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Short communication

Insights on the United Nations Sustainable Development Goals scope: Are they aligned with a 'strong' sustainable development?

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ABSTRACT

The seventh edition of the International Workshop "Advances in Cleaner Production" (IWACP) was held at Universidad de La Costa, Colombia, in June 2018. Thematic sections were held for allowing theoretical discussions and practical activities, with the main goal of supporting discussions on the United Nations Sustainable Development Goals (UN-SDGs). Participants provided their perception on the allocation of UN-SDGs as relevant for managing the main forms of capital (environmental, economic and social) within two different sustainability conceptual models: a "traditional" model (representing the interdependence and substitutability among the environment, social and economic capitals), and the five sectors sustainability model (5SenSu). Results show an unbalanced distribution of SDGs among the capitals for both sustainability models, with social capital perceived as the most relevant across the SDGs. Particularly, the environment as a resource provider supporting societal development is perceived as relevant only for SDG 6 (Clean Water and Sanitation). The main outcomes of the workshop emphasize the need for further efforts towards a more objective interpretation of policy goals in post Agenda-2030 initiatives. The SDGs must be clearly understood and have a scientific resonance to objectively support public policies. Sustainability models, such as the 5SenSu, have the potential to support a more balanced definition of sustainable development goals across the different dimensions of sustainability.

1. Introduction

The International Workshop on Advances in Cleaner Production (IWACP; advancesincleanerproduction.net) is a multi/interdisciplinary forum for the exchange of information and research results on technologies, concepts and policies focused on cleaner production. Its main target is to assist the desired transition to a sustainable society. Its 7th edition was held in Barranquilla, Colombia, as a three-days event under the theme 'Cleaner Production for achieving the Sustainable Development Goals' (SDGs) discussed by all participants during the event. The event brought together 58 universities and colleges from 20 countries, presenting 99 academic contributions and recent achievements in cleaner production. Major challenges and solutions for mapping and maximizing the contribution of cleaner production for achieving the SDGs were extensively discussed at plenary sessions, in oral presentations, and workshops.

As one of the current hot topics in scientific and political arenas, the UN SDGs were the event's backbone. Although recognized as fundamental in both theoretical and practical studies, the UN SDGs have been criticized in supporting discussions and actions towards a sustainable development of society because they are not, or only incompletely, rooted on a strong conceptual model of sustainability (Wackernagel et al., 2017). Biggeri et al. (2019) also highlighted the need for a more balanced and integrated set of SDGs, as well as the

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need for a stronger sustainability conceptual model that recognizes the importance of environment, economy and society as irreplaceable capitals.

It is not hard to find scientific works on sustainability in which a conceptual model supporting indicators choice, interpretation of results, and discussion is missing (Agostinho et al., 2019). The definition of sustainability by the United Nations Brundtland Report (1987) allows different interpretations and the proposition of different conceptual models, including "weak", "medium" and "strong" relationships among the three main forms of capital (social, economic and environmental). The weak sustainability model, named from here as 'traditional', is characterized by an interdependent relationship among capitals, allowing their total substitutability. For example, the environmental capital can be reduced as far as this reduction causes an equal increase in economic or social capital, and vice versa. On the other hand, the strong sustainability model implies that the different capitals cannot be substituted among each other, since they provide different and unique contributions. Although several different models exist, it is recognized that strong sustainability must be pursued for medium to long-term strategic political planning, since it considers the Earth's biophysical limits in providing resources and receiving waste (Rockström et al., 2009).

As a contribution to the scientific discussion on sustainability assessment, Giannetti et al. (2019) proposed a different interpretation of sustainability, which is represented by the five sectors sustainability model (5SenSu; Fig. 1). This model stems upon: (i) a multi-dimensional approach embracing social, economic and environmental dimensions or capitals; (ii) multiple perspectives, by assuming both the donor and receiver side of different forms of capital; (iii) a multi-metric approach allowing the use of different indicators; (iv) a multi-criteria approach that requires the use of weighting techniques and composite indicators. According to the authors, all these characteristics together with the consideration of all of the three forms of capital, make the 5SenSU a more holistic model than others available in literature.

Accommodating the seventeen SDGs within the 5SenSu model is a relevant exercise to verify: (1) if and how the SDGs cover aspects of each one of the different forms of capital; (2) if the SDGs are distributed in a balanced way among the forms of capital; and (3) if sustainability experts have similar understandings of each SDGs. To perform this task, there is no better room than a scientific meeting with high quality audience - scientists from different disciplines and countries - dealing with sustainability issues in their research activities.

2. The 7th IWACP thematic sections

When submitting their scientific work to the 7th IWACP, authors were requested to choose from one to three among the seventeen SDGs (Appendix A) considered as closely related to the main theme of their work. Having this information, and knowing the scientific profile of the invited key speakers and the number of participants (including listeners and presenters), the workshop's organizing committee selected four SDGs (Table 1) with the aim of putting together experts that, potentially, could provide different perspectives on one particular SDG during the workshop discussions. All the thematic sections were carried out under a similar structure by including a half hour exposition of concepts and ideas behind the SDG, followed by an exercise in which each participant provided his/her thoughts on the SDGs as related to two different conceptual models of sustainability: the 5SenSU and the traditional models. The two following key questions were considered by the thematic sections' chairs to steer the discussions:

Question #1: Is the use of the 5SEnSU model helpful in allocating the SDGs among the different forms of capital (or sectors)? Do you identify any disadvantage or misunderstanding about the 5SenSU as a conceptual model for sustainability? Would you suggest any improvement?

Question #2: Should the SDGs come first as a conceptual model

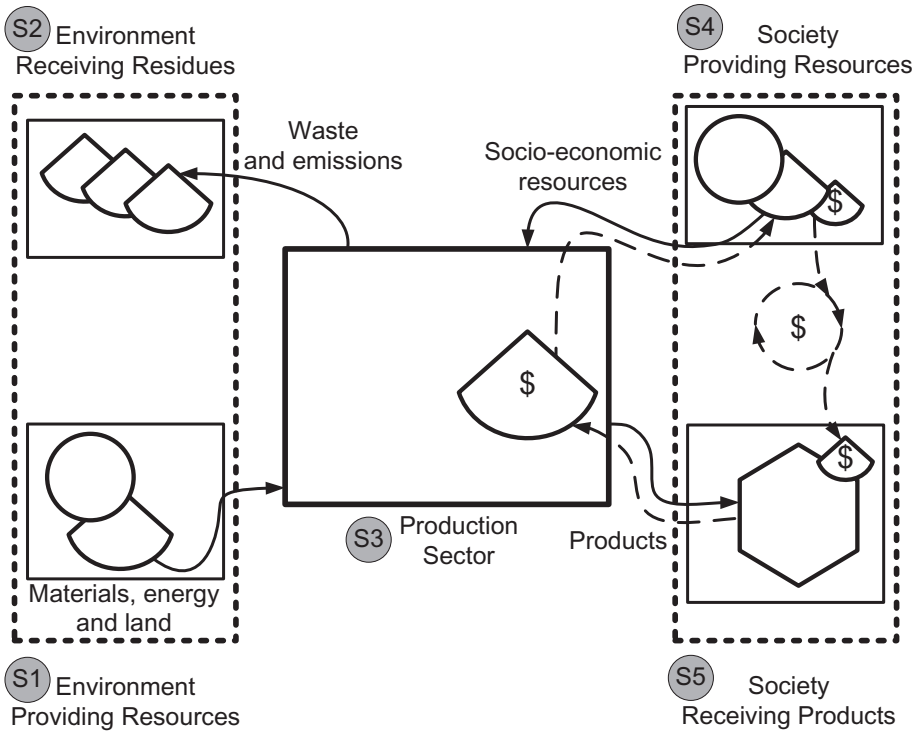

Fig. 1. Five sectors sustainability model (5SenSu). S: sectors. Dashed lines indicate monetary flows in exchange to energy flows. Model adapted from Giannetti et al. (2019).

Table 1
Main characteristic of the thematic sections.

Thematic sections	Chairman	Chairman's main research topics	Participants
Responsible consumption and production, SDG 12	Prof. Dr. Feni Agostinho, Paulista University, Brazil Prof. Dr. Gengyuan Liu, School of Environment, Beijing Normal University, China	- Sustainability assessment of production systems. Cleaner production and Industrial ecology. - Urban ecological planning and management. Emergy analysis. Food-energy-water nexus. Circular economy.	28
Climate action and affordable clean energy, SDG 7	Prof. Dr. Carlo Vandecasteele, University of Leuven, Belgium Prof. Dr. Luís E. Velázquez Contreras, University of Sonora, Mexico	- Waste management, treatment and recycling. Cleaner production. Environmental impact assessment. - Sustainability. Cleaner production. Pollution prevention. Sustainable universities.	24
Sustainable cities and communities, SDG 11	Dr. Luca Coscieme, Researcher at Trinity College Dublin Prof. Dr. Paul Sutton, University of Denver, USA	- Ecosystem services and natural capital evaluation. - Geography, ecology, economics and Philosophy. Human, environment, sustainability problematic.	26
Industry innovation and infrastructure, SDG 9	Carlos Poveda (MSc. & MBA), Universidad de Bogotá Jorge Tadeo Lozano, Colombia Prof. Dr. Cecília M.V.B. Almeida, Paulista University, Brazil	- Technical and financial evaluation of waste recovery projects, generation of energy from waste, treatment and reuse of wastewater. - Cleaner production. Industrial ecology. Sustainability indicators.	22

representing sustainability, or should a *construct* supporting the SDGs come first?

The chairmen were assigned to the thematic sections that better aligned with their expertise. A similar number of participants attended each one of the four thematic sections (Table 1). Overall, the SDGs selected for the thematic sections are in line with the vision of the Advances in Cleaner Production Network, which identifies cleaner production and sustainable consumption as powerful tools for continuous applications of integrated, preventive strategies when holistically applied in process optimization, and in ethical product and service design and delivery in accelerating the transition to equitable, sustainable, livable, post-fossil carbon societies.

3. Results

Fig. 2 presents the perception of the 100 participants of the four thematic sections on the traditional conceptual model of sustainability. The highest share of participants understands most of the SDGs as directly related to social capital. Specifically, considering the higher percentage of participants perception for each SDG as a criterion, four of them (6, 13–15) were related to the environmental capital, three to the economic capital (7–9), and ten to the social capital (1–5, 10–12, 16–17). This perception of the SDGs as mostly related to the social dimension is in line with further groupings of the SDGs as environmental, social, and economic. For example, Costanza et al. (2016) identify eight SDGs as social (1–5, 10, 16 and 17), four as economic (7–9, 11 and 12) and four as environmental (6, 13–15), similarly to Kettunen et al. (2018) which refer to a classification by the Stockholm Resilience Centre. This classification is also recalled by Fioramonti et al. (2019), which relate eight SDGs specifically to social capital. Mortensen (2018), further distinguish three SDGs (13–15), as core environmental.

From these results, a lack of balance emerges among the SDGs in terms of how they relate with the three main forms of capital, with social capital overrepresented, followed by the economic and environmental ones. In a scenario where a country, a region, a city, an industry, etc. achieves all the established SDG targets, it will be labelled as sustainable even if the SDGs mostly focus on social aspects. Assuming that a 'weak' sustainability conceptual model allows the substitution of any form of capital with another one without compromising sustainability, this unbalance is acceptable, but it calls for the implementation of a 'strong' sustainability thinking for monitoring progress towards sustainability in the long-term.

Although few SDGs were perceived as related to only one form of capital (i.e., 98% of participants understands SDG5 as a social indicator, and 80% understands SDGs 3, 10 and 16 as social as well), the classification of most of the SDGs was heterogeneous among the participants. For example, SDG 7 (affordable and clean energy) was related to environmental capital by about 22% of participants, to economic capital by about 42% of participants, and to social

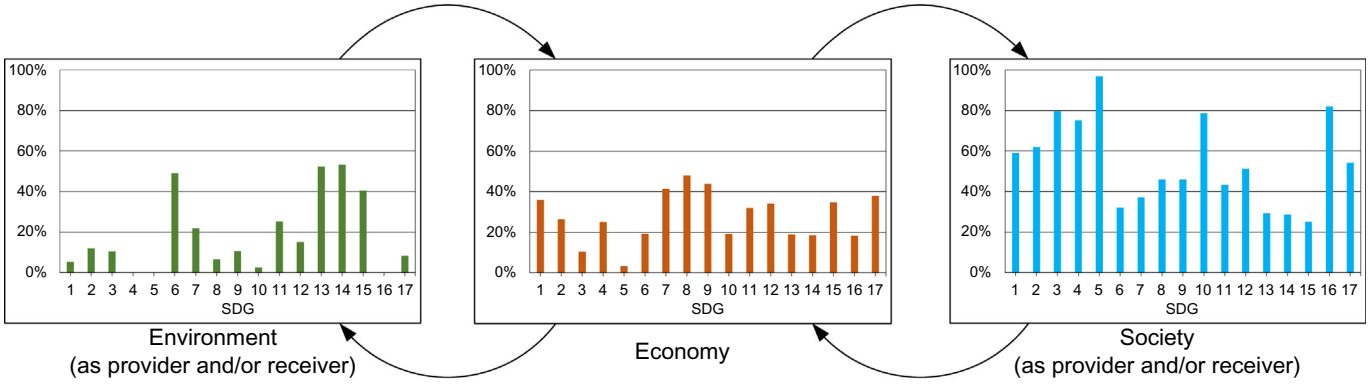

Fig. 2. Perception of the participants to the 7th IWACP on the distribution of 17 SDGs along the three main forms of capital (environment, economy and society) in the traditional conceptual model of sustainability. Table B1 shows the results separated by thematic sections.

capital by about 36% (similar results were found for SDGs 6, 8, 9, 11–15). We understand this heterogeneous interpretation as a negative signal for the SDGs, which calls for the definition of a sustainability model based on which targets should be structured for aligning a scientific understanding of sustainability with practical policy purposes.

Considering the same criterion of higher percentage of participants' perception for each SDG, a similar analysis was performed considering SDGs allocation under the 5SenSUS model (Fig. 3). In this case, SDGs 13, 14 and 15 were related to the environment receiving waste, SDG 6 to the environment providing resources, SDGs 7, 8, 9, and 12 to the production sector, SDGs 5, 10, 11, 16, and 17 to society as provider, and SDGs 1, 2, 3, and 4 to society as receiver of products. As well as for the traditional sustainability model, there is an unbalanced distribution of the SDGs across the five sectors of the 5SenSU model. In particular, there is a concentration of SDGs related to society as provider (five SDGs), while only one SDG is related to the environment providing resources. As also observed by Wackernagel et al. (2017), our results suggest that according to the participants perception, the biophysical limits of the natural environment in providing resources to support societal development at the basis of the 'strong' sustainability approach (Neumayer, 2003; Meadows et al., 1972; Wackernagel and Rees, 1996; Odum, 1996; Odum and Odum, 2006), are underconsidered in the UN 2030 Agenda and the SDGs. All other sectors seem to be balanced and/or well represented with a similar number of SDGs.

With the exception of SDGs 8 and 9 (decent work and economic growth; industry, innovation and infrastructure), with about 70% of participants relating them to the production sector, it is evident from Fig. 3 a heterogeneous allocation of the SDGs across the five sectors. For example, focusing on SDG 2 (zero hunger), 12% understands it as belonging to the environment as supplier sector, 2% to the environment as receiver, 28% to the production sector, 24% to the society as supplier, and 34% to the society as receiver. A similar heterogeneous allocation emerges for all other SDGs. Should not the SDGs be related to one form of capital or sector within a sustainability model in order to allow a homogeneous interpretation and quantification by researchers for informing policy?

According to the United Nations, the SDGs provide "*a shared blueprint for peace and prosperity for people and the planet, now and into the future*", by recognizing "*that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests*" (UN-SDGs, 2019). These statements have important key aspects related to a 'strong' sustainability vision: (i) they recognize the importance of people but also of the planet; (ii) they recognize that 'time' is an important variable, and short, medium and long term actions and policies should be strategically considered; (iii) they recognize the society, economy and environment as important forms of capital relevant to sustainability. On the other hand, our results show that the environment as a provider of resources, and its biophysical limits, are only partially addressed by the SDGs.

Considering now the initial questions #1 and #2 that guided the discussions in the thematic sections, Tables 2 and 3 show the main outcomes from participants as well as from the section chairs. The outcomes can be summarized as follows: (1) the 5SenSu provides a good representation/conceptual model for sustainability, although it lacks the consideration of biophysical boundaries as limits to growth; (2) most of the SDGs are not clearly allocated to one specific sector or form of capital, which, although reflecting the complexity of environmental, social and economic contributions to sustainability, might imply that SDGs are difficult to implement in sectorial policies; (3) the SDGs are perceived as the result of a more practical rather than scientific-based approach to sustainability, a strong conceptual model is thus fundamental to ensure that sustainable development policies reflect scientific knowledge.

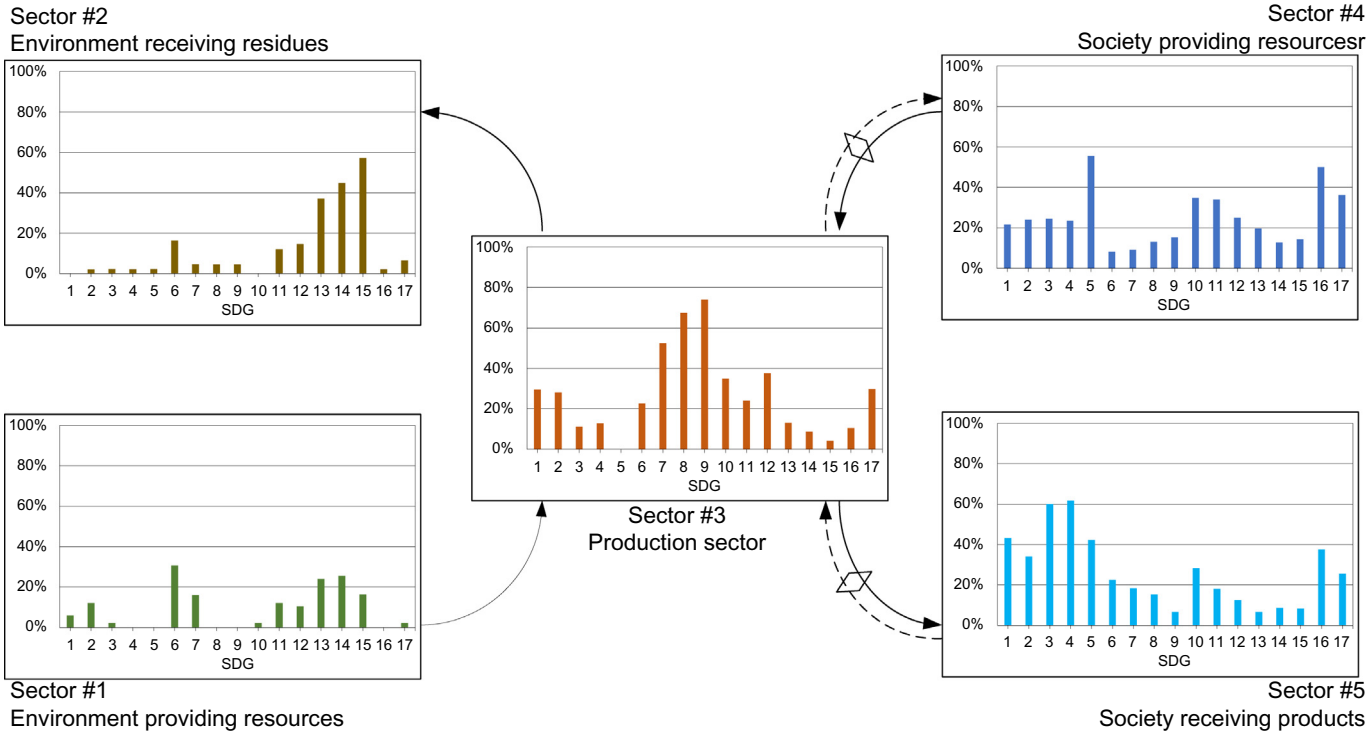

Fig. 3. Perception of the participants to the 7th IWACP on the distribution of 17 SDGs along the 5 sectors of the 5SenSu sustainability model. Dashed lines indicate monetary flows, connected by the diamond symbol with respective energy/matter flows. Appendix B shows the results separated by thematic sections.

Table 2
Highlights from the discussions regarding Question #1: Is the use of the 5SEnSU model helpful in allocating the SDGs among the different forms of capital (or sectors)? Do you identify any disadvantage or misunderstanding about the 5SenSU as a conceptual model for sustainability? Would you suggest any improvement?

Thematic sections	Chairman	Outcomes
Responsible consumption and production, SDG 12	Prof. Dr. Feni Agostinho & Prof. Dr. Gengyuan Liu	Yes, the 5SenSu is helpful in allocating SDGs because it provides more options (5 sectors) than the traditional conceptual model (3 capitals). Problems identified: (i) Since both donor and receiver sides of the environment and society are represented by the 5SenSu, a deeper understanding (that demands time and specific knowledge) is needed about the meaning of each SDG and its targets. (ii) Usually, one SDG focuses on a unique capital or sector, but others reach more than one capital; notwithstanding, the "action" from a SDG can be easily allocate to one capital or sector, but the "results" of that action would fallen into a different SDG. This raises doubts about in which capital or sector that SDG should be really allocated. No misunderstanding about the use of 5SenSU representing sustainability was discussed; participants easily understood that 5SenSu derives from an open system receiving resources and generating outputs, including the negative ones. One identified disadvantage of 5SenSU is the lack of clear representation for biophysical restrictions for growth, a current important global aspect due to energy and materials scarcity and global warming issues. No comments suggesting improvements for the 5SenSU were provided during the thematic section, since its limitations were understood - as well for all existing models.
Climate action and affordable clean energy, SDG 7	Prof. Dr. Carlo Vandecasteele & Prof. Dr. Luís E. Velázquez Contreras	No disadvantage or misunderstanding about the 5SenSU as a conceptual model of sustainability were noticed. One could wonder if the SDGs are not by their formulation confusing. If it were the purpose that each SDG would be mainly be attributed to one sector, one should e.g. SDG 7 affordable and clean energy not bring these two together, affordable is a social criterion and clean an environmental one. A major criticism on the SDGs is that there is no direct SDG on conserving essential resources (critical metals) for the future. Of course, this is part of SDG 12, but it is not visible. Nevertheless, this is very important and essential for the sustainability and for the production and use of green energy.
Sustainable cities and communities, SDG 11	Dr. Luca Coscieme & Prof. Dr. Paul Sutton	The participants highlighted how trans-boundary issues are not covered within SDG 11 targets and indicators. As the 5SEnSU specifically considers the capacity and the limits of the environment in providing resources and absorbing waste, it can serve as a model for making post-2030 Agenda initiatives more relevant for global, instead of only local, sustainability. Specifically, for SDG 11 on "sustainable cities and communities", no target nor indicator informs on how big a city could be in order to be sustainable, in terms of either built area or population. Regarding society, as provider and receiver of services, the participants suggested that SDG 11 should include an indicator accounting for how much money people make compared to how much money people need to live in a specific city. We believe that the 5SEnSU may assist people in identifying the structure of relations among the environment, society and the economy, thus suggesting what aspects (or flows, or relations) are not being properly addressed by an evaluation model such as the SDGs.
Industry innovation and infrastructure, SDG 9	Carlos Poveda (MSc. & MBA) & Prof. Dr. Cecília M.V.B. Almeida	The challenges that most business currently face in order to become more sustainable are complex and interdependent. Participants saw the proposed 5SEnSU as very effective in establishing the correlation and inter-dependency among the different capitals involved in business sustainability. It was helpful, in the sense that capitals and sectors were recognized and understood. However, the 5SEnSU model mainly focuses on the interactions between the economic capitals and environment and society, missing apparently to show that there is also an important correlation between the societal and environmental capitals. These two capitals have important interactions related direct and indirectly to the SDGs such as providing sufficient food, clean water and sanitation, and access to renewable energies. One suggestion discussed was in representing inlet and outlet lines among environment (S1 and S2) and society (S4 and S5), transforming the graphic representation in a circular figure.

Table 3
Highlights from the discussions regarding Question #2: Should the SDGs come first as a conceptual model representing sustainability, or should a *construct* supporting the SDGs come first?

Thematic sections	Chairman	Outcomes
Responsible consumption and production, SDG 12	Prof. Dr. Feni Agostinho & Prof. Dr. Gengyuan Liu	Although the 5SenSU was considered as helpful, the same difficulties in allocating the SDGs as found in the traditional model of sustainability persisted in the 5SenSU. Participants discussed about the lack of a "connection" or "relationship" among the SDGs and the conceptual models of sustainability presented, which resulted in an operational difficult in allocating SDGs among the capitals or sectors (this is confirmed by the graphs presented in the main text of this report). This identified operational difficult raises a discussion on whether the SDGs are well represented and distributed into sustainability conceptual models (traditional or the 5SenSU one). At this point, two perceptions were pointed out: (i) Yes, the SDGs must considerer a conceptual model of sustainability as a construct to avoid misunderstandings. (ii) No, the SDGs proposition is a result of studies from experts in the field of sustainability focused on public policies, because that, SGDs should be seeing as preferably applicable *in factum* instead of for theoretical purposes. Anyhow, no consensus on this issue was achieved and the issue is still open for discussions.
Climate action and affordable clean energy, SDG 7	Prof. Dr. Carlo Vandecasteele & Prof. Dr. Luís E. Velázquez Contreras	The most logical is to have a model first. The model should assure that if all sectors in the model are addressed sustainability is achieved. The model should also allow quantification of the progress towards sustainability. For this, appropriate indicators are needed. The best indicator would relate to one sector rather than being multi-sectorial. However the SDGs are not indicators for sustainability, they are goals. They list goals that are good for humanity, but it is not sure that they assure a sustainable world "where our children have the same possibilities as we received".
Sustainable cities and communities, SDG 11	Dr. Luca Coscieme & Prof. Dr. Paul Sutton	Based on our answers to question 1, we believe that goals should be defined on the basis of an understanding of the set of relationships existing among the environment, society and economy. This understanding should be based on recognizing the global dimension of sustainability and the Earth's biophysical limits. This would highlight the importance of including measures of trans-boundary impacts (how a city is impacting the surrounding areas and how is affecting other systems globally?), and measures of total, extensive, impact, as opposed to only focusing on intensive measures of efficiency.
Industry innovation and infrastructure, SDG #9	Carlos Poveda (MSc. & MBA) &	From the discussions during the workshop, there was evidence that there is some grade of misinterpretation on the SDGs, largely because some of the targets are very open and not sufficiently specified. There was identified a significant room for improvement in defining priorities and indicators, especially when the goals are connected

(*continued on next page*)

Table 3 (*continued*)

Thematic sections	Chairman	Outcomes
	Prof. Dr. Cecília M.V.B. Almeida	to industries, business and private sectors. At the same time, it was acknowledge that by setting these goals and targets, there has been significant public awareness that brought the discussions about sustainability to the public agenda in many countries, bringing the opportunity to open spaces for discussions such as those during the 7th IWACP. An exciting discussion was held on the need of a construct supporting SDGs, but no consensus was gathered; while some understand that a conceptual sustainability model should help to set goals in a fairer fashion by contemplating environment and society equally, others understand that more plans for actions are indeed needed.

4. Conclusions

The unbalanced distribution of the SDGs as relevant to the three main forms of capital (environmental, social and economic) indicates that both environmental and economic capital should receive further attention in terms of number of goals, in post-2030 agendas for sustainable development. By considering the 5SenSU model, we were able to understand further which specific capital or sector of sustainability are less represented by the SDGs. In particular, the environment acting as provider of resources was related to only one of the SDGs (i.e. SDG 6, clean water and sanitation). Since 'strong' sustainability must be understood within the Earth's biophysical limits, it is urgent to rethink about the SDGs and their targets, making some of them more relevant for the environment as a source. This aspect is strongly aligned to cleaner production concepts and practices towards resource savings.

In spite of the inspirational nature of this kind of global initiative, the heterogeneous interpretation of the SDGs by the participants to the 7th IWACP calls for further efforts by policymaking for improving the understanding and scientific resonance of future SDG-like initiatives.

Credit author statement

Biagio F. Giannetti: Conceptualization, methodology. Feni Agostinho: Data curation, Writing (original draft preparation, reviewing and editing). Cecília M.V.B. Almeida: Writing (review). Gengyuan Liu: Writing (review). Luis E.V. Contreras: Writing (review). Carlo Vandecasteele: Writing (review). Luca Coscieme: Writing (reviewing and editing). Paul Sutton: Writing (review). Carlos Poveda: Writing (review).

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.

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Appendix A. UN 2030 agenda for sustainable development. Source: UN-SDGs (2019)

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reducing Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life On Land
16. Peace, Justice, and Strong Institutions
17. Partnerships for the Goals.

Appendix B. SDGs allocation according to thematic sections

Table B1
Results of the 7th IWACP participants perception on the allocation of UN-SDGs within the capitals of sustainability conceptual models. Values are in % of total participants.

SDG	Thematic section: Responsible Consumption and Production (28 participants)								Thematic section: Climate action and affordable clean energy (24 participants)							
	Traditional model[a]			5 SenSU model[b]					Traditional model[a]			5 SenSU model[b]				
	S1	S2	S3	S1	S2	S3	S4	S5	S1	S2	S3	S1	S2	S3	S4	S5
#1	0	24	76	5	0	21	37	37	0	29	71	7	0	29	7	57
#2	6	41	53	6	0	35	35	24	0	36	64	14	0	21	7	57
#3	6	24	71	6	0	29	35	29	7	7	86	0	0	0	7	93
#4	0	12	88	0	6	11	33	50	0	21	79	0	0	0	8	92
#5	0	0	100	0	6	0	67	28	0	0	100	0	0	0	31	69
#6	47	29	24	33	11	33	6	17	57	14	29	31	23	15	8	23
#7	35	47	18	27	7	47	7	13	29	36	36	15	8	46	8	23
#8	0	82	18	0	0	82	6	12	0	93	7	0	0	77	8	15
#9	0	76	24	0	0	76	18	6	14	64	21	0	8	77	8	8
#10	12	59	29	6	0	65	18	12	0	36	64	0	0	21	36	43
#11	29	24	47	17	17	11	39	17	21	36	43	0	7	43	29	21
#12	29	53	18	6	22	50	17	6	7	50	43	7	7	50	14	21

Table B1 (*continued*)

SDG	Thematic section: Responsible Consumption and Production (28 participants)								Thematic section: Climate action and affordable clean energy (24 participants)							
	Traditional model[a]			5 SenSU model[b]					Traditional model[a]			5 SenSU model[b]				
	S1	S2	S3	S1	S2	S3	S4	S5	S1	S2	S3	S1	S2	S3	S4	S5
#13	67	17	17	47	24	18	12	0	64	7	29	14	57	7	7	14
#14	82	12	6	35	47	12	6	0	86	0	14	29	64	0	0	7
#15	88	12	0	11	83	6	0	0	79	7	14	38	46	0	8	8
#16	0	6	94	0	6	6	39	50	0	14	86	0	0	14	36	50
#17	6	24	71	0	11	17	39	33	14	29	57	7	0	29	36	29
SDG	Thematic section: Sustainable cities and communities (26 participants)								Thematic section: Industry innovation and infrastructure (22 participants)							
	Traditional model[a]			5 SenSU model[b]					Traditional model[a]			5 SenSU model[b]				
	S1	S2	S3	S1	S2	S3	S4	S5	S1	S2	S3	S1	S2	S3	S4	S5
#1	10	70	20	11	0	44	11	33	0	30	70	0	0	33	22	44
#2	25	25	50	20	10	20	30	20	11	33	56	11	0	33	22	33
#3	10	30	60	0	0	0	40	60	11	0	89	0	11	0	22	67
#4	0	30	70	0	0	29	29	43	0	22	78	0	0	22	22	56
#5	0	0	100	0	0	0	80	20	0	0	100	0	0	0	56	44
#6	50	40	10	33	11	22	11	22	44	11	44	22	22	11	11	33
#7	9	64	27	0	0	57	14	29	11	67	22	11	0	67	11	11
#8	27	45	27	0	25	25	25	25	0	56	44	0	0	63	25	13
#9	25	42	33	0	14	57	14	14	0	78	22	0	0	78	22	0
#10	0	29	71	0	0	14	57	29	0	11	89	0	0	13	50	38
#11	38	31	31	33	22	22	11	11	0	22	78	0	0	22	56	22
#12	30	40	30	38	0	13	25	25	22	11	67	0	25	13	63	0
#13	30	20	50	0	17	0	67	17	56	22	22	11	44	22	22	0
#14	40	0	60	14	14	14	14	43	44	11	44	11	33	11	44	0
#15	27	18	55	11	22	11	22	33	56	0	44	0	56	0	44	0
#16	0	25	75	0	0	14	57	29	0	11	89	0	0	11	89	0
#17	0	44	56	0	0	50	17	33	11	44	44	0	11	44	44	0

[a] For the traditional conceptual model of sustainability: S1 – environmental capital; S2 – economic capital; S3 – Society capital.
[b] For the 5SenSu conceptual model of sustainability: S1 (sector 1) – environmental capital as provider; S2 (sector 2) – environmental capital as a receiver; S3 (sector 3) – production sector; S4 (sector 4) – society as provider; S5 (sector 5) – society as a receiver.

References

Agostinho, F., Richard Silva, T., Almeida, C.M.V.B., Liu, G., Giannetti, B.F., 2019. Sustainability assessment procedure for operations and production processes (SUAPRO). Sci. Total Environ. 685, 1006–1018.

Biggeri, M., Clark, D.A., Ferrannini, A., Mauro, V., 2019. Tracking the SDGs in an 'integrated' manner: a proposal for a new index to capture synergies and trade-offs between and within goals. World Dev. 122, 628–647.

Costanza, R., Daly, L., Fioramonti, L., Giovannini, E., Kubiszewski, I., Mortensen, L.F., Pickett, K.E., Vala Ragnarsdottir, K., De Vogli, R., Wilkinson, R., 2016. Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals. Ecol. Econ. 130, 350–355.

Fioramonti, L., Coscieme, L., Mortensen, L.F., 2019. From gross domestic product to wellbeing: how alternative indicators can help connect the new economy with the Sustainable Development Goals. Anthropocene Rev. 1–16.

Giannetti, B.F., Sevegnani, F., Almeida, C.M.V.B., Agostinho, F., García, R.R.M., Liu, G., 2019. Five sector sustainability model: a proposal for assessing sustainability of production systems. Ecol. Model. 406, 98–108.

Kettunen, M., Bowyer, C., Vaculova, L., Charveriat, C., 2018. Sustainable Development Goals and the EU: Uncovering the Nexus between External and Internal Policies, Think2030 Discussion Paper, IEEP Brussels. www.think2030.eu.

Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W.W., 1972. The Limits to Growth: a Report for the Club of Rome's Project on the Predicament of Mankind. Universe Books, New York.

Mortensen, L.F., 2018. EESC Hearing on Civil Society Indicators for the Sustainable Development Goals. European Environment Agency, Copenhagen, Denmark. www.eesc.europa.eu.

Neumayer, E., 2003. Weak versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms. Edward Elgar, Northampton.

Odum, H.T., 1996. Environmental Accounting – Emergy and Environmental Decision Making. John Wiley & Sons, Inc., p. 370p

Odum, H.T., Odum, E.C., 2006. The prosperous way down. Energy 31, 21–32.

Rockström, J., Steffen, W., Noone, K., et al., 2009. A safe operating space for humanity. Nature 461, 472–475.

United Nations Brundtland Report, 1987. Report of the world commission on environment and development: our common future. http://www.un-documents.net/our-common-future.pdf. (Accessed 9 February 2019).

UN-SDGs, 2019. United Nations sustainable development goals platform. https://sustainabledevelopment.un.org/?menu=1300. (Accessed 9 April 2019).

Wackernagel, M., Rees, W.E., 1996. Our Ecological Footprint – Reducing Human Impact on the Earth. New Solutions Publishers, USA.

Wackernagel, M., Hanscom, L., Lin, D., 11 July 2017. Making the sustainable development goals consistent with sustainability. Front. Energy Res. https://doi.org/10.3389/fenrg.2017.00018.