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Enhance environmental policy coherence to meet the Sustainable Development Goals

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A B S T R A C T

Ensuring policy coherence across environmental, social and economic goals is a key challenge to sustainable development. The United Nations Sustainable Development Goals (SDGs) and their constituent targets and indicators provide a framework to track progress of the multiple dimensions that characterise sustainability. Though the SDGs are all expressly equally important, they vary in complexity, the level of agreement on key concepts and definitions, representativeness of indicators, and availability of data. Here, by analysing quantitatively the implementation of the SDGs in the European Union, we show that the environmental goals are by some distance the most complex and least coherent of the SDGs. We highlight the need to improve data availability and prioritise both monitoring and strengthening of coherence within and among biodiversity and climate SDGs in particular. Our findings inform critical areas for financing sustainable development and provide solutions for designing post-2030 Agendas with improved potential for achieving policy coherence.

1. Introduction

The agreement of the United Nations (UN) member states on the Sustainable Development Goals (SDGs) amounts to a major global policy achievement (UN, 2015; Ripple et al., 2017). Governments around the world have committed to protect ecosystems, promote equality and focus on sustainable development, while simultaneously recognizing the interconnectedness of these objectives for achieving human wellbeing. Though a fundamental accomplishment, this interconnectedness also creates a significant challenge. As synergies are emerging both across and within the goals, so are trade-offs. These trade-offs increase the complexity of the goals and challenge the implementation of coherent political solutions for sustainable development, increasing the risk that the process of balancing interests and priorities will fail (Lu et al., 2015; Le Blanc, 2015; Scherer et al., 2018; Pham-Truffert et al., 2020). In contrast, when trade-offs are minimized and synergies enhanced, Agenda 2030 delivers on its potential and progress towards the SDGs accelerates (Nilsson et al., 2016).

Policy coherence refers to the integration of all dimensions of sustainable development (that is, economic, social, environmental and governance) at all stages of domestic and international policymaking (OECD, 2015). The SDGs are designed such that no one goal should be prioritised over others (UN, 2015). However, intergovernmental policy processes, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the Intergovernmental Panel on Climate Change (IPCC), the Paris Agreement, and the European Union (EU) New Green Deal, are calling for much greater emphasis on climate change and biodiversity loss in particular. These calls are likely to be fuelled further by the ongoing coronavirus crisis, which is linked to the destruction of ecosystems (Dixon-Decléve et al., 2020; Davidson, 2020), and demonstrates so clearly the inextricable connections between nature conservation, health security and economic stability. There is, therefore, a real need for renewed efforts to ensure policy coherence not only within and among the very broad policy areas of the SDGs (Mortensen and Petersen, 2017), but also among the SDGs and emerging national and international policies, such as incoming policy actions for addressing the impending economic recession and its impacts, and climate change adaptation and mitigation policies (Jenetschek et al., 2020; Ronzon and Sanjuán, 2020).

Here, we examine how the complexity and coherence of the

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SDGs varies both within and among the goals, and explore the factors underlying this variation. First, we discuss the multidimensional nature of the SDGs, and how their breadth and interconnectedness—their key advance (Costanza et al., 2014; Le Blanc, 2015)—simultaneously comprise a threat to their attainment. We then examine how policies that are coherent at the highest level of the policymaking process can lose much of their coherence and become more complex during policy implementation, as those goals are translated into targets and, ultimately, the indicators that are used to measure progress towards them. Using the EU as a case study, we then quantify the complexity and coherence of the SDGs and show that this problem is especially acute for environmental goals, which are both more complex and less coherent than social and economic ones. Finally, we suggest solutions, highlighting critical areas where further resources and research efforts should be directed for improving coherence for the SDGs and to inform the definition of post-2030 Agendas.

2. The multidimensional nature of policy goals

Progress towards meeting the SDGs and the 2030 Agenda is quantified and monitored through a set of targets and indicators for each goal (https://sdgs.un.org/goals). Targets expound the goals, specifying explicitly the various dimensions that together comprise the overall goal. Indicators are the metrics used to track progress towards achieving each target (Ritchie and Mispy, 2018). Every SDG is, therefore, explicitly multidimensional, with its dimensionality, or complexity, then reflected by the number of targets that underpin it and the relationships between those targets. The latter defines the coherence of the goal. The more targets that constitute a goal, the more important their coherence becomes.

If all targets are aligned and relationships between them strong, the overall goal is both coherent and conceptually simple. For example, one target for SDG 15 "*Life on Land*" is to "*take urgent … action to reduce the degradation of natural habitats, [and] halt the loss of biodiversity*" (Target 15.5). Another (Target 15.1) is to "*ensure the conservation, restoration and sustainable use of … ecosystems and their services*". Clearly, these targets align closely, and progress towards one will likely reflect progress towards the other. Where relationships between targets are weak or non-existent, however, the goal becomes increasingly complex and less coherent. Another target (15.6) of SDG 15 is to "*promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources*". Inclusion of this target increases the complexity of the overall goal, as progress towards it could be made entirely independently of the others. Indeed, focus on it might even hinder progress towards them. The increase in dimensionality that arises from this loss of coherence makes policy goals considerably more difficult to attain. It demands more and more effort from all stakeholders to be placed into an increasing breadth of frequently unrelated actions, and therefore increases the risk of failing to achieve targets.

Agreement on policy objectives, though a major achievement, is only one step in the policymaking process. Ultimately, the success of policy depends upon the faithful translation of policy goals into clearly defined targets that are directly quantifiable. Many policy targets are, however, non-specific or vague, and most biophysical targets lack detailed quantification (Stafford-Smith, 2014). This leaves room for different interpretations, adding to the problem of incoherence. The necessity for directly quantifiable targets demands use of unambiguous and clearly defined terms throughout to enable consistent and meaningful quantification of progress and evaluation of success or failure. Many policy initiatives—including the SDGs (Bosch et al., 2015; Lu et al., 2015; Donohue et al., 2016)—describe targets that may appear, on face value, explicit and measurable, yet contain terms that are ambiguous, or have multiple definitions that mean different things to different people. The use of such terms in policy can cause crippling disconnects from the science that is needed to underpin it (Donohue et al., 2016). Elsewhere (Donohue et al., 2016; Pimm et al., 2019), we examine the use of many such terms relating to sustainability in policy and suggest modifications that remove ambiguity and make targets measurable.

Though meaningful measurements are essential to effect meaningful change, the choice of indicators used to measure progress towards policy targets is not determined solely by scientific understanding and the extent to which targets use defined and unambiguous terms. Ultimately, this choice is determined by the availability of relevant and precise data collected at appropriate spatial and temporal resolutions. Thus, while the conceptual complexity of policy goals is encapsulated in the targets that underpin them, the choice of indicators determines their realised complexity. Next, we discuss how this contributes to considerable disparities in the complexity of economic, social and environmental policy goals.

3. Environmental goals are more complex than social and economic ones

In March 2017, the United Nations Statistical Commission (UNSC) adopted a global SDG indicator set developed by the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs). UN Member States are encouraged to adapt this indicator set to their national contexts for designing SDG monitoring reports. This approach provides flexibility for countries to develop more specific indicator sets and implementation policies. It also enables countries with limited measurement and reporting capacities to report on the SDGs in a flexible way (Bizikova and Pinter, 2017). The choice of indicator set plays a fundamental role in implementing the SDGs, not only because of its role as a management tool to measure progress and design and refine strategies for sustainability, but also because it guides the allocation of resources and identification of key stakeholders and their contributions to delivering on the SDGs (Kroll, 2015). In addition, it exposes where knowledge is lacking and more information, data and research are needed.

Defining distinct indicator sets that comprehensively reflect our understanding of the different SDGs is an ambitious—and perhaps unrealistic—condition. In reality, the development and availability of appropriate statistics is highly unequal across the economic, environmental and social sciences and does not always reflect advances in theory or empirical understanding. Perception of the relevance of, and connections among, environmental, social and economic policy goals varies considerably across countries and stakeholder groups (Bain et al., 2019). Economic goals such as increasing Gross Domestic Product typically receive widespread policy agreement, irrespective of scientific evidence or the loss of coherence such policies can bring about (Coscieme et al., 2020). There is, for example, broad evidence that GDP is a misleading indicator of progress and wellbeing (Fioramonti, 2013; Coscieme et al., 2020), as economic growth above a certain threshold brings about environmental and social impacts that overshadow further marginal benefits to wellbeing (Stiglitz et al., 2010; Stiglitz, 2012; Trebeck and Williams, 2019).

In contrast, there is a widespread shared understanding of the fundamental role of the environment for human development and existence (Reid et al., 2017; IPBES, 2019). Whereas economic data and, to a lesser extent, social data dominate global development databases, environmental data are, however, remarkably under-represented. Of the 1600 indicators in the World Bank World

Development Indicators database (WDI, World Bank, 2019), only 8% (138) pertain to the environment. The UN Statistical Yearbook (2019), which provides "*internationally available statistics on social, economic and environmental conditions and activities at the national, regional and world levels*", includes a similar proportion (11%, 3 out of 28). This skewed distribution across economic, social and environmental indicators is typical of perhaps all such databases, and brings about a significant problem when it comes to choosing indicators. It means that the risk of critical disconnects between targets and how meaningful are our measurements is disproportionately strong for environmental policy goals.

While this disparity is unfortunate in itself, it also reflects in part a deeper problem. Though broad agreement exists on measures of economic wealth and on how to define the structure of human populations (e.g. Fioramonti, 2014), scientific disagreement around such fundamental concepts as how ecosystems respond to environmental change (e.g. Rockström et al., 2006; Steffen et al. 2015; Montoya et al., 2019; Heck et al., 2018; Hillebrand et al., 2020) have led to a range of narratives on what and how to measure (e.g. Hodgson et al., 2015; Grafton et al., 2019; Pimm et al., 2019). As a consequence, communication between environmental science and policy on this most critical of issues has been poor (Donohue et al., 2016). Ultimately, these issues reflect perhaps the difficulties scientists have in comprehensively understanding complex ecological responses to environmental change and encapsulating them in as few dimensions as possible. Even so, more consistent and coherent communication from scientists on the detailed measurements that are needed to support policy—and on the research that is needed to attain those—is essential in order to develop and make available meaningful indicators of environmental change that are relevant from national to global scales (Adshead et al., 2019; Lucas et al., 2019).

Certainly, achieving comprehensive and coherent indicator sets for the SDGs is a significant challenge. By exploring how different countries and groups of countries are finding solutions for completing this task, we gain valuable information for designing more effective SDG-like initiatives in the future and for directing resources to critical areas for enhancing knowledge, communication, data gathering and indicator development. The EU SDG Reference Indicator Framework is exemplary in its ambition to regularly monitor progress towards the SDGs in all EU Member States by means of a set of indicators that not only have to be relevant and available across all countries, but also representative of the overall diversity of the Union. Next, we examine how this choice of indicators realises the complexity of the SDGs in the EU, and explore the coherence and trade-offs that occur both within and among them.

4. Complexity of the SDGs in the EU: a case study

In November 2017, the European Commission, led by the EU statistical office Eurostat, selected a list of 100 indicators to be used to measure progress towards SDG targets across all countries in the European Union in a consistent manner (Table S1). In accordance with the UN Fundamental Principles of Official Statistics (General Assembly resolution 68/261), the SDG indicators are disaggregated, where relevant, by income, sex, age, or other characteristics. This returns a total of 270 metrics used to measure progress towards the SDGs that comply with the quality criteria of the European Statistics Code of Practice (Eurostat, 2019).

We used Principal Component Analysis (PCA) to measure the realised complexity of the SDGs in the EU. Specifically, we compared the proportion of variance accounted for by the first principal component calculated from the full EU indicator set (that is, using all measures available, and based on correlation matrices calculated from standardised indicator data) for each SDG. Lower proportional variance in the first principal component equates to higher dimensionality, and thus greater complexity, of the goal. We used the most recent data point available for each of the EU-28 Member States, returning one value per indicator per country (all data from 2016 to 2018; there are 27 EU Member States from 31 January 2020). We found (Fig. 1a) that the environmental goals SDGs 13 "*Climate Action*" and 15 "*Life on Land*" are the most complex of all the SDGs, whereas the economic goal SDG 8 "*Decent Work and Economic Growth*", and social goals SDGs 17 "*Partnership for the Goals*" and 10 "*Reduced Inequalities*" have lowest realised complexity. When we scale up from examining complexity within goals to that within the groups of core environmental, social and economic SDGs (as identified by Costanza et al. 2016), we find that the core environmental goals are the most complex, followed by the economic and social goals (Fig. 1b).

As the realised complexity of the SDGs is determined both by the number of indicators and the relationships among them, standardising by the number of indicators allows us to compare the relative coherence of the goals. Doing this reveals (Fig. 2a) that the four environmental goals 13 "*Climate Action*", 15 "*Life on Land*", 12 "*Responsible production and Consumption*" and 6 "*Clean Water and Sanitation*" are the least coherent of all the SDGs. When we scale up from individual SDGs to examine coherence among the indicators pooled across the three core groups of SDGs, we find a pattern consistent with that for complexity, with the environmental SDGs being least coherent, followed by the economic goals, with the social goals being the most coherent (Fig. 2b).

Next, we explored the prevalence of potential trade-offs among indicators both within SDGs and in the core groups of economic, environmental and social SDGs. We did this by quantifying the proportion of pairwise correlations between indicators that were significantly negative, after first accounting for the directionality of the indicators (that is, whether an increase or decrease in their value indicates progress towards targets; Table S1). We found significant negative correlations between indicators within all but three of the SDGs—SDGs 1 "*No Poverty*", 4 "*Quality Education*" and 13 "*Climate Action*" (Fig. 3a). Typically, these potential trade-offs were driven primarily by a single indicator behaving in opposite pattern to others (Table 1). For example, trade-offs in SDG5 "*Gender Equality*"—the goal with the highest prevalence of negative correlations between indicators——were driven primarily by the indicator "*Physical and sexual violence to women*" correlating negatively with most other measures of gender equality, which typically (though not exclusively) correlated positively with each other (Table 1). Though potential trade-offs at the within-SDG scale occurred broadly across all goal types (Fig. 3a), the proportion of negative correlations within the core environmental SDGs was less than half those within the core economic and social goals (Fig. 3b).

So, in the EU, environmental goals are the most complex and least coherent of all the SDGs, reflecting the disparate and frequently unconnected ways we characterise environmental quality. However, we also found that the environmental goals exhibit the fewest trade-offs among policy goals. This suggests that improving coherence within and among environmental goals will have a disproportionately positive and rapid effect in terms of progress towards achieving targets compared to the social and economic goals, where greater frequencies of trade-offs among indicators are more likely to hamper progress. These results are particularly informative for identifying areas where extending and strengthening policy coherence is urgently needed. They also provide evidence as to where improvements in data collection and indicator design are necessary and provide mechanisms to enhance and monitor policy coherence in order to produce more effective outcomes. Next, we discuss how these insights could bring about

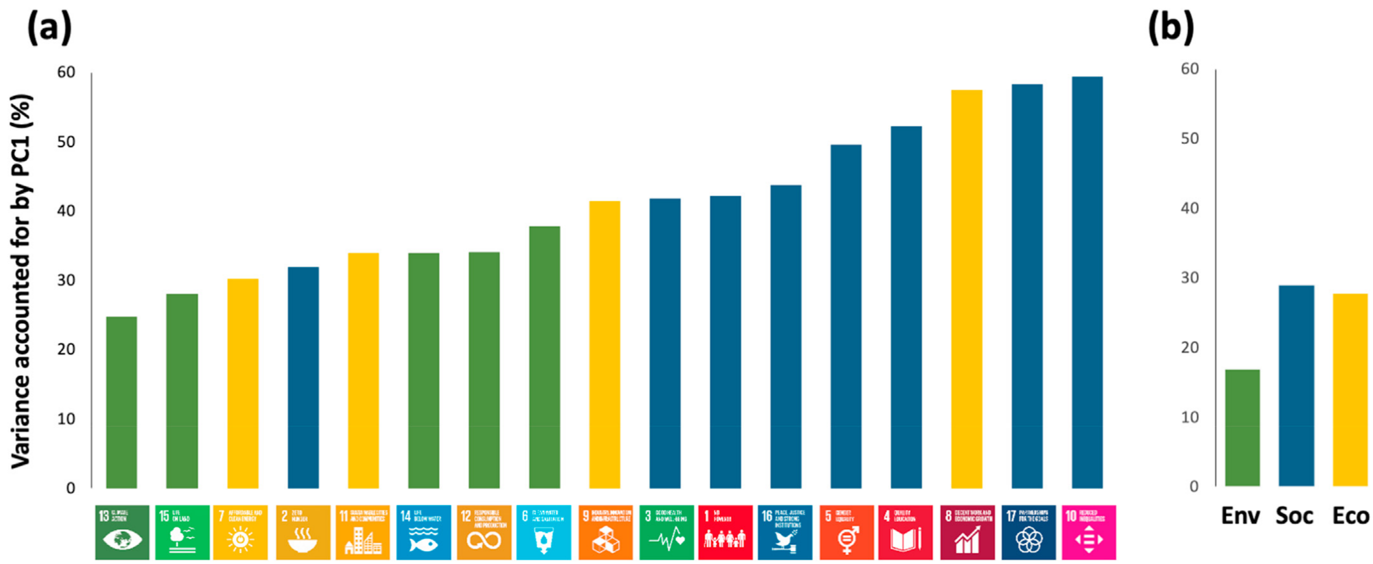

Fig. 1. Complexity of the SDGs. The proportion of variance in the full EU indicator set accounted for by the first principal component (PC1) for (a) each SDG and (b) pooled across the core environmental (Env), social (Soc) and economic (Eco) SDGs. Lower proportional variance in PC1 equates to higher dimensionality—and thus greater complexity—of the overall goal. Green, blue and yellow bars correspond, respectively, to environmental, social and economic SDGs. All indicators were standardised before analysis. Analyses were done using the *factoextra* package in R (version 4.0; Kassambara and Mundt, 2020).

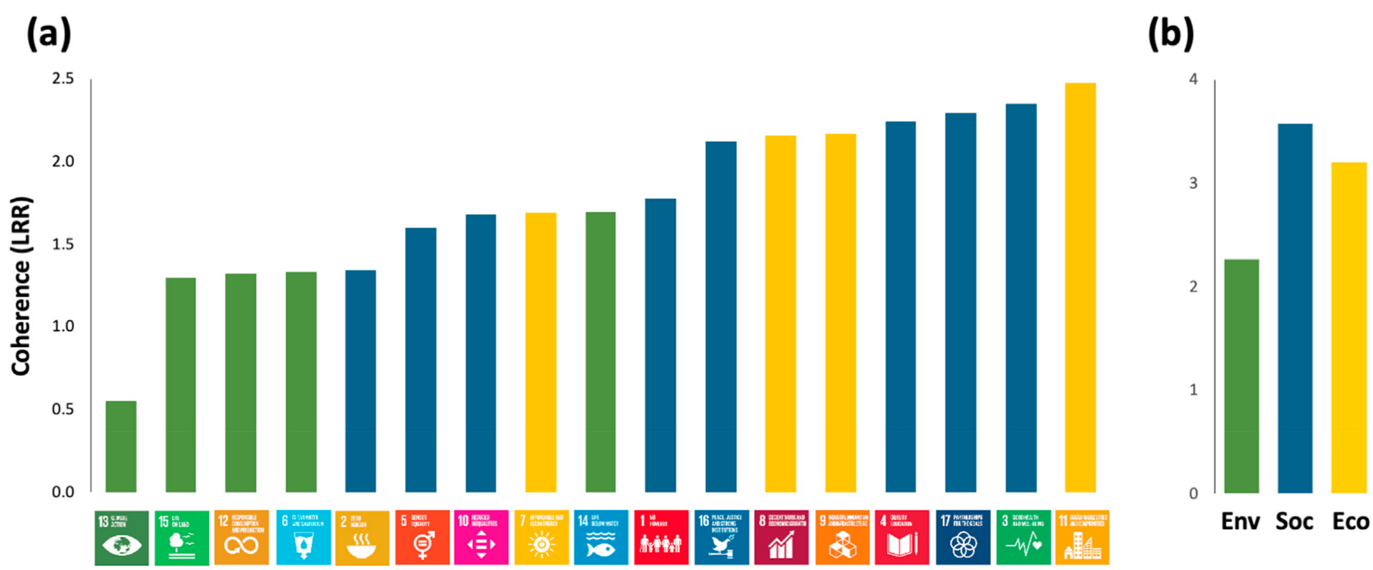

Fig. 2. Coherence within and among the SDGs. The relative coherence of indicators within (a) each SDG and (b) the core environmental (Env), social (Soc) and economic (Eco) SDGs, measured as the log response ratio (LRR) of observed proportional variance accounted for by PC1 relative to the variance expected if there was zero coherence among indicators (that is, the null expectation). The latter (calculated as 1/[number of contributing indicators]) enables us to standardise for the varying number of indicators underpinning each SDG. Higher LRRs correspond to greater coherence. Green, blue and yellow bars correspond, respectively, to core environmental, social and economic SDGs.

solutions for designing post-2030 Agendas with improved potential for achieving policy coherence.

5. Discussion

In spite of widespread and shared acknowledgement of the urgent need to tackle environmental issues such as the climate and biodiversity crises (IPBES, 2019; IPCC, 2018; Prober et al., 2019), our results demonstrate that much of the coherence that is present in policy agendas is then lost at the implementation phase (Reyers and Selig, 2020; Turney et al., 2020). This highlights a pressing need to explore new ways for designing more effective and coherent environmental policies before they are implemented, with more complete delineation and partitioning of environmental goals in particular. Our finding that they are quantitatively the least coherent and most complex of the SDGs in the EU indicates that the individual environmental goals are excessively broad, and need to be partitioned further into more coherent groupings. The relative lack of negative correlations we found among the environmental indicators in general (that is, within the core group of environmental SDGs) suggests that this process would be unlikely to introduce unanticipated new trade-offs.

Creating more, and more focussed, environmental goals is, however, only part of the solution. Addressing urgent and complex global challenges such as climate change and biodiversity loss also requires more comprehensive consideration of better knowledge

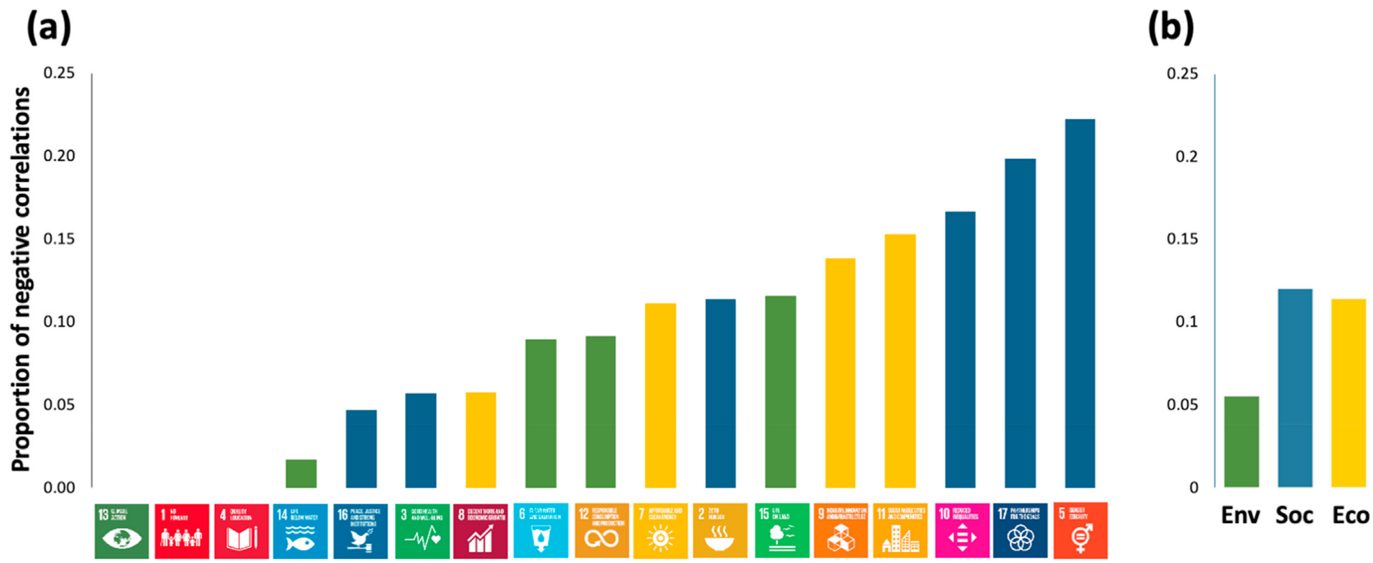

Fig. 3. Trade-offs within and among the SDGs. Proportion of significant ($P < 0.05$) negative correlations (a) within each SDG and (b) within the core groups of economic, environmental and social SDGs, calculated using EU SDG indicators. Negative correlations were assessed after correcting for the directionality of indicators (that is, whether an increase or decrease in their value indicates progress towards targets). Green, blue and yellow bars correspond, respectively, to core environmental, social and economic SDGs.

Table 1
Indicators driving potential trade-offs within the SDGs. Potential trade-offs (that is, negative correlations) across indicators within each SDG tend to be largely driven by a single indicator, as shown by the proportion of negative correlations in the EU SDG indicator set. SDGs 1, 4 and 13 did not present any potential trade-offs. Negative correlations were assessed after correcting for the directionality of indicators (that is, whether an increase or decrease in their value indicates progress towards targets).

SDG	Indicator responsible for most negative correlations	Negative correlations accounted for by that indicator (%)
1 "*No Poverty*"	–	–
2 "*Zero Hunger*"	Ammonia emissions from agriculture	33.3
3 "*Good Health and Well-Being*"	Smoking prevalence by sex - smoking occasionally males	17.6
4 "*Quality Education*"	–	–
5 "*Gender Equality*"	Physical and sexual violence to women by age group	35
6 "*Clean Water and Sanitation*"	Water exploitation index by type of water source - Fresh groundwater	50
7 "*Affordable and Clean Energy*"	Final energy consumption in households per capita	17.6
8 "*Decent Work and Economic Growth*"	Real GDP per capita	50
9 "*Industry, Innovation and Infrastructure*"	Share of rail and inland waterways in total freight transport	19
	Share of busses and trains in total passenger transport - Motor coaches, buses and trolley buses	19
10 "*Reduced Inequalities*"	Relative median at-risk-of-poverty gap	50
11 "*Sustainable Cities and Communities*"	Difficulty in accessing public transport by level of difficulty and degree of urbanisation - high, total	12.6
12 "*Responsible Consumption and Production*"	Volume of freight transport relative to GDP	40
13 "*Climate Action*"	–	–
14 "*Life Below Water*"	Surface of marine sites designated under NATURA 2000	50
15 "*Life On Land*"	Share of forest area - Forest FAO	16.7
	Artificial land cover per capita by type - artificial land	16.7
	Estimated soil erosion by water - area affected by severe erosion rate	16.7
16 "*Peace, Justice and Strong Institutions*"	Population reporting occurrence of crime, violence or vandalism in their area by poverty status - below 60% of median equivalised income	25
	General government total expenditure on law courts	25
17 "*Partnerships for the Goals*"	General government gross debt	22.2

when designing policy agendas. It demands significantly improved availability and quality of environmental data to enable selection of a meaningful, equitable and coherent set of indicators for monitoring progress towards policy goals. When such resources are not available, means have to be directed for filling gaps in knowledge and data. Statistical criteria for inclusion of indicators may also need to be altered. Excessively stringent requirements, in terms of, for example, frequency of dissemination and timeliness, though perhaps appropriate for many social and economic indicators, result in the exclusion of vast swathes of key environmental data. This includes data on biodiversity, which changes over longer timescales and tends to be considerably more complex and time-consuming to measure. Omitting potentially meaningful indicators because of inclusion criteria that work well for some but not other goals ultimately undermines policy coherence and is self-defeating. This requires that alternative ways of integrating indicators with different temporal, and indeed spatial, resolutions are explored.

After appropriate indicators have been selected, coherence can be enhanced during the policy implementation phase by monitoring the indicator set to minimise potential trade-offs and measuring the realised dimensionality and coherence within and among policy goals, much as we have done. Identification of indicators that respond differently to others, for example, provides the basis for informing tailored interventions for addressing potential trade-offs. Where significant negative correlations likely reflect non-causal statistical associations between indicators (that is, where there is no clear mechanistic link between the patterns or processes measured by the indicators), the indicator responsible should be considered for removal or replacement in order to increase coherence. However, where identified negative relationships are likely to be causal, this awareness can direct management interventions to address the cause of the trade-off in order to maintain and enhance progress towards achieving targets.

6. Conclusions

Achieving policy coherence is particularly important for policy goals that entail a global dimension, such as tackling climate change or environmental degradation and biodiversity loss. The global nature of today's markets for energy, goods, money and environmental resources, coupled with the high mobility of people and production systems, requires that international policies become increasingly effective, coordinated, and complete. This will necessitate stronger coherence not only within policies, but also among them.

Our analyses identified a lack of coherence within and among environmental policy goals in particular. Our findings thus resonate with policy recommendations from the UN Report "*The Future is Now*" (UN, 2019), and the WWF synthesis of the IPCC and IPBES reports (WWF, 2019), among others, in calling for countries to improve coordination of climate, biodiversity and sustainable development policies. Current Nationally Determined Contributions for mitigating climate change will need to be enhanced significantly by the end of 2020 to close the gap between what pledged under the Paris Agreement and what is needed to limit global warming to 1.5 °C (WWF, 2019; IGES et al., 2019), while more coherent biodiversity protection would contribute substantially to multiple international obligations, given the strong interlinkages between, for example, biodiversity and public health, water and soil conservation, and climate change mitigation. The one-year postponement, as a consequence of the coronavirus crisis, of the 2020 meetings of the Conference of the Parties (COP) for the United Nations Framework Convention on Climate Change (UNFCCC COP26) and the Convention on Biological Diversity (CBD COP15) is being seen as an opportunity to create an integrated policy framework between the two (Turney et al., 2020). Broadening and intensification of such efforts is critical to addressing urgent global environmental problems.

Achieving policy coherence is a challenge, but at the same time an absolute necessity. It requires not only agreement on the most relevant aspects of sustainable development, but also clear and faithful translation of the many dimensions of goals to quantifiable targets and meaningful indicators, and monitoring of the performance of those indicators throughout the lifetimes of policies. Against this backdrop, our work comprises an important step forward by developing a novel quantitative analysis for assessing policy coherence. Though others have explored policy coherence at the level of targets (*e.g.* Le Blanc, 2015; Nilsson et al., 2018), we focused on coherence further down the implementation chain, where it could be quantified by means of indicator values. This provides a pathway for future studies to apply our quantitative framework to design comprehensive sets of sustainability indicators with the aim of maximising coherence and orienting more effective policy agendas. Given the significant disparities we identify, prioritising the enhancement of coherence within and among environmental policies in particular is essential, not only to enhance implementation of the SDGs and inform the design and impact of post-2030 Agendas, but to provide the basis for the meaningful environmental protection that is essential to underpin truly sustainable development.

CRediT authorship contribution statement

Luca Coscieme: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, writing, Visualization, Funding acquisition. **Lars F. Mortensen:** Conceptualization, writing, Supervision. **Ian Donohue:** Conceptualization, Methodology, Formal analysis, writing, Supervision.

Declaration of competing interest

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.

Table S1
Eurostat list of indicators for the SDGs. Indicators are disaggregated, where relevant, by income, sex, age, or other characteristics. Data were extracted from the Eurostat website (https://ec.europa.eu/eurostat) on January 2018.

SDG	Indicators
1 "*No Poverty*"	People at risk of poverty or social exclusion - People at risk of income poverty after social transfers - Severely materially deprived people - People living in households with very low work intensity – Housing cost overburden rate - Population living in a dwelling with a leaking roof, damp walls, floors or foundation or rot in window frames of floor by poverty status
2 "*Zero Hunger*"	Obesity rate by body mass index (BMI) - Agricultural factor income per annual work unit (AWU) - Government support to agricultural research and development - Area under organic farming - Gross nitrogen balance on agricultural land - Ammonia emissions from agriculture
3 "*Good Health and Well-Being*"	Life expectancy at birth by sex - Share of people with good or very good perceived health by sex - Smoking prevalence by sex - Death rate due to chronic diseases - Suicide rate - Self-reported unmet need for medical examination and care by sex
4 "*Quality Education*"	Early leavers from education and training by sex - Tertiary educational attainment by sex - Participation in early childhood education by sex - Underachievement in reading, maths or science - Employment rates of recent graduates by sex - Adult participation in learning by sex
5 "*Gender Equality*"	Physical and sexual violence to women by age group - Gender pay gap in unadjusted form - Gender employment gap - Inactive population due to caring responsibilities by sex - Seats held by women in national parliaments and governments - Positions held by women in senior management positions
6 "*Clean Water and Sanitation*"	Population having neither a bath, nor a shower, nor indoor flushing toilet in their household by poverty status - Population connected to at least secondary waste water treatment - Biochemical oxygen demand in rivers - Nitrate in groundwater - Phosphate in rivers - Water exploitation index by type of water source
7 "*Affordable and Clean Energy*"	

Table S1 (*continued*)

SDG	Indicators
	Primary energy consumption - Final energy consumption - Final energy consumption in households per capita - Energy productivity - Share of renewable energy in gross final energy consumption by sector - Energy import dependency by products - Population unable to keep home adequately warm by poverty status
8 "*Decent Work and Economic Growth*"	Real GDP per capita - Young people neither in employment nor in education and training by sex (NEET) - Employment rate by sex - Long-term unemployment rate by sex - Involuntary temporary employment - People killed in accidents at work, by sex
9 "*Industry, Innovation and Infrastructure*"	Gross domestic expenditure on R&D by sector - Employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors - R&D personnel by sector - Patent applications to the European Patent Office - Share of busses and trains in total passenger transport - Share of rail and inland waterways in total freight transport
10 "*Reduced Inequalities*"	Purchasing power adjusted GDP per capita - Adjusted gross disposable income of households per capita - Relative median at-risk-of-poverty gap - Gini coefficient of equivalised disposable income - Income share of the bottom 40% of the population - Asylum applications by state of procedure
11 "*Sustainable Cities and Communities*"	Overcrowding rate by poverty status - Population living in households considering that they suffer from noise, by poverty status - Difficulty in accessing public transport - People killed in road accidents - Exposure to air pollution by particulate matter - Recycling rate of municipal waste
12 "*Responsible Consumption and Production*"	Resource productivity and domestic material consumption (DMC) - Average CO2 emissions per km from new passenger cars - Volume of freight transport relative to gross domestic product (GDP) - Generation of waste excluding major mineral wastes by hazardousness - Recycling and landfill rate of waste excluding major mineral waste
13 "*Climate Action*"	Greenhouse gas emissions - Greenhouse gas emissions intensity of energy consumption - Climate related economic losses by type of event - Contribution to the international 100bn USD commitment on climate related expending - Population covered by the Covenant of Mayors for Climate & Energy signatories
14 "*Life Below Water*"	Surface of marine sites designated under NATURA 2000 - Catches in major fishing areas - Bathing sites with excellent water quality by locality
15 "*Life On Land*"	Share of forest area - Surface of terrestrial sites designated under Natura 2000 – Artificial land cover per capita – Change in artificial land cover - Estimated soil erosion by water - Common bird index by type of species
16 "*Peace, Justice and Strong Institutions*"	Standardised death rate due to homicide by sex - Population reporting occurrence of crime, violence or vandalism in their area by poverty status - General government total expenditure on law courts - Perceived independence of the justice system - Corruption Perceptions Index - Population with confidence in EU institutions by institution
17 "*Partnerships for the Goals*"	Official development assistance as share of gross national income - EU financing to developing countries by financing source - EU imports from developing countries by country income groups - General government gross debt - Share of environmental taxes in total tax revenues

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