takes us only one step further. It is the operationalization of this knowledge that is of crucial importance and on which we and the future generations depend. We have started addressing these urgent matters in this paper, but more research is needed.

To broaden the knowledge base within the accomplishment of the 2030 Agenda, the impact of taking a biosphere-based sustainability perspective at the local level could be assessed more comprehensively, including several or all, SDG targets. In addition to this, the practical implications of operationalizing SDG interaction models, such as the one developed in this paper, in local governments would be a natural next step for building upon the findings of this paper. Furthermore, implications of the indivisibility principle of the SDGs with regard to the biosphere and policy coherence is an area with many conflicting interests, yet it is an urgent area to address. Given the emissions gap (van Soest, 2022) and the deteriorating state of the planet's ecosystems (IPBES, 2019), incorporating a biosphere-based approach to sustainability is perhaps the only reasonable approach to sustaining the planet as we know it.

ACKNOWLEDGMENTS

We would like to thank Liv Kjersti Finholt in Ålesund Municipality for sharing valuable insights relevant for the case study. This research was funded, in part, by The Research Council of Norway (327222).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ORCID

Rita Nerland https://orcid.org/0000-0002-8812-5750

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How to cite this article: Nerland, R., Nilsen, H. R., & Andersen, B. (2022). Biosphere-based sustainability in local governments: Sustainable development goal interactions and indicators for policymaking. *Sustainable Development*, 1–17. https://doi.org/10.1002/sd.2371

APPENDIX

A. SDG 11 - SUSTAINABLE CITIES AND COMMUNITIES

TABLE A1 SDG 11 targets and united for smart sustainable cities KPI overview.

SDG 11 targets	United for smart sustainable cities KPIs
11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	• Integrated building management systems in public buildings • Informal settlements • Housing expenditure
11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	• Dynamic public transport information • Traffic monitoring • Intersection control • Public transport network • Public transport network convenience • Bicycle network • Transportation mode share • Travel time index • Shared bicycles • Shared vehicles • Low-carbon emission passenger vehicles
11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	• Voter participation • Public building sustainability • Pedestrian infrastructure • Urban development and spatial planning - compact
11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage	• Cultural expenditure • Cultural infrastructure
11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations	
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	• Solid waste collection • Air pollution • GHG emissions • Solid waste treatment • Noise exposure
11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	• Green areas • Green area accessibility • Recreational facilities
11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	• Urban development and spatial planning - compact
11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels	• Resilience plans • Population living in disaster prone areas
11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials	• Integrated building management systems in public buildings

B. SDG 13 - CLIMATE ACTION

TABLE A2 SDG 13 targets, united for smart sustainable cities KPI overview and interaction findings.

SDG 13 targets	United for smart sustainable cities KPIs	11.2 interaction findings
13.1 strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Natural re-disaster lated deaths	Synergistic
13.2 Integrate climate change measures into national policies, strategies and planning	GHG emissions	Synergistic
13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning		Not evaluated
13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible		Out of scope
13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities		Out of scope

C.SDG 14 - LIFE BELOW WATER

TABLE A3 SDG 14 targets, united for smart sustainable cities KPI overview and interaction findings.

SDG 14 targets	United for smart sustainable cities KPIs	11.2 interaction findings
14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution		No interaction[a]
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans		Trade-off
14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels		No interaction[a]
14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics		No interaction[a]
14.5 By 2020, conserve at least 10% of coastal and marine areas, consistent with national and international law and based on the best available scientific information	Protected natural areas	Trade-off
14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation		No interaction*
14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism		No interaction[a]
14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries		Out of scope
14.b Provide access for small-scale artisanal fishers to marine resources and markets		Out of scope
14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"		Out of scope

[a]No interaction in Pham-Truffert et al. (2019).

D.SDG 15 - LIFE ON LAND

TABLE A4 SDG 15 targets, united for smart sustainable cities KPI overview and interaction findings.

SDG 15 targets	United for smart sustainable cities KPIs	11.2 interaction findings
15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	Protected natural areas	Trade-off
15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally		Trade-off
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world		No interaction[a]
15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development		No interaction[a]
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species		No interaction[a]
15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed		No interaction[a]
15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products		No interaction[a]
15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species		No interaction[a]
15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts		No interaction[a]
15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems		Out of scope
15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation	Protected natural areas	Out of scope
15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities		Out of scope

[a]No interaction in Pham-Truffert et al. (2019).