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The 2030 Agenda for Sustainable Development and the WEF Nexus

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Abstract

The 2030 Agenda for Sustainable Development is the most ambitious international effort to integrate the three dimensions of sustainability in a unifying and universal vision for the future, but the interconnectedness of its 17 Sustainable Development Goals (SDGs) requires national and local governments to overcome silosization and consider existing synergies and trade-offs among them. This work reviews the potential benefits from employing a nexus approach, originally developed to deal with systems of interconnected natural resources, to address these interconnections and effectively implement the 2030 Agenda. First, as a discourse, the nexus may improve the integrated understanding of the SDGs and guide their prioritization. Second, as a governance framework, it could foster cross-sectoral and multi-level coordination and policy coherence to enable the implementation of the 2030 Agenda. Last, as an analytical tool, it could offer a large set of interdisciplinary methodologies to model SDGs' interactions, synergies, and trade-offs. While several limitations are still to overcome, a nexus lens to the implementation of the 2030 Agenda promises to support the adoption of sound policies for dealing with complex challenges in the Anthropocene.

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1 The 2030 Agenda for Sustainable Development

In September 2015, the United Nations (UN) General Assembly approved the *2030 Agenda for Sustainable Development* (hereafter, 2030 Agenda) as a transformative plan of action for people, the planet, prosperity, peace, and partnership. Its 17 *Sustainable Development Goals* (SDGs), 169 targets, and 230 indicators comprise basic human needs, economic growth, environmental protection, climate change, and governance (UNDESA, 2016). The 2030 Agenda had been discussed since the 2012 Rio+20 conference to prosecute the UN *Decades of Development* and the more recent *Millennium Development Goals* (MDGs), which defined the global agenda for economic and human development from 2000 to 2015. Hence, the 2030 Agenda was designed to overcome many limitations of its predecessors and is recognized as the most innovative and ambitious instrument of global governance through goal-setting to date (Stevens & Kanie, 2016). Contrary to previous top-down and country-focused approaches, it allows and invokes the contribution of all governments, UN organizations and agencies, and civil society. This inclusive and open process embraced the design and preparation of the 2030 Agenda as well as its current implementation and monitoring (Biermann, Kanie, & Kim, 2017). Furthermore, for the first time a UN development initiative is equally directed to all countries regardless of their level of development, thus becoming truly universal (Biermann et al., 2017). Moreover, the 2030 Agenda aims to benefit everyone including those left behind by previous development programs, and to provide a fully integrated approach to sustainability, where environmental challenges are addressed together with social and economic needs (Nilsson, Griggs, & Visbeck, 2016; UNDESA, 2016; UNDP, 2018).

Despite the high-level political commitment received, halfway to its expected completion the transformative value of the 2030 Agenda is still debated. Most countries have integrated the SDGs in their development plans and institutionalized interministerial and parliamentary committees (Breuer, Leininger, & Tosun, 2019; OECD, n.d.), but the actual influence on policy priorities appears limited (Forestier & Kim, 2020). Furthermore, progress on the goals is slow and uneven. Since 2015, generalized positive trends have been registered for SDG 1 and SDG 9, while SDG 2, SDG 12¸ SDG 13, SDG 14, and SDG 15 stagnated or regressed. However, while advanced economies are in line to meet most of the SDGs by 2030 and countries in South and East Asia display large improvements, other regions are struggling. This is particularly true for Sub-Saharan Africa, where access to basic services and infrastructures is limited and 40% of the population lives in extreme poverty (Sachs, Kroll, Lafortune, Fuller, & Woelm, 2021). Moreover, global progress on the SDGs has been seriously impacted by the pandemic of Covid 19, reducing available financial resources and pushing into poverty an estimated 124 million people, back to 2015 levels (Sachs et al., 2021; UNDESA, 2021). Therefore, to truly leave no one behind and meet the SDGs by 2030, adequate implementation strategies that could overcome existing institutional and resource challenges are needed (SDG Center for Africa & SDSN, 2020).

Adopting policies able to consider the interconnections among SDG goals constitutes a major challenge, and an unprecedented opportunity, in the implementation of the 2030 Agenda. Contrary to the MDGs, the 2030 Agenda states the indivisibility of its 17 goals and acknowledges their interdependence, meaning that pursuing one goal would impact the progress of others (UNDESA, 2016). Indeed, the 17 SDGs resulted from protracted negotiations and consultations of national governments, agencies, and non-governmental organizations: they are mostly aspirational and their targets frequently overlap, reinforcing as well as countering each other (Loewe & Rippin, 2015; Weitz, Carlsen, Nilsson, & Skånberg, 2017b). However, despite invoking the adoption of integrated approaches for its implementation, the 2030 Agenda does not offer any information or guide on how to do that. Hence, while it made clear that synergies and trade-offs in goal attainment would have emerged, it said nothing on how to deal with these complex dynamics. (Elder, Bengtsson, & Akenji, 2016; Nilsson et al., 2016; UNDESA, 2016).

Accordingly, identifying the best strategies and instruments to efficiently and effectively meet the SDGs has been a key responsibility for the scientific community since 2015 (Bennich, Weitz, & Carlsen, 2020).

Contributing to this effort, the current work reviews the potential benefits from employing a nexus approach, originally developed to deal with systems of interconnected natural resources, to address SDGs interconnections and effectively implement the 2030 Agenda. The following section introduces the origin and key features of the nexus approach. Next, its relevance for the 2030 Agenda is presented, specifically focusing on the nexus contribution to SDGs prioritization, SDGs governance, and SDGs interactions modeling. In the fourth section, a summary of the remaining challenges for the adoption of a nexus lens to the implementation of the 2030 Agenda is presented, before providing concluding remarks in the fifth and last section.

2 The Water-Energy-Food Nexus

The World Economic Forum originally proposed the water-energy-food nexus (WEF Nexus) in 2011, as a concept to tackle business concerns over resource scarcities driven by population and consumption growths and complicated by urbanization and climate change (Allouche, Middleton, & Gyawali, 2015; Halstead, Kober, & Zwaan, 2014; Marko et al., 2018). The nexus highlights the interdependent nature and complex dynamics amongst water, energy, and food resources (WEF resources), conceptualizing them as subsystems of the same nexus rather than as independent ones (Terrapon-Pfaff, Ortiz, Dienst, & Gröne, 2018). Since sectoral policies can't address trade-offs nor leverage synergies among the three subsystems, attempts to increase the production of one resource could result in collateral consequences in the other sectors. Hence, drawing from the field of *Integrated Water Resource Management* (IWRM), the WEF Nexus offers an integrated and systemic approach to address these interactions between subsystems (Benson, Gain, & Rouillard, 2015; Braun & Mirzabaev, 2016; Weitz, Strambo, Kemp-Benedict, & Nilsson, 2017).

Indeed, almost 800 million people still don't have access to modern energy services while about 2 billion are not granted safe drinking water or food globally (UNDESA, 2020). Moreover, demand for water, energy, and food is expected to respectively increase by 50%, 80%, and 60% in the coming years (Flammini et al. 2014). Since these conditions often affect the same peoples or countries (Stevens & Gallagher, 2015), not accounting for collateral consequences amongst the three subsystems would result in a zero-sum game directly impacting the lives of the left behind. Therefore, the WEF Nexus has been increasingly recognized by academia, national and international agencies, funders, and policy-makers as a key approach to improve policy integration and coherence, thus fostering sustainable development and the realization of the 2030 Agenda (Biggs et al., 2015; Bleischwitz et al., 2018; Marko et al., 2018; Yumkella & Yillia, 2015).

Despite primarily focused on irrigation, biofuels, hydropower, water desalination, and forestry (Biggs et al., 2015), heterogeneous literature and practice adopting the WEF nexus have emerged (Endo, Tsurita, Burnett, & Orencio, 2017; Yang & Yamazaki, 2013) as the concept has been expanded to include materials, land, ecosystems, and human security (Bleischwitz et al., 2018; Hoff, 2011; Lawford et al., 2013; Marko et al., 2018). Moreover, the term "nexus" is three-dimensional and contemporarily describes a discourse, a conceptual governance framework, and a mix of analytical tools (Harwood, 2018; Nhamo et al., 2019). First, as a discourse, it provides a systemic understanding of the interconnectedness of WEF and other resources and encourages cross-sectoral collaboration among stakeholders. However, by framing issues in the language of security and technical rationality, it overlooks cultural, institutional, and political dimensions of reality. On the one hand, this has resulted in literature biased towards quantitative methods and abstract or large-scale development levels, possibly undermining the effectiveness of the resulting policies (Albrecht, Crootof, & Scott, 2018; Stevens & Gallagher, 2015). On the other, the technical and managerial framing of the nexus has shadowed the inequalities underlying most water, energy, and food issues, therefore neglecting key problems of global justice (Biggs et al., 2015; Leese & Meisch, 2015). Proposed solutions include expanding the nexus to the concept of environmental livelihood security (Biggs et al., 2014), as well as integrating it with political ecology and ecosystem services perspectives to account for power distributions, support integration, and encourage negotiation (Pahl-Wostl, 2019).

Second, as a governance framework, the WEF Nexus could address the wicked nature of water, energy, and food interdependencies. The word "wicked" highlights how sustainability issues often emerge from the interconnectedness of different societal and environmental domains, their complex and non-linear behavior, and the resulting uncertainty. They emerge when actors' interactions in the biophysical system are not adequately reflected in social interactions (Pahl-Wostl, 2019). By fostering the adoption of a system perspective as well as actors' collaboration and coordination, the WEF Nexus encourages integrated policies able to overcome sectoral fragmentation, improve horizontal and vertical policy coherence, and resource optimization (Hoff, 2011; Weitz, Strambo, et al., 2017). Specifically, to overcome the traditionally sectoral distribution of public goods (Scheumann & Phiri, 2018), polycentric nexus governance has been suggested. Thanks to its multiple centers for decision-making, it would offer a decentralized, multi-level and recursive structure that could balance top-down, bottom-up, and lateral influences, as well as foster adaptability, social learning, legitimacy, and integration (Bleischwitz et al., 2018; Pahl-Wostl, 2019). However, this could happen at the expense of the overall efficiency for the consequential redundancies and limited economies of scale (Pahl-Wostl, 2019).

As an analytical tool, the WEF Nexus has been primarily employed to qualitatively and quantitatively map the interactions among water, energy, and food on topics such as irrigation, biofuels, hydropower, water desalination, and forestry at the national or international level (Biggs et al., 2015). Key methods have been selected from environmental management, economics, and numerous social sciences. They include system and agent-based modeling (ABM), input-output analysis, footprinting, life cycle assessment, scenario analysis, computable general equilibrium (CGE) models, and integrated assessment models (IAM) (Albrecht, Crootof, & Scott, 2018), some of which have been adapted specifically for the nexus (Bekchanov & Lamers, 2016; de Strasser, Lipponen, Howells, Stec, & Bréthaut, 2016; Perrone & Hornberger, 2016). However, lack of data, particularly for smaller scales, makes these methodologies hardly applicable to real-life situations and hampers attempts to translate the nexus from paper to practice (Harwood, 2018; Nhamo et al., 2019).

3 The 2030 Agenda through a Nexus Lens

The WEF Nexus discourse influenced the design of the 2030 Agenda (Biggs et al., 2015), shaping it in a network of targets where several interconnections are explicit and many more are implicit or indirect (Le Blanc, 2015). Indeed, a nexus-sound development agenda could overcome some of the issues that had affected its precursors, for instance in coordinating actors, building and sustaining partnerships, and avoiding redundancies (Yumkella & Yillia, 2015), as well as finally integrating all three dimensions of sustainability – the economy, the environment, and society – in a unifying vision (Le Blanc, 2015). However, despite generic references to their interconnectedness and indivisibility, the 2030 Agenda does not provide much conceptualization nor guide on how the 17 SDGs should be pursued or prioritized in practice (UNDESA, 2016). To address this need, as in Raworth's doughnut model (Raworth, 2017) and Rockström's planetary boundaries (Rockström et al., 2009), scholars have prominently developed concentrical frameworks where external environmental limits (SDGs 13, SDG 14, and SDG 15) bound economic and human development (SDG2, SDGs 6, SDG 7, SDG 8, SDG 9, SDG 11 and SDG 12). In these frameworks, SDG 16 and SDG 17 constitute enabling goals, while SDG 1, SDG 2, SDG 3, SDG 4, SDG 5, and SDG 10 are at the center, thus representing the apex of sustainable development efforts (Niestroy, 2016; TWI2050, n.d.). For this, they have been praised for meaningfully conceptualizing the 2030 Agenda within the larger idea of sustainable development (Breuer, Janetschek, & Malerba, 2019, p. 3), but also criticized for the instrumental understanding of nature (Breuer, Janetschek, et al., 2019). Indeed, anthropocentrism dominates also economic approaches assessing monetary returns and welfare benefits (Barbier & Burgess, 2017) and results from expert surveys (Scott, Leitner, & Hynes, 2017) attempting to prioritize the SDGs.

To best achieve the transformative potential of the 2030 Agenda and account for the complex synergies and trade-offs between its goals and targets, a wide and diverse literature on SDGs interconnections has been produced (Bennich et al., 2020). Whilst many articles aren't explicit on the policy challenges addressed, a

large percentage deals with policy integration and coherence and how to foster them (Bennich et al., 2020). As already happening (Allen, Metternicht, & Wiedmann, 2018), polycentric governance recommends institutionalizing interministerial committees to balance competing interests and foster coordination, accountability, social learning, and representation (Srigiri & Dombrowsky, 2021). Specifically, they are recommended to focus on designing and overseeing the complex implementation of the SDGs, leaving lower bureaucratic levels to engage with external actors and solve shared problems (Breuer, Janetschek, et al., 2019). This could overcome the traditionally thematic silosization of the public sector (Weitz, Carlsen, et al., 2017b), in favor of more problem-oriented designs such as that of problemsheds (Srigiri & Dombrowsky, 2021). These advancements would require additional interventions, such as spreading the use of system thinking to support trade-offs negotiations (Collste, Pedercini, & Cornell, 2017; Obersteiner et al., 2016), and of course mapping of SDGs interconnections (Elder et al., 2016; D. L. McCollum et al., 2018; Nilsson et al., 2016). Another focus is that of innovative policy outputs, whether by integrating system thinking (Keesstra et al., 2018), addressing alternative instruments such as technological innovation, governance arrangements, and lifestyle change (Moyer & Bohl, 2019), or accounting for problem shifting (Font Vivanco, Sala, & McDowall, 2018). Moreover, research has also looked into the contextualization of the SDGs according to local social and ecological dynamics and needs (Singh et al., 2018), as well as into the engagement of multiple stakeholders (Hutton et al., 2018; Yillia, 2016).

The analytical tools developed and adapted to study SDGs interconnections are equally various (Bennich et al., 2020). Next to studies on interactions among all or a sample of SDG goals (Hutton et al., 2018), there are studies on the interactions among SDG targets (Alcamo, 2019), or indicators (Pradhan, Costa, Rybski, Lucht, & Kropp, 2017), sometimes also including external scenarios for specific policy areas (Font Vivanco et al., 2018; Glover, Hernandez, & Rhydderch, 2016). Moreover, these interactions are conceptualized in several different ways, ranging from simple correlations (Pradhan et al., 2017) to mono-, multi-directional (Nilsson et al., 2016), or circular (Zhang, Prouty, Zimmerman, & Mihelcic, 2016) causal relations (Collste et al., 2017). Ultimately, by modeling these complex interactions, they aim to explain how progress on one SDG (goal, target, or indicator) influences the progress of another, thus providing insights on synergies and trade-offs for policy-makers and other societal actors (Maes, Jones, Toledano, & Milligan, 2019; Weitz, Carlsen, Nilsson, & Skånberg, 2017a). In this regard, dedicated tools have also been developed, whether focusing on the international level ("UN EMG SDG Nexus Visualization Tool," 2017), country or river basin levels ("SDG Interlinkages Web Tool," n.d.), on specific economic sectors (PWC, 2019), National Determined Contributions ("Explore NDC-SDG Linkages," n.d.), or public investments (Cavalli et al., 2021).

These efforts strongly rely on scientific literature, international or national official databases, and expert and stakeholder knowledge, analyzed via qualitative as well as quantitative methods (Bennich et al., 2020). Network analysis has been vastly used to identify clusters of targets (Weitz, Carlsen, et al., 2017b) and thematic areas requiring integrated approaches (Lim, Søgaard Jørgensen, & Wyborn, 2018), or to understand resource governance structures (Lusseau & Mancini, 2019). A predominant role has also been played by cross-impact analyses, often providing functional or hierarchical labels to SDGs interconnections (Nilsson et al., 2016; Singh et al., 2018). On the other hand, key participatory methods such as surveys, focus groups, and workshops have been employed to obtain information on SDGs interconnections and engage policy-makers in the co-creation of models and scenarios (Allen et al., 2017; Glover et al., 2016). Furthermore, qualitative modeling has been used to identify SDGs system archetypes (Zhang et al., 2016), while many quantitative modeling techniques, including system dynamics modeling (Pedercini, Zuellich, Dianati, & Arquitt, 2018), IAM models (Hutton et al., 2018), ABM models (Guijun, Yongsheng, Daohan, & Hongtao, 2017), CGE models (Campagnolo et al., 2018), and input-output models (Scherer et al., 2018), have been used. Most recently, statistical analyses have also been employed successfully, whether to identify correlations between SDG indicators (Pradhan et al., 2017) or combined with other methodologies (Lusseau & Mancini, 2019; Obersteiner et al., 2016).

Overall, SDGs synergies seem to outweigh trade-offs, with SDG 6 and SDG 7 displaying the most synergetic interactions and SDG 2 the most trade-offs (Buonocore et al., 2019; Fader, Cranmer, Lawford, & Engel-Cox, 2018; Fuso Nerini et al., 2018; Malagó et al., 2021; D. McCollum et al., 2018). However, results from different studies are not always consistent, especially when applied to different countries (Fader et al., 2018; Mainali, Luukkanen, Silveira, & Kaivo-oja, 2018). More research is necessary to provide conclusive evidence, especially for monitoring (Pradhan et al., 2017) and policy-support (Fader et al., 2018).

4 Remaining Challenges

Despite some initial successes, research on SDGs interconnections is still limited and faces several challenges. First, attempts to systemically conceptualize and prioritize the SDGs have proven anthropocentric (Nilsson et al., 2016; Scott et al., 2017) and partially irreconcilable with the declared indivisibility of the SDGs (UNDESA, 2016). Nonetheless, such prioritizations resonate with the freedom of implementation granted to national governments according to local priorities and circumstances (Biermann et al., 2017) and are inevitable in a context of limited resource availability (Breuer, Janetschek, et al., 2019; Pongiglione, 2015). Accordingly, SDGs prioritization is likely to prosecute in the future, thus opening delicate ethical questions for researchers and policy-makers (Breuer, Janetschek, et al., 2019; Pongiglione, 2015).

Second, research on SDGs interconnections inherits the limitations of the 2030 Agenda as well as of the WEF Nexus. Both paradigms are rooted in technical rationalities which overlook the complexity of social reality with its power constellations, structures, and cultures, by this neglecting problems of social justice and hindering their implementation and effectiveness. These were major shortcomings of the MDGs and IWRM, and are likely to persist (Allouche et al., 2015; Biggs et al., 2015; Fukuda-Parr & McNeill, 2019; Leese & Meisch, 2015; Pahl-Wostl, 2019). Moreover, just like the WEF Nexus, the conceptualization of SDGs interconnections is still immature, vague, and unable to address geographical spillovers, time delays, and exogenous factors, therefore impeding translation from theory to practice (Bleischwitz et al., 2018; Breuer, Janetschek, et al., 2019; US DOE, 2014).

Third, conceptualizations are not always adequately reflected in empirical research (Albrecht et al., 2018). Indeed, studies on the WEF Nexus often focus only on two subsystems and studies on SDGs interconnections generally consider samples of goals or targets rather than on the full set, thus hindering integration and usability (Bennich et al., 2020; Shannak, Mabrey, & Vittorio, 2018). Additionally, research has given limited attention to key aspects for real-life application, including issues of policy and technological innovation, societal and political dimensions, meaningful stakeholder engagement, and localization (Bennich et al., 2020; Purwanto, Sušnik, Suryadi, & Fraiture, 2021; Shannak et al., 2018). Another key issue concerns the limited data availability, as only half of the 230 indicators of the 2030 Agenda are globally and consistently accessible (Dunning & Kalow, 2016), and even fewer are available for the local level (Miralles-Wilhelm, 2016). Furthermore, insufficient data impedes using quantitative empirical methodologies which would, also, require adequate strengthening and customization (Bazilian et al., 2011; Perrone & Hornberger, 2016).

5 Conclusion

The 2030 Agenda constitutes the most ambitious international effort to integrate the three dimensions of sustainability in a unifying and universal vision for the future (Kanie & Biermann, 2017). However, the interconnected nature of the SDGs calls national and local governments to account for existing synergies and trade-offs and change their working mechanisms accordingly (Bhaduri et al., 2016; Pahl-Wostl, 2019). Therefore, for its focus on policy integration and coherence, the WEF Nexus has been increasingly recognized by academia, national and international agencies, funders, and policy-makers as a key approach to foster sustainable development and the realization of the 2030 Agenda (Biggs et al., 2015; Bleischwitz et al., 2018; Marko et al., 2018; Yumkella & Yillia, 2015). First, as a discourse, WEF Nexus fosterers the complex and integrated understanding of the SDGs (Le Blanc, 2015). Second, as a governance framework, it supports decentralized institutional architectures, as well as cross-sectoral and multi-level coordination (Srigiri &

Dombrowsky, 2021). Last, as an analytical tool, it offers interdisciplinary methodologies to model SDGs' interactions to maximize synergies and minimize trade-offs (Bennich et al., 2020). However, several limitations must be overcome to effectively employ the nexus to pursue the 2030 Agenda: they include normative considerations on SDGs prioritization (Breuer, Janetschek, et al., 2019), adequate inclusion of societal and cultural dimensions, geographical scales, and spillovers, localization, and time-delays (Bennich et al., 2020; Purwanto et al., 2021; Shannak et al., 2018), as well as improved data availability and tailored methodologies (Bazilian et al., 2011; Dunning & Kalow, 2016). Despite the challenges, adopting a nexus approach to the implementation of the 2030 Agenda may foster the governance of complex systems in the Anthropocene and enable governments to meet the SDGs (Biggs et al., 2015).

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