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Systems Thinking in a Fluid Environment: SDG 14 and the Ocean-Climate Nexus †

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Abstract: Systems thinking is a mechanism to robustly consider the interconnected world we live in and move away from a 'siloed' approach to policy. Similarly, the SDG goals and targets contained in the UN 2030 Agenda on Sustainable Development require an integrated approach to diverse human and planetary health challenges. This paper contemplates these efforts and then looks to one of the SDGs considered the least interconnected in SDG analyses: that of 'life below water'. It examines the Oceans Goal as part of the SDGs and considers in more detail the process of nexus thinking, in particular as it relates to the ocean-climate nexus. This highlights that there are risks in relying on SDG interaction analysis due to skewed results or a failure to accommodate rapid transformation or knowledge gain in certain fields. We suggest that greater recognition of planetary boundary tipping points will enhance the inclusion of oceans in climate considerations, and improve the likelihood of achieving both SDGs 13 and 14.

Keywords: ocean-climate nexus; SDGs; systems thinking; SDG14 life below water; transformational change; oceans governance; marine policy; international law

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1. Introduction

Both the goals of systems thinking, and the SDGs represent a move toward recognition of the deeply connected world we live in and encourage a move away from a 'siloed' approach to policy. Systems thinking is variously defined, but commonalities highlight interconnectivities and its utility as a tool to understand the role of different elements in relation to the behaviour and outputs of the system [1]. In its preambular language the UN General Assembly describes the 17 SDG goals as 'integrated and indivisible'. It is logical then that the technique of systems thinking be applied to the question of how to holistically consider the SDGs.

The oceans goal is repeatedly considered to be one of the least interconnected of the SDGs. This may not however be an accurate representation of the oceans' relatedness to other goals, and the reasons for this provide useful lessons in considering future SDG interaction analysis. The process of nexus thinking or contemplation of specific linkages between 2 or more SDGs is related. Life under Water, SDG14, in nexus language is most commonly associated with the climate goal. To be sure, the ocean and the climate are fundamentally and inextricably intertwined, both in terms of how they function and their future. The question now is how to engage systems thinking to recognise the danger posed by failing to embrace the ocean-climate nexus.

2. Oceans and SDG 14

The ocean is the main support system for human and planetary wellbeing, and it is increasingly recognised as being in crisis, with a diminishing window of opportunity for action. It is often reported that the ocean occupies 71% of the surface of the planet, however if considered in terms of liveable space in both breadth and depth then the ocean actually occupies more than 97 per cent [2]. Climate change is the preeminent issue driving change in the oceans, and overall, its effects have been global and manifested rapidly and at larger scales [3]. Oceanic warming, acidification and deoxygenation issues are of critical concern, resulting in major impacts on ecosystem structure, function and service provision as well as being of high regulatory complexity and with large socio-economic impact [4–7]. These alterations in the ocean system are cumulative and often occur at an exponential scale, that is changes in ocean chemistry may not be reversible, especially in terms of gross ecological and ocean processes [2,8–11].

The oceans are contemplated in SDG14 Life Below Water, the goal of which is to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development'. Ocean targets comprise ecological and socioeconomic concerns, including reducing marine pollution (SDG 14.1); restoring marine habitat (SDG 14.2); reducing impacts of ocean acidification (SDG 14.3); eliminate overfishing as well as illegal, unreported and unregulated fishing (SDG 14.4); conserve marine areas (SDG 14.5); eliminate harmful fishing subsidies (SDG 14.6); and increase economic benefits to Small Island Developing States (SIDS) and least developed countries (LDCs) (SDG 14.7).

It is only in recent years that the ocean has been broadly recognised as exhaustible, with previous policy positions equating the immensity of the ocean to inviolability [2]. This is a significant paradigm shift in that it requires an entirely new mindset approach to the management of oceanic resources and conservation approaches. The shift from inexhaustible resource to shared responsibility has been a slow one, due *inter alia* to the common property character of the maritime area, the longstanding nature of extractive interests, the siloed sectoral management systems and complex multilateral governance regime. To be sure, only transformational change will allow for the scale of action needed to keep pace with the escalating impact of humans upon the ocean.

3. Systems and Transformational Change

There is still time left to achieve the sustainable development goals, but it will require an unprecedented global effort and transformational change across all sectors of the economy. Such transformation will also need to go beyond a siloed policy approach and affirmative remedies to symptoms, to address the root cause of our unsustainable socioeconomic structures and political and environmental issues, while enhancing human rights and gender equity [12,13]. To achieve the 2030 Agenda for Sustainable Development, it will also have to go beyond integrating the 169 development indicators into national strategies, and venture into a global context.

Whilst the term 'transformational change' is now being widely used in international sustainability discourse [12,13], and despite many attempts to define it, there is no one commonly agreed definition. A range of general attributes of the processes of transformational change can however be extracted from the wide range of examples in literature:

- Is a highly non-linear process.
- Involves a multi-actor, multi-level approach.
- Explicitly changes the structure or fundamental attributes of a system.
- Large scale system-wide alterations that are sustained over a long period of time.
- Does not imply normativity; moreover, is defined by a transformational goal [14].

Transformational change can be understood as going beyond other types of change, such as incremental change or integrated policy and institutional reform and innovation, however these changes can create the enabling environment for transformational change [13,14]. Efforts to disrupt old path dependencies and forge new paradigms, however, do not inherently lead to positive transformational outcomes towards sustainable development. Similarly, change can be unpredictable, with chains of causal processes often hard to identify.

To help decision-makers target policy interventions and actions that achieve transformational change and avoid unintended consequences, the entire systemic context must be considered [14] and progressive pathways identified [13]. To ensure a better state is achieved from the transformational change, long-term transformational goals should be set, and designed to harmonise planning across climate and sustainable development. In setting such goals for major structural transformations, concepts of planetary boundaries can aid in defining a safe operating space to support natural systems, societal well-being and growth [15].

3.1. Thresholds and Tipping Points

There are various concepts used to describe the constraints of our earth's finite natural resource base, such as 'tipping points', 'sustainable production and consumption' and 'carrying capacity' [15]. The planetary boundaries framework outlines the key limits to seven of earth's life support systems: climate change; biodiversity loss; nitrogen and phosphorus cycles; freshwater use; land system change; ocean acidification; stratospheric ozone depletion; chemical pollution and aerosol loading, can aid in describing such constraints from a necessary global perspective. The interconnected nature of complex systems means that taking this global view will illuminate interactions and overlap of subsystems beyond that of an approach at the local or national level.

Systems planning and understanding of SDG interaction is particularly relevant where action to achieve one SDG may generate a tipping point or system transition that could dramatically affect the ability to achieve another goal [16]. Thresholds and tipping points however remain a central knowledge gap. What is known is that reaching such limits catalyses abrupt change and transition to novel states [17]. There are a number of high-probability high-impact tipping points in the ocean's systems such as warming, acidification and deoxygenation. Low-probability high-impact tipping points include ice sheet instability and circulation changes, which would cause dramatic sea level rise and changes in earth's heat budget respectively [18]. It is critical to monitor and prevent not only abrupt systems change from singular catastrophic events, such as those typically associated with climate-induced tipping points, but also gradual change which can be cumulative, as well as tipping points cascading from other tipping points. Such climate and GHG-induced ocean changes would have a profound impact not only on the marine environment, but on the ecosystem services it provides and as well as society [18].

In order to avoid ocean tipping points, mitigation metrics need to include not only CO_2 concentrations and global mean surface temperatures, but also socio economic targets and confounding ecosystem stressors such as overfishing, pollution and plastic contamination [18]. In this regard SDG modelling needs to identify interactions that are likely to catalyse movement towards tipping points so as to allow policy priority for those thresholds that are most likely to result in irreversible or exponential change, and where the risks of passing a tipping point are catastrophic. Transformational change is needed to prevent systems that are nearing tipping points exceeding their limits and priority must be given to these in any assessment of SDGs. Improved knowledge of thresholds and tipping points would inform understanding of interactions between SDGs and would be crucial to SDG achievement [19]. Interactions of SDGs with extended understanding of planetary boundaries may be a useful way to include otherwise omitted elements from the Agenda 2030 SDG inter relational analysis.

3.2. Obstacles to Transformational Change

There are a range of obstacles to achieving transformational change, with outcomes often hindered by not having a deeper understanding of the impacts of power dynamics—risking further marginalisation of vulnerable groups; policy incoherence; conservative gender norms; inability to sustain change; special interests that reinforce business as usual (BAU) and weakened state capacity including fiscal capacity [12,13]. Furthermore, transformational change must be translated beyond academic concepts and applied into practice, which will require attention towards not just transformational outcomes, but also related to institutional structures and implementation processes [12]. This shift remains ambiguous [12]. Perhaps the most critical overarching barrier is that the field remains somewhat nascent, with a limited body of research and ongoing questions around what constitutes transformational change, leaving the concept open to potential manipulation and justification of the status quo [12]. Effecting transformational change remains however perhaps the most effective hope we have of correcting systems that are nearing or past tipping points. As such attention needs to be given to understanding the systems and the elements necessary to facilitate transformational shifts.

4. SDGs and Nexus Thinking

The United Nations' 2030 Agenda on Sustainable Development describes the 17 goals and the 169 targets as forming an 'indivisible whole' [20]. They are intended to accelerate an integrated approach to the consideration of diverse human and planetary health challenges. This alignment of the SDGs challenges current sectoral interests, processes and structures. In stating that countries should implement the agenda as a whole, the UN recognises that actions to advance any one SDG will likely affect the achievement of the others and, moreover, that substantial economic, social and environmental benefits will accrue from actions that capitalise on synergies between multiple SDGs [16,21]. Reflecting this, calls have been made for approaches and tools to support increased understanding of the nature and strength of interactions between SDGs, in particular trade-offs, co-benefits and perverse outcomes [22,23]. This is intended to lead to the design of implementation strategies to optimise the effectiveness of actions.

This thinking has led to the development of systems thinking methodologies for how SDGs interact. From this has arisen the nexus language typically applied to the interrelation of two or more SDGs, specifying interactions, and discussing synergies and trade-offs from the perspective of that issue area [24]. Broader attempts at whole of SDG analysis has, by and large, been restricted in application to country specific scenarios. Indeed and notwithstanding the UN emphasis on priority, there have been relatively limited practical advances in methods to understand and prioritise interrelated and systemic approaches to the entire suite of goals, and the properties of the system as a whole are poorly understood [21,25].

There is, to be sure, a high level of complexity in modelling the interactions between such a large number of goals, targets and supporting actions. Early mapping exercises have demonstrated the important interconnections between achieving goals, but experience suggests that government departments and international agencies do not always have the mandate or skills to apply whole of systems thinking or realistically address what might at first appear to be inconvenient and politically contentious trade-offs and unintended consequences. Unfortunately, very little attention has been paid to the institutional structures required to achieve the goals and interactions [26].

A broader concern that has been given very limited attention is the question of the appropriateness of relying upon a series of ultimately politically determined goals to dictate the priorities of human and planetary boundaries into the future. To be sure, although the SDGs were a bold inclusion of environmental imperatives into the precursor Millennium Development Goals and based on scientific premise, the creation of SDGs was an essentially political process [27], the product of which had to be both palatable to governments and achievable within a politically appropriate timeframe. Acknowledging that selection bias exists in SDGs and that they are neither entirely comprehensive nor based on purely scientific needs assessments, allows recognizing that prioritising actions based on these goals alone may lead to non-optimal outcomes. Although intended to be interactive, the use of these targets to prioritise and drive global action in this manner risks additional perverse outcomes through the omission of other equally important factors and actions that were not included in the goals.

As a series of goals and targets, the SDGs do not purport to be prioritised or even inclusive of all identified planetary health needs. Indeed, SDG13 climate is recognised as of preeminent importance [2] but in no way is this reflected in the goals themselves. Adding to this is a recognition of the age of the goals. Several years in the negotiating, and now over five years old, a mechanism for the inclusion of new information, priorities and concerns in areas of rapidly developing understanding such as oceans, is absent. In a time of rapid change, the goals on which we base planetary health decisions need to be adaptive to the inclusion of new knowledge and priorities. Emphasis is placed on the need for 'up-to-date empirical knowledge' on how the goals and interventions of one sector affect another [21]. Though not suggesting a constantly moving framework which would lead to confusion and inaction, such empirical assessment necessarily includes consideration of emerging or escalating issues within the goals. It is important to recall that if a matrix of interactions is not valid then the derived and prioritised actions will be equally invalid [25]. Steps to ameliorate this problem include the integration of planetary boundary measures in Agenda 2030 analyses.

Methodology of SDG Interaction Analysis

Considerable focus has been paid to the identification of synergies or trade-offs among SDGs and the context in which they may occur [21,28,29]. A recognised range of elements are fundamental to any such analysis including that of directionality, strength and necessity, as well as context dependency. To illustrate this one author describes relationships in terms of trade-offs, co-benefits, optionality and context dependence or independence [30]. To date studies that have developed frameworks to examine the interactions among the SDGs, we have applied a range of different classification schemes [21,23–25], although progress has been made in the categorisation of relationships through a widely accepted seven step system [21,23]. Notable in its absence in assessment methodology are the more nuanced aspects of goals and targets such as the level of uncertainty, the irreversibility, temporal and physical scale and the emergence of new knowledge.

Analyses vary in scale: some at the level of goal and others at the level of target. Those done at goal level are broader and more amenable to interpretation. At the target level, much greater specificity occurs and as such substantive interactions are more easily discerned [28]. As such although targets include more detail, they also have the negative element of possibly limiting the analysis to the sphere of the particular targets, whereas goal level analysis may allow for broader interpretation and as such a wider range of linkages to be recognised.

Generally, studies have applied a global forward-looking model-based analysis, with most papers focused on a holistic analysis of the 17 SDGs relying on some form of data mining or expert survey [24,25]. One early exception was a study that applied a textual analysis, which although instructive in the language is unable to contemplate nuanced or implicit linkages in the targets. As such goals that use unique technical language are likely to receive reduced correlations as compared to those with similar descriptors [31]. For example, target 14.3 'Minimise and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels' shares no textual overlap with SDG 13 relating to climate change. Predictably, model-based studies have revealed additional linkages between goals and targets to that of textual analysis, and confirm that scientifically relevant connections go beyond the targets that are explicitly reflected in the SDGs [31].

The viability of a globally applicable methodology is uncertain. Assessments on SDG interactions, synergies and trade-offs vary widely in their conclusions [16]. Significant issues arise from existing studies where information is derived primarily from systematic literature reviews and expert opinion, including that of data source and participant bias. Methodologies employed means that the quality of the analysis depends on human interpretation and assessment and consequently interactions may be missed, and the true nature of the relationships misunderstood. For example, the scoring of interactions in a cross-impact matrix will reflect the knowledge areas and biases in judgment-based assessors [25]. That is to acknowledge that scientists too are influenced by worldviews and beliefs [32]. Future assessments would benefit from robust review of data inputs, carefully designed systematic expert selection and use of consensus methodologies such as the Delphi method [16,33,34]. Similarly, reliance on data mining and systematic literature reviews is also susceptible to biases, including those similar to that of direct SDG textual analysis in that some SDGs may have a comparatively low range of cross-disciplinary terminology than occurs between other SDGs. In addition, results will be influenced by the breadth of scholarship in an area and the substantive content produced, and as such the size of a body of work within a discipline may influence how interrelational it appears. To be sure, priorities derived from interaction analysis may reflect biases similar to those that were present in the political process from which the SDGs emerged. This is not to criticise or undermine the validity of such methods but suggest that these methods will be more reliable and robust if enhanced by a systematically comprehensive knowledge and epistemological base.

5. Systems Change in the Ocean-Climate Nexus

5.1. The Interrelationship between the Ocean Other SDGs

In the majority of assessments SDG14 is among the least interconnected of the SDGs [30]. The ocean is immense in size, of fluid nature, with high biological and physical variability. Topic based analysis from extensive multidecadal literature analysis however reveals many more linkages, a result that is supported by expert-based analysis when oceans expertise is engaged in this process [30]. This is in part due to the physical, jurisdictional, logistical and financial difficulties inherent in researching the ocean, which translates to a reduced number of publications and resultant lower occurrence of SDG14 interactions. The need for greater oceans research is recognised in the declaration of the UN Decade of Ocean Science for Sustainable Development (2021–2030). As a research field, the ocean is relatively young, all of which result in an unusually high number of scientific unknowns, and often complex and qualified results. This lack of recognition of connectivity is part of the reason that SDG14 has the least identified progress, and has received the third lowest philanthropic funding of all SDGs [30].

For example, it is seldom recognised in analyses that there are strong co-beneficial linkages between SDG7 'affordable and clean energy' and the oceans goal. These include Target 14.6, wherein successful negotiation of an agreement under the auspices of the World Trade Organisation to eliminate harmful fisheries subsidies, including fossil fuel subsidies, will pave the way for possible broader consideration of the removal of environmentally deleterious fossil fuel subsidies. Similarly offshore wind has emerged as a major source of energy with the potential to power the world's current energy needs 18 times over, and hence there is a strong correlation between oceans and the goal of achieving clean and affordable energy [35]. Additionally emerging wave and tide technologies are one of the few renewable energy sources that are not limited in their continuity of provision. These are rarely represented in SDG matrix assessments. Similarly, SDG14.1 relates to marine plastics pollution which is heavily linked to SDG12 of Responsible Consumption and Production, but also has impacts on phytoplankton's ability to process CO_2 (Climate Action); as well as marine ecosystem health, sustainable fisheries and hence SDG2 on hunger and food security.

Of additional concern in SDG analysis, and highlighted by SDG14, is the limited consideration of the temporal scale beyond its contemplation in terms of deadlines for SDG targets [20,24]. Implicit consideration may occur in the assessment of interactions as the assigned strength of relationship depends heavily on timeframes for change, ranging from real time to those substantial time lags. The problem with only implicitly considering the temporal scale is that we fail to plan for the fact that the longer we pursue unsuitable actions the less likely it is that there is an available pathway to recovery, and the closer we move towards ecological disaster. Herein the reversibility of change is of critical importance. For example, the introduction of plastics or the overharvesting of the ocean may not have an immediate impact but will create irreversible issues for future poverty and hunger alleviation.

Moreover, also of influence are the governing institutions and frameworks which is the topic of SDG16. Negative impacts are more likely to occur, or be larger, when institutions and rights are weak [28]. This is a form of governance-dependency wherein a negative relationship occurs as the result of poor governance, rather than an intrinsic trade-off itself. For example, fisheries have been associated with ecosystem destruction, however this is a non-genuine trade-off, since the trade-off is not intrinsic to fish extraction but comes from the manner in which it is managed.

5.2. Ocean-Climate Nexus Thinking

Nexus thinking has recently expanded to include ocean-climate interactions. The physical relationship between the climate and ocean is well known, with the ocean having absorbed 93% of anthropogenically generated heat and almost one-third of the CO_2 [36]. Similarly, oceans are heavily linked to climate impact and along with coastal areas are a significant part of adaptation and resilience action. Ocean based industries also offer significant opportunities for emission mitigation and have a substantial role in options for the removal of legacy emission [37]. To be sure the ocean-climate nexus is complex and as with other nexus fields there is a lack of clarity in its meaning, with little explanation beyond highly scientific data or fundamentally superficial definitions. The highest priorities and greatest number of linkages identified in the SDGs relate to climate change and the limiting of temperature rise to 1.5 degree [2]. As related to the marine environment, research paints a dire picture of accelerated ocean heating, reaching depths much greater than previously realised [6,8,9]. Additionally, the ocean as a slow changing environment is particularly prone to difficult to reverse impacts such as changed states of eutrophication and consequential acidification. By the time we address these measures the time for known remedies may have passed. Whilst the ocean-climate nexus has been considered in terms of various needs and opportunities little progress has been made in its organisation and prioritisation.

Emphasis on the need to consider the ocean-climate nexus has come primarily from oceans practitioners across the range of fields. Resistance to this recognition and engagement has been seen from climate practitioners and institutions, and is likely due to a multitude of reasons. It can primarily be explained in systems language as mistaking path dependency with the need to pursue multiple pathways. That is path dependency implies that several equally plausible solutions are possible, and the solution depends on the path that is followed. However, this is not a path dependency scenario and there are not multiple equally plausible solutions. Instead, all possible actions need to occur in order to achieve the desired result of keeping temperatures within the 1.5 degree limit. Climate action requires the simultaneous pursuit of emissions mitigation across sectors and environments, application of nature based solutions, and innovations to capture and store legacy carbon.

This reluctance to engage in ocean-climate nexus issues can be seen within the UNFCCC framework [37]. The climate area is a challenging and complex one, adding to this the additional difficulty of conceptualising oceans, with the multifaceted problems of ocean-atmosphere heat and gas exchange, ocean-atmosphere biological feedback loops, emissions beyond national jurisdiction, a multifaceted and disparate governance system and high comparative level of scientific uncertainty. The reluctance of the UNFCCC to engage in oceans is reflected in the fact that the decision in 2016 to draft the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) came not from the UNFCCC but from the IPCC itself. That is, it was the scientific intergovernmental body, not the governance entity, that recognised the need for engagement with the ocean-climate nexus.

The question is what happens when only one SDG wants to consider an interaction and what are the impacts of reluctance in engagement? Applying a terrestrial lens to climate minimisation in relation to food production (SDG2) and presuming the ocean as a panacea as has been done in the past through assumptions of inexhaustibility will lead to perverse outcomes and threaten the achievement of multiple SDGs. Whilst acknowledging SDG13 as a priority area with greatest linkages to other SDGs does not however justify a siloed approach. The omission of ocean-based climate action in favour of existing climate priorities will amount to only one result—system failure. That is, 'if the Paris Agreement is to be successful then the ocean must be fully integrated into the climate regime . . . so ocean–climate interactions and consequences are properly recognised and managed' [2].

5.3. Tragedy of the Oceans Commons

One particular challenge that faces systems thinking in relation to SDG14 is the common property nature of oceans and their resources. The 'tragedy of the commons' is a phase applied in the 1960s to the situation of a shared resource that is overexploited due to individuals acting to their own advantage, or failing to realise or choosing to disregard that the net disbenefit would result in the depletion and exhaustion of the resource for all [38]. Tragedy can be applied not only to the over extraction of a resource but also to its overuse as a sink, and thus is relevant also in terms of climate goals.

The concept behind State territorial boundaries is that clarity in legal obligation based on jurisdiction will limit the potential for conflicts over sovereign authority: it is a mechanism designed to maintain peaceful world order. In the maritime context the Law of the Sea Convention prescribes a series of zones of differing jurisdiction. For the purpose of our discussion the most important of these is the 200 nm Exclusive Economic Zone wherein states have the right to exploit the natural resources contained therein with a concomitant responsibility to protect the environment. Beyond this zone is a shared area of ownership referred to as the Area Beyond National Jurisdiction (ABNJ), and covering almost two-thirds of the oceans. Problems arise with respect to such areas precisely because no clear jurisdiction exists [39]. Though long recognised as an issue in oceans management, little has been done to redress the problem and different uses are managed in a siloed piecemeal fashion. Even current negotiations relating to ABNJ are oriented on a sectoral basis, through fisheries, deep seabed mining or biodiversity forums. Transformational change is needed in the approach taken to managing economic activities in ABNJ [2], wherein biodiversity and ecosystem resilience must be at the forefront, and a cross-sectoral approach to policy, planning and management is developed. Without an integrated functional governance through which a common resource can be managed the system as a whole is vulnerable to perverse outcomes. Such an absence, moreover, creates a substantial disincentive and barrier for other regimes to interact in a mutually beneficial manner.

Other issues with the common resources relate to disparity from those that are causing the impact and those that are facing the consequences. In relation to the ocean-climate nexus, it is the SIDS that are likely to face the greatest negative consequences from ocean-climate impacts [40]. This environmental vulnerability means that sustainable ocean development is a priority to these States, however economic vulnerability makes them dependent upon 'international partnerships to address global issues over which it has little control' [26]. Blue economy activities that have negative impacts need to be taxed sufficiently to fully remedy the cost to the global commons [2]. Historically SIDS lacked political power or financial resources, however as one of the most affected regions by climate change SIDS have become a vocal group in the movement to have oceans included in climate change discussions. Indeed, in the context of SDG interactions, the relative lack of links between SDG14 and other goals may be more problematic to SIDS than appears at the global level [31]. With mind to this, more attention should be paid to their calls for ocean-climate action.

5.4. Complexity and System Boundaries

Barriers to the consideration of issues with a high level of uncertainty and complexity have been contemplated above. In terms of systems thinking, the extent to which complex issues are integrated into a system varies greatly, but, as a generalisation, as the number and complexity of interactions increases, so do impediments to the application of systems thinking. Issues of marine sustainable use tend to be complex, and the surrounding policy process reflects these complexities. The marine environment has a high level of variability in influencing factors and it is often difficult to distinguish between causal relations and correlations.

Although on the surface there is an attraction in understanding the interaction of all 17 SDGs, the validity and utility of this process must be continually reassessed. The earth's functions have no ultimate boundaries, yet to ensure interactions are at a conceptually and functionally manageable level systems thinking requires the creation of boundaries. The goal of understanding whole-of-system interactions may result in information that is so complex that it obscures the outputs [1]. Such complexity may be used nefariously to camouflage inaction when the pursuit of political goals in the national interest are prioritised over globally agreed targets. Translating complex information into effective policy planning and implementation remains an elusive goal [26].

It is essential to remember that system boundaries are however a human construct [1]. The extent to which evidence and logic impact upon a final policy is tempered by political and systematic constraints. Complexity and uncertainty has the effect, in polarised settings, of allowing science to simultaneously validate several opposing arguments. It can be used as both a key lever as well as a barrier to paralyse policy decisions, and cause the premature closure or exclusion of an issue. The extent of scientific influence is highly dependent upon the 'organisation of the relationship between science and politics' [41]. This relates to the malfunctioning of the communications process between policy makers and the scientific community, as well as the determinative influence of the structure and role of the particular institutions involved. Even where ideal conditions exist for the successful translation of scientific advice into a policy position, the ultimate solution for human society is political and expressed as policy [42].

5.5. The Barrier of Uncoordinated or Disparate Governance

International regimes vary considerably according to their scope and form, the level of adherence and the instruments through which they are given effect, as well as their administrative arrangements, budgets and resources. Whilst SDG linkage analysis can assist in structuring a plan for realising the goals [43] without transformational change this necessarily sits within existing frameworks of operation, and both national and intergovernmental responses will be impacted by both competing priorities and limited budgets [25]. The importance of institutions and regulatory frameworks is recognised in Goals 16 and 17 though are predominantly at the national level, with inadequate contemplation at the global scale.

A governance system may be fit for purpose for managing a single sector and yet overly complex when needing to interact with other SDG sectors. As such 'an emerging major research theme in sustainability science is determining appropriate and interconnected governance structures to achieve such multi-attribute goals within very complex systems' [26]. Although often discussed in the national context [26] this applies equally to the UN system of international governance which lacks any mechanism by which those universally consistent co-benefits and trade-offs among the SDGs can be contemplated or negotiated.

Indeed, the global ocean governance framework is highly fragmented. As such attention to the ocean-climate nexus has primarily been directed through the UNFCCC process as this offers a single coordination point. Consequently, oceans have had to justify their inclusion in the process, which has to date met with limited success [44]. Unlike the Executive of the UNFCCC, the UN Special Envoy for the Oceans does not have access to the breadth of institutional support afforded their climate counterpart. In addition, ocean literacy remains poor and enhanced capacity building and awareness raising are needed to support the implementation of SDG14 at all levels [28]. It is for this combination of reasons that, although inextricably linked, climate has both public and political priority over oceans warming.

6. Conclusions

Systems thinking is a range of things including a basis for a science-policy dialogue, a tool for policy coherence and a means by which to prioritise for efficient and effective action. Systems thinking, however, is only as good as the systems definition and there are risks if we get this wrong. Research that disentangles interaction amongst the SDGs can provide for better policy decisions, less unintended consequences, higher probability of goal realisation.

Whilst intended to benefit SDG implementation, assessments of SDG interaction and assignment of priority based on this measure must be approached cautiously. Recognising that existing methodologies and metrics may skew results away from demonstrating need, additional considerations such as irreversibility ought to be included in assessments. Additionally, there is a danger in accepting an analysis as fixed, especially in quickly transforming fields (such as climate innovation) and those with rapid knowledge gain (such as oceans).

Whilst agreeing that international collaboration must give primacy to action on climate change, the impact of such action is diminished when it does not include all the key elements. That is, failure to consider the oceans prevents the realisation of SDG13. Remedying this could take several forms, including alignment within the climate regime of the universally accepted approach to countries boundaries to include maritime areas as contained under the ocean regime [44]; acknowledgement of the complexity, cultivation of greater ocean literacy and acceptance of the scientific communities emphasis on ocean-atmosphere interactions in climate talks; and improved ease of cross communication between ocean and climate through the assurance of a single oceans focal point within both national and international systems.

Going forward a means of ensuring that interdependencies among sectors are taken into consideration may be achieved through the inclusion of planetary boundary thinking. This could accelerate transformative change and lead to the prioritization of issues and nexus areas based on their proximity to reaching planetary tipping points. The need to urgently prioritise action within the ocean-climate nexus would necessarily emerge from such a process. The reality is that irrespective of whether oceans are accepted as a mainstream part of the climate dialogue, a failure to adequately and expeditiously consider the oceans will result in a systemic failure to achieve the 1.5 degree goal.

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