Three Horizons for the Sustainable Development Goals: A Cross-scale Participatory Approach for Sustainability Transformations

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ABSTRACT. Navigating towards safe, just and sustainable futures poses an overarching challenge for human societies. At the global scale, addressing this challenge has been conceptualized as reaching the 2030 Agenda within planetary boundaries.

However, global definitions of related goals and pathways to reach them have been criticised as not being sensitive to context and thus not relatable to communities at sub-global scales. To avoid this, solutions discussed in international fora need to be contextualized and informed by locally prevalent worldviews, values and contexts.

This paper introduces a stakeholder-based approach for visioning and exploring sustainable development pathways to meet the 2030 Agenda ambitions - the Three Horizons for the SDGs (3H4SDG). The approach combines the Three Horizons framework with multi-scale scenario and systems thinking approaches. 3H4SDG facilitates explorations of (a) alternative pathways to reach the SDGs in an integrated way; and (b) convergences and divergences between the pathways and across scales. The *convergence* analysis provides information on common premises and actions that are perceived to be the consensus of all pathways. The *divergences* may entail branching points of different future pathways, representing issues to be further deliberated at different levels.

We illustrate 3H4SDG on the case study of the 2018 African Dialogue on The World In 2050, which discussed how transforming the food and agricultural systems in Africa could contribute to reaching the 2030 Agenda goals. We detail the premises and steps of the 3H4SDG approach. We also summarize the results of our pilot application. The results incorporate a set of convergences and divergences among the explored future pathways, including divergences in

relation to urbanization, population growth, consumption changes and the future role of the agriculture sector in the African economy.

We conclude that participatory approaches grounded in systems thinking represent a promising way to link local aspirations and values with global goals.

Key words: 2030 Agenda; Africa; co-production futures; cross-scale analysis; participation; scenarios; SDGs; SDG interactions; Sustainable Development Goals; three horizons; transformations;

INTRODUCTION

The United Nations' 2030 Agenda was agreed in 2015. The Agenda represents an unprecedented global outline for sustainable development that has been argued to require transformative changes for its realization (Randers et al. 2018, Linnér and Wibeck 2019). The agenda embodies strong principles, namely: *universality, leaving no one behind, inclusiveness, interconnectedness and indivisibility of the goals, and multi-stakeholder partnerships* (United Nations 2015). Despite the Agenda's aspiration of inclusiveness in the goal formulation process (Caballero 2019), it represents a top-down approach to agenda setting where goals are formulated at a high political level - to be realized across scales. Furthermore, the agenda has been criticised for incorporating uniform vision that is dominated by the idea of "progress" (Victor 2019, van der Leeuw 2020), and for focusing on economic growth which contradicts other goals (Hickel 2019). This uniformity could cause a backlash in societies set to implement the Agenda while not fully accepting its premises. Therefore, implementing the Agenda must involve a sense-making process at the national and local levels that allows it to be translated into tangible actions specifically designed to local contexts.

A challenging principle of the Agenda is its focus on interconnectedness and indivisibility (see Collste 2021 for a wider discussion on indivisibility in the 2030 Agenda context). Siloed approaches to the Agenda may overlook the system complexity, and risk unintended consequences. These approaches may also not sufficiently account for synergies or trade-offs (Pedercini et al. 2019, Maes et al. 2019), and goal spill-overs across temporal and spatial scales (Engström et al. 2021, Downing et al. 2021). While there are many ways of integrating the goals, including e.g. rating connections (Nilsson et al. 2016), using cross-impact matrices (see, e.g., Weitz et al. 2018), and tracing and quantifying causal connections across policies and targets (Collste et al. 2017, Pradhan et al. 2017, Pedercini et al. 2019), **few take the overarching systems perspective** needed to grasp the transformation of domains and dimensions of sustainability. However, important global initiatives such as TWI2050 and the Global Sustainable Development Report (TWI2050 - The World in 2050 2018, 2019, 2020, Independent Group of Scientists appointed by the Secretary-General 2019, Sachs et al. 2019) propose to focus

on a set of domains/systems to be transformed as a means to achieve all goals. Furthermore, Bennich et al. (2020) argue that there is a lack of systems approaches that cover the full Agenda as well as a lack of participatory methods informed by systems thinking. See also Allen et al. (2021a) arguing that there is a lack of systems thinking and integrated analytical approaches. This lack of overarching systems perspective comes with a risk of tools being overly detailed and not comprehending root causes and social-ecological dynamics of large-scale societal transformations.

In our understanding, an overarching systems perspective on 2030 Agenda transformations refers to taking into account diverse aspects of the Agenda and including them in decisions with a holistic perspective. Such a perspective is not limited to observations of facts but necessarily incorporates value evaluations about what is considered to be desirable and feasible outcomes (this is presented as "systemic boundary critique", see Ulrich 2003. In Collste 2021 this is discussed in relation to the 2030 Agenda.). **Value evaluations** are inherent in integrated sustainability studies, including in modeling and scenario efforts. This value contingency has been emphasized since the early days of world models (see, e.g., Meadows et al. 1982, and Meadows and Robinson 1985). Currently, a new generation of scenarios and models are being developed to support the implementation of the agenda, exploring pathways to sustainable futures (TWI2050 - The World in 2050 2018, 2019, 2020, van Soest et al. 2019, Allen et al. 2021b). However, global scenarios have historically been explored with limited participation from stakeholders other than modellers. Besides, modellers' backgrounds are often uniform from universities and research institutions in the Global North and they may envisage futures which lack local groundings in the Global South (Pereira et al. 2018). This may influence the selection of acknowledged worldviews, incorporating values as well as the information that is included in the exploration of pathways. In particular, solutions proposed by global models and scenarios developed by the Integrated Assessment Model (IAM) community have a strong influence in global forums such as the United Nations Framework Convention on Climate Change. This dominance reinforces the need to diversify the views represented in these fora by exploring multiple perspectives in integrative studies.

An overarching systems perspective can contribute to shedding light on the different values incorporated in the formulation of global narratives, across scales. To be meaningful to the society and decision-makers at different levels, new sustainability-oriented scenario narratives need to reflect major tensions and debates in the society, including dominant and non-dominant perspectives. To do this, multiple stakeholder perspectives need to be included in the co-design of the scenarios (this is further discussed and presented in the companion paper, Aguiar et al. 2020).

In this context, we propose a novel participatory approach that we refer to as 3H4SDG to include stakeholders to discuss pathways to the SDGs at multiple scales, with the dual goal of: (a) providing input to the design of new global sustainability-oriented scenarios considering multiple perspectives across scales; (b) providing relevant insights to practitioners and policy makers involved in SDG implementation processes by highlighting the option space, including tensions around alternative sustainability pathways. The approach was designed to address several of the challenges mentioned and the five principles of the 2030 Agenda (United Nations 2015). It incorporates an integrated perspective and promotes systems thinking. It also takes an enabling approach to transformations (see Scoones et al. 2020) by inviting participants' ownership of the process. The approach builds on insights from sustainability participatory approaches, particularly the systems focus of sustainability pathways (Leach et al. 2010) and the enabling features of the Three Horizons approach (Sharpe 2020). The approach is applied on the 2030 Agenda but is not limited to specific goal formulations of the Agenda as it takes an overarching perspective.

This paper is structured as follows. We first provide a theoretical background about participatory approaches and pathways approaches in the context of sustainability science, relating them to the 2030 Agenda. Then, we describe in detail the participatory approach of 3H4SDG and the case study we used to test it (the 2018 African Dialogue on the World in 2050, held in Kigali). Then we present the case study results and the participants' evaluation. Finally, we broadly discuss the approach, its applicability and limitations. We close the paper with our main conclusions.

THEORETICAL BACKGROUND

Participatory approaches

There is a rich history of participatory processes being used to think about the future and how to make better management decisions in the present (including, e.g., Robert Chambers' participatory rural appraisal, Chambers 1994). From adaptive management (Olsson et al. 2004, Stringer et al. 2006) through to participatory scenario development (Oteros-Rozas et al. 2015, Kok et al. 2015), the ongoing research that involves bringing diverse stakeholders together to unpack complex challenges and come up with potential solutions for action is critically important. However, as with all methods that involve a need to bring diverse groups together, there are a lot of issues that need to be taken into account when convening a group for participation, such as context and process design (Font et al. 2018). Often there is a need to ensure that people with decision-making power are involved in the process to improve implementation. In any case, power dynamics always have to be navigated. Sometimes in transdisciplinary processes where researchers work together with another convening body who has more say over the participants, a truly representative group may not be possible to convenene due to internal politics. This both affects the subsequent process and demonstrates asymmetries that surface in co-production processes (Cornwall 2008, Pereira et al. 2020). As this is sometimes unavoidable, the process has to be carefully accounted for and should not pretend to be fully representative, bringing together a non-representative group of stakeholders (but one whose viewpoints are nevertheless important to engage), can still lead to an effective outcome - and bring different points of view to the forefront.

Whilst currently only a few participatory approaches have been applied to 2030 Agenda studies, incorporating stakeholder perspectives in SDG processes has been identified as a key policy challenge (see Bennich et al. 2020, and Allen et al. 2018, for 2030 Agenda literature reviews). Examples of studies include Hutton et al. (2018) that combines integrated assessment modeling in coastal Bangladesh with stakeholders to elucidate value conflicts regarding policy prioritization, and trade-offs between different policies with regards to the 2030 Agenda implementation. They find significant trade-offs between several SDGs that need to be taken into

consideration for implementation. Kanter et al. (2016) provide another example of an integrated SDG study with a focus on the Uruguayan beef sector. They use a backcasting approach that incorporates stakeholders to develop national agricultural transformation pathways. Hodes et al. (2018) use participatory visual methods with HIV-positive adolescents to shed light on stakeholders' aspirations across the domains of health and social development. Glover and Hernandez (2016) take a more overarching perspective using foresight methods and imaginative storytelling involving development scholars in discussing the interactions between inequality, security, and sustainability. The approach presented by Weitz et al. (2018) uses a cross-impact matrix to assess systemic and contextual interactions between SDGs and has been used in case studies in Colombia, Mongolia and Sri Lanka (TWI2050 - The World in 2050 2020). These participatory approaches are all promising but do not explicitly incorporate global multidimensional narratives. **They thereby do not focus on inviting a wider discussion on overarching and systemic 2030 Agenda pathways**.

Participatory approaches to transformations: Structural, systemic and enabling

In the context of participatory approaches, Scoones et al. (2020) suggest three types of overarching perspectives on transformations: (1) Structural approaches which focus on underlying socio-political foundations and the need for complete ideological overhaul; (2) Systemic approaches which focus on identifying particular systems features that are enabling transformations; and (3) Enabling approaches which emphasize the creation of capacities to empower individuals as well as communities to take action (Scoones et al. 2020).

The pathways approaches (Leach et al. 2010), with a grounding in science and technology ('STS') literature, lend themselves to more structural analyses by incorporating discussions on different system boundaries (i.e. what to include in an analysis as 'the system'), bringing to center the political nature of visions of the future, including social justice elements. This is also the case for Critical System Heuristics that is designed for questioning boundary judgments (Ulrich and Reynolds 2010). Pathway approaches (Leach et al. 2010), also focus on system structures and system elements such as feedback. Participatory scenario building is an example of a prominent early approach in social-ecological studies, taking a systemic approach to

transformations, which emphasises how multiple kinds of uncertainties can give rise to different development trajectories (Carpenter et al. 2015, Harmáčková and Vačkář 2018, Harmáčková et al. 2021). Another approach is 'Future Design' which uses imaginary future generations to envision sustainable futures that are radically different from the current - enabling its participants to see alternatives (Saijo 2019). One critical question however is *who* participates and what contesting values and narratives are brought together (Vergragt and Quist 2011). Vergragt and Quist (2011) ask the rhetorical question *"Can [visioning] be left to experts, or should it be a democratic or a deliberative process involving stakeholders and citizens?"* (Vergragt and Quist 2011 p. 749). Envisioning the future can lift voices not heard or deprived (Cvitanovic et al. 2019), and question the status quo. It can also play an emancipatory role for those involved, through the discovery of leverage points previously not acknowledged (Meadows 1997, Ulrich 2003, Leach et al. 2010). Work on adaptation pathways has also highlighted the need to recognize multitudes of actors and the need to work with a plurality of values (Fazey et al. 2016).

*The Three Horizons Approach combining systematic and enabling features*

The Three Horizons is a tool to think about the future that focuses on three qualities of the future visible in the present: present dominant system features that are declining in importance, desired future features of the system and change elements to reach a desired future. The tool is typically used in participatory settings to explore possible alternative futures. It focuses on a diagram with what is dominant on the Y-axis and time on the X-axis (Sharpe et al. 2016, Colloff et al. 2017, Pereira et al. 2018, Sharpe 2020). The horizons represent respectively (Fig. 1): The system to transform from (Horizon 1), the changes that are needed to break the current dominant patterns that are undesirable and to reach desirable alternative patterns (Horizon 2); and the system to transform to (Horizon 3). The Three Horizons is widely used in business management and increasingly in research. The method has characteristics of all three approaches to transformations presented by Scoones et al. (2020); Three Horizons tool can invite structural approaches to transformations as it brings a focus to the potential for alternative futures. It is also systemic as it brings an overarching frame, although it does not explicitly use systems concepts

such as feedback loops. It could be argued that all the above-mentioned participatory techniques are engaging with enabling approaches to transformations as they enable participants to engage in critical discussions of alternative futures.

In our approach that is outlined below in this paper, we are using elements of the Three Horizons visuals and therefore borrow its name. However, as will be seen in the following section, we significantly depart from the tool by embedding it in a broader, cross-scale process focused on capturing multiple perspectives and deep-level causes.

Fig. 1 The Three Horizons diagram showing the different horizons, steps and post-it notes colors used during Step 1 and Step 2 of the process. The horizons represent respectively: The system we want to transform from (Horizon 1), the changes that are needed to break the current dominant patterns that are undesirable and to reach desirable alternative patterns (Horizon 2); and the system we want to transform to (Horizon 3). Pink post-it notes represent society (SDGs 1-6), Yellow represents economy (SDGs 7-12), Green represents environment (SDGs 13-15), Orange represents governance (SDGs 16-17) and Blue represents changes (these are only used during Step 3).
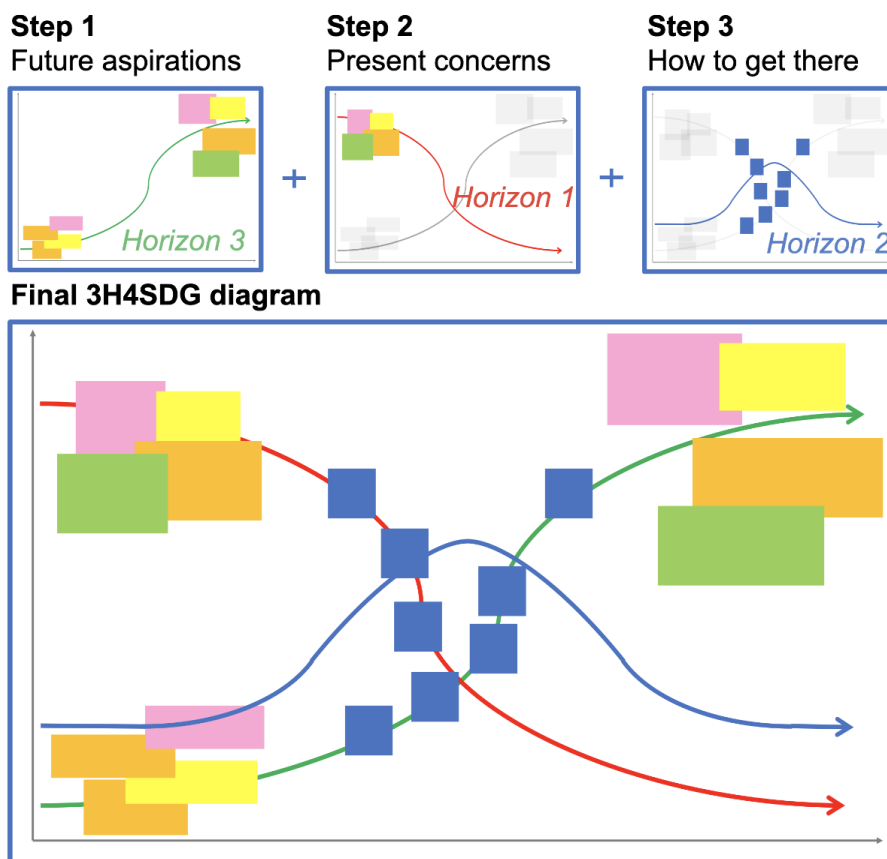
A METHOD TO EXPLORE SUSTAINABLE DEVELOPMENT PATHWAY NARRATIVES ACROSS SCALES: THREE HORIZONS FOR THE SDGS (3H4SDG)

Reflecting the context introduced above, we embarked from the following premises when designing our approach: (a) the approach must explicitly embrace a systems perspective of sustainability pathways, addressing obstacles and leverage points to reach the 17 SDG goals in an integrated way; (b) the approach needed to facilitate the exploration of multiple and alternative pathways, including ones proposed by non-dominant voices, and narratives from different contexts and at different scales.(based on the need to ground the implementation of the 2030 Agenda in locally prevalent narratives, see van der Leeuw 2019, 2020, and the importance of working with a plurality of values, see e.g. Fazey et al. 2016). The approach needed to use the 2030 Agenda as a boundary object to deliberate differences between pathways that would achieve multiple sustainability goals emerging from global and lower scales, without imposing prevalent top-down global perspectives. (c) The participants need to feel ownership over the pathway narratives so that the envisioned pathways and change processes would actually matter to them, thereby increasing the likelihood of implementation. (d) finally, we wanted the process to be simple, easily adaptable to multiple contexts and timeframes

The approach we propose uses the Three Horizons framework to pace and facilitate conversation, enriched with cross-scale participatory scenarios methods (Zurek and Henrichs 2007, Aguiar 2015, Folhes et al. 2015), pathways approaches (Leach et al. 2010, Sharpe et al. 2016) and creative methods. Next subsection presents an overview of the approach. The subsection that follows next describes the pilot case study.

Process outline

The dialogue is structured into sessions corresponding to three steps, usually adopted in backcasting exercises (Börjeson et al. 2006, Quist and Vergragt 2006): Step 1 surfaces future aspirations and existing initiatives hinting at this future, Step 2 presents concerns and Step 3

highlights necessary changes to reach the desired futures expressed in Step 1 or address present concerns identified in Step 2. Starting from the desired future focus can avoid anchoring the discussions in today's concerns and norms and supports the exploration of what may be currently non-dominating visions. Figure 1.b illustrates the full process. Each step requires at least 90 minutes, ideally more. For each step, participants are divided into small groups. We propose around six to eight people each, plus two facilitators. Ideally, a variety of perspectives are represented in each group, allowing for diverse views and narratives through which to discuss the 2030 Agenda. We therefore suggest pre-allocating people into groups so that each group incorporates the sought diversity of perspectives. During the process, divergent perspectives are noted down by the facilitator in a board, thereafter discussed in plenary and later analyzed by the researchers.

In each group, participants have a large Three Horizons diagram in front of them (Fig. 1). The diagram is used as a visual device to facilitate conversation between the participants, and for capturing their ideas. The participants gradually populate the diagram with their contributions, in the form of coloured post-it notes, as requested by the facilitators. Each step has a guiding question that can be adapted to different contexts, see the example from out pilot case study below. In general terms, Step 1 of the process focuses on questions about the desired future for a given region or theme (Horizon 3) and seeds of the desired future in the present. Step 2 focuses on present concerns (Horizon 1).

To ensure all dimensions of sustainability are covered when discussing future aspirations and present concerns (steps 1 and 2), we use coloured post-it notes to represent dimensions, respectively, society, economy, environment and governance (Fig. 1). After populating the diagram with post-it notes in Step 2, the dimensions are discussed integratively. The facilitator asks the stakeholders to analyze the deep causes underlying the present concerns: the core obstacles that are standing in the way to reach sustainability. The activities include clustering the post-its, creating a list of deep causes underneath them, including, if possible, the sketching of influence or causal loop diagrams with the participants (de Vries 2013) .

The facilitators have the following roles in the process: (a) to support all participants are able to contribute equally, avoiding dominance of more outspoken or powerful participants; (b) to support that a broad range of sustainability dimensions are covered in steps 1 and 2; (c) when disagreements among participants emerge, the facilitators note the divergences a separate board, and move the process forward (to avoid long discussions about individual topics but still acknowledge the issue); (d) facilitators should listen, take note and organize the discussion, but avoid interfering with their own views.

After steps 1 and 2, there are exchanges among groups and a presentation of existing external perspectives on sustainability for the region, e.g., those that are dominant in existing global scenarios (Fig. 2). The exchange among participants can take place through a '**World Cafe**' session, in which group participants rotate between the groups allowing the sharing of results and taking note of contrasting perspectives. Thereby, participants are exposed to issues they may not have considered. A '**Global Perspectives**' session exposes participants to assumptions underpinning recent global scenario studies and their implications for the context under discussion. This step is carried out through a presentation prepared by the facilitators. This session takes place after Step 2 to avoid constraining the thinking of participants as they brainstorm their preferred future. Multiple perspectives may also emerge by contrasting global perspectives to the results of the discussions for different regions or groups of actors.

Only after that, **Step 3** is introduced, in which each group discusses the possible actions and actors necessary to overcome the current obstacles and reach the SDGs in an integrated manner, across all dimensions, using single colour post-its. Participants are asked to think about: (a) short-term and long-term actions to break the present concerns and their deep causes, removing the obstacles to reach sustainable futures; (b) tactions to give scale to existing non-dominant initiatives in the future; (c) who are the actors behind these actions. Finally, as in the other steps, the facilitators ask the participants to summarize the pathways.

Fig. 2. The complete process to uncover multiple pathways using the 3H4SDG.
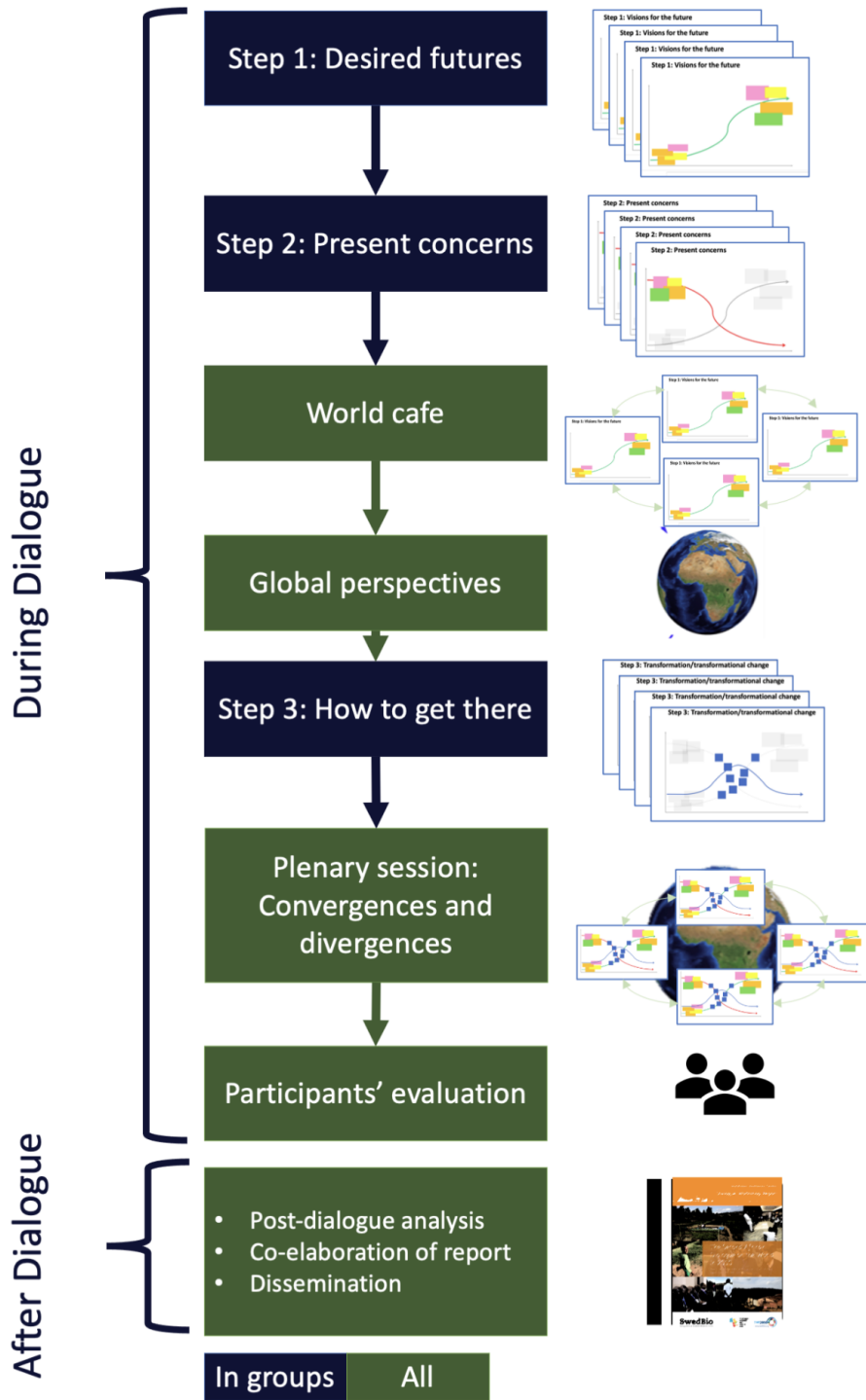
Based on Folhes et al. (2015), at the end of each step, participants are asked to use a **creative method to summarize the discussion** (Fig. 3, Outcome 3). The facilitators then leave the room, and participants are asked to write a story, a letter, create hashtags, imagine newspaper headlines, draw, create a theater play, a video - or use whatever media they prefer. The goal is to facilitate the participants to unleash their imagination and take ownership of the process, by including their emotions in the visioning process. Imagination in participatory approaches contributes to inspiring and empowering the participants (Pereira et al. 2018, 2021).

Fig. 3. Illustrations of the outcomes from each step of the 3H4SDG process.

Outcome 1
The 3H4SDG diagram

Outcome 2
List of divergences

Outcome 3
Creative product
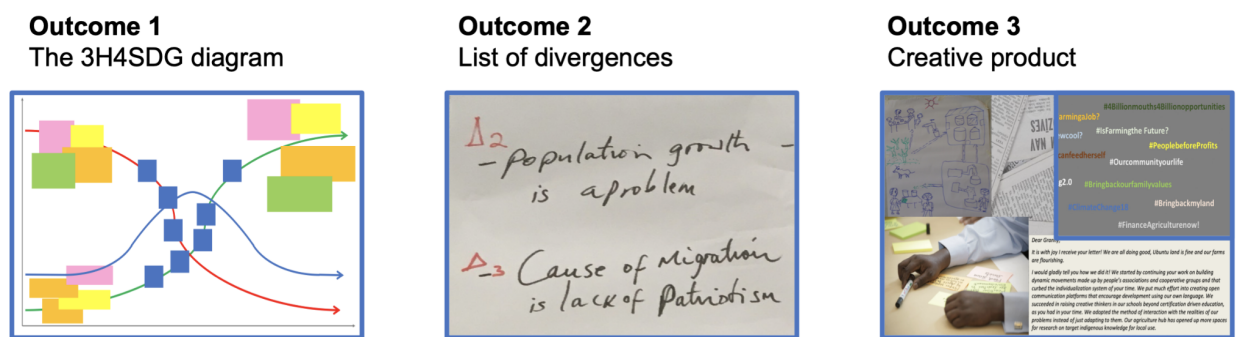
In sum, each step has three outcomes: (a) the diagram with post-its; (b) the list of divergences; (c) the creative synthesis product (Fig. 3). In the case of Step 2, participants may create a list of root causes or create additional diagrams (influence, causal loop) if time allows. In the **final plenary**, group results are presented, and convergences and divergences within and across the groups and in relation to the global perspectives are discussed in the context of narratives.

After the plenary, a **facilitated evaluation** session provides participants with time to reflect upon the dialogue process, and gives organizers feedback to improve the dialogue process.

After the Dialogue, the researchers transcribe and organise the outcomes, and analyze the convergences and divergences among the pathways. *Convergences* are common elements among different pathways. The convergence analysis can provide information on common premises and actions that are perceived to be consensus parts of all pathways to sustainability. The divergence analysis aims at shedding light on multiple alternatives of sustainability pathways. *Divergences*

may entail branching points of different future pathways as seen differently by participants. An example of branching points may be a society where a big part of the population lives in rural areas versus a more urban future, or a future in which community relations stay important with extensive local trade transactions versus a future in which an extensive part of products are exported and imported. *Convergences* can indicate points where agreement prevails and may mandate specific actions, while *divergences* are the points which need to be further discussed, understood and/or the basis for the narratives of scenarios, based on a process fully described in Aguiar et al. (2020).

All the dialogue results and subsequent analysis are then structured as a report, reviewed by the stakeholders and distributed to society. In the next section, we briefly present how the approach was applied in an illustrative case study.

An illustrative case study: The 2018 African Dialogue on the World in 2050

We piloted the approach during the 2018 African Dialogue on the World in 2050, held in Kigali, Rwanda, October 2018, over two days. The Dialogue focused on the following overarching question: *How can transforming the food and agriculture systems in Sub-Saharan African contribute to attaining the SDGs within planetary boundaries?* following the proposal to focus on critical domains/systems to be transformed as a means of achieving the SDGs in an integrated way (TWI2050 - The World in 2050 2018, 2019, 2020, Independent Group of Scientists appointed by the Secretary-General 2019, Sachs et al. 2019). The Dialogue was a pilot to our approach with the goal of providing insights to practitioners, policymakers, and scenario builders

about alternative pathways to sustainable futures, capturing convergences and divergences across different groups of actors and scales.

The event was organized with financial support from the Swedish International Development Cooperation Agency, Sida, through SwedBio at Stockholm Resilience Centre. The Dialogue had 40 participants (31 stakeholders and 9 facilitators) from 11 different countries, including representatives of national governments, UN organisations, civil society and local communities, academia and research. The stakeholders were selected based on their expertise and experience (relevant to African agriculture and agro-biodiversity); and for having understanding of related policy processes (e.g., social and economic development strategies, spatial planning, research-development-innovation, conservation and resource management). The Dialogue took place over a span of two days, with the first two steps of the process and the World Cafe taking place on the first day, and the presentation of global perspectives, the third step, the synthesis and the evaluation, taking place the second day.

The participants were divided into four regionally focused sub-groups, based on Sub-Saharan African regionalization from the African Union, including: (i) West and Central Africa (combining the two African Union zones), (ii) East Africa, (iii) Southern Africa, *and* (iv) (Sub-Saharan) African continent. The goal of this division was to increase the multiplicity of perspectives and enrich the cross-scale comparison (global, Africa-wide, and regional). The division of participants among the groups considered various aspects such as the location of the participant, professional background, and the practical requirement of having manageable groups (in line with Pereira et al. 2018). Diversity within groups was also sought, so as to include a variety of competencies, values and narratives, in the respective groups. Each group incorporated around six stakeholders and two facilitators. Facilitators were trained to guide the process, and not to contribute with expertise in the themes being discussed.

Considering the overarching theme for the Dialogue, the specific guiding questions for Step 1 was: "*What are our visions for the future of agriculture and food systems in the group region?*" and "*What do you see of the desired future already existing in the present (initiatives, project, proposals etc.)*? Step 2 guiding questions were: "W*hat concerns do we have about the present

agriculture and food system in your group region?" Step 3 guiding questions were: "*How do we change the present system to transform to the desired futures?*" and "*Which measures and actions are required (considering the root causes)*?"

The presentations of global perspectives about pathways to reach multiple goals were based on IIASA's The World in 2050 report (2018) and are further deliberated and compared to the outcome of the 2018 African Dialogue in Aguiar et al. (2020). At the end of the Dialogue, an evaluation form was provided for all the participants (see Appendix C for the form, replies available on: https://osf.io/prj8v/) and after the Dialogue, results were shared and compiled in a report (Aguiar et al. 2019).

Fig. 4. An illustrative photo from the 2018 African Dialogue on The World in 2050. The Three Horizons diagram on the floor is in the middle of the group discussion.

RESULTS OF THE CASE STUDY

Outcomes from the parallel groups

The 3H4SDG process resulted in future visions, lists of current challenges and their root causes (in one of the cases these were transferred to a causal loop diagram), and lists of changes needed to attain a sustainable future discussed in each group (Appendix A). The results also included a complete analysis of the divergences and convergences across the groups and in relation to the Global Perspectives (Appendix B).

To illustrate the process outcomes, below we provide a brief description of the resulting visions, summarized in Table 1. The West and Central Africa group named their pathway *the Ubuntu pathway* after the word in Nguni (a group of Bantu languages spoken in Southern Africa) for the quality of human inter-dependence and connectivity. The Ubuntu pathway describes a future of African agriculture and food systems dominated by farmers associations and cooperatives. Africa embraces its diversity and the right to land is inclusive. Agroecology takes the lead and the farming systems are fully organic.

In the pathway developed by the group focusing on Eastern Africa, *the Peaceful and Prosperous East Africa Pathway*, food security is assured through either small-scale agriculture or large-scale commercial farming, as this is one of the divergences that emerged from the process. Investments in agriculture and education enable a prosperous future. Agriculture is private-sector led and gender-balanced. Farmers are secured financial resources.

The Southern Africa group named their pathway after the Swahili and Kinyarwanda word for pathway or direction: *the Urugendo pathway*. In *the Urugendo pathway*, agriculture provides livelihoods and drives the economy. Agriculture is private-led and peace is emphasized as a precondition for a prosperous future. Both cooperatives and private businesses are participating and the government provides preconditions through enabling credit and enabling legal frameworks.

Table 1. A summary of the four pathways explored during the 2018 African Dialogue on The World In 2050.

Pathway and *unique features*	Future aspirations	Present concerns & seeds of the positive future	Change actions
Ubuntu (West and Central Africa): *Fully organic and cooperatives dominating.*	Agriculture and food systems dominated by farmers' associations and cooperatives. Future characterized by diversity, inclusiveness, and agroecology.	Environmental degradation, the low interest in agriculture among youth, growing inequalities and the collapse of social values in communities. Seeds of a positive future lie in organic farming systems.	Building dynamic movements through empowered farmers' organizations and cooperatives and intensify farmers' relations and interaction for better communal agriculture. Leaving fossil resources in the ground.
Peaceful and Prosperous East Africa: *Divergence between whether small-scale agriculture or large-scale commercial farming is dominating.*	Food security assured through either small-scale agriculture or large-scale commercial farming- divergences in groups. Science collaborates with the local community to solve community problems is important.	East African countries suffer from food insecurity because production is low as a consequence of low technology adoption and inadequate investments and research.	Investments in agriculture and education enable a prosperous future. Farmers' financial resources are secured and mobilized.
Urugendo (Southern Africa): *Focus on peace as a precondition.*	Agriculture provides livelihoods, drives the economy and is run by young people. Agriculture is private-led and peace is emphasized as a precondition for a prosperous future. Farmers organized in cooperatives, no hunger.	Lack of investments in agriculture, many governance problems within cooperatives and governments are constraining a positive development.	Both cooperatives and private businesses are participating and the government provides preconditions through enabling credit and enabling legal frameworks.
Rainbow (Sub-Saharan Africa): *Strong focus on the role of the governments in providing institutional frameworks and regional partnerships.*	An aware and educated society empowers its citizens and promotes home-grown and local knowledge. States are capable, with strong institutions that can deliver and are accountable for their citizens. Citizens are actively participating in society and collaboration platforms are provided.	Low human capital as a consequence of poor educational quality and brain drain causes high population growth. Climate change and environmental degradation threaten production and well-being.	Building infrastructure, implementing education programs, and promoting local solutions stimulate the necessary innovation. Agro-forestry is promoted and upscaling programs emphasized. Cultural and behavioral changes powered by synergies, cooperation and coordination, and increased access to finance and insurance.

The final group had an overarching focus on Sub-Saharan Africa and named their pathway *the Rainbow pathway*. In *the Rainbow pathway*, an aware and educated society empowers its citizens and promotes home-grown and local knowledge. States are capable, with strong institutions that can deliver and be accountable to their citizens. Citizens are actively participating in society and collaboration platforms are provided. The Sub-Saharan Africa group, when compared to the sub-regional groups, emphasized more aspects related to regional cooperation, including data generation/sharing and the importance of alliances for change (across Africa and with the other continents). In the following section we explore the convergences and divergences which emerged from the exercise. Table 2 illustrates some of the creative methods from the groups.

Table 2. Examples of creative synthesis products for different steps

Step 1 - Future aspirations Urugendo (Southern Africa)	Step 2 - Present concerns Urugendo (Southern Africa)	Step 3 - How to get there Urugendo (Southern Africa)
Dear friend, What a wonderful Sunday morning. Young people here are cultivating large areas of land that were once barren but have now been restored because of reforestation, water towers and through improved irrigation systems. .. Currently, the farmers are organized into cooperatives and have invested and own agro-based businesses and are major exporters of agro-processed products (e.g., beer, fruit juices, etc.). The youth are outstanding in agriculture and doing what they love. … Urban and peri-urban areas have also become sources of food production through intensive investments in green houses within the urban setting.	Let's check our 2018 library Newspaper Headlines: 1. Dairy farmers register losses due to power outage 2. Farmers' cooperatives close down their businesses due to heavy taxes 3. Disagreement in the cabinet causes farmers to lose billions of money 4. Thousands of hectares of food crops destroyed by floods 5. Farmers complain of lack of appropriate techniques in dairy farming 6. Farmers cry out for affordable financing 7. Farmers lose money through their cooperatives due to mismanagement 8. Information technology still a nightmare for farmers 9. Free farmers from middlemen	Dear friend, I have received your reply to my letter asking me how we achieved our visions. Farmers, through our cooperative societies, worked closely with the government to put in place an enabling environment through the legal and policy framework that streamlined our governance systems for accountability and transparency. Through development of cooperative society's policy and enactment of cooperative Act, both productivity and aggregation of our produce increased. This translated into structured marketing and hence increased incomes for us farmers. Cooperatives empowered farmers who subsequently engaged the government to create an agriculture credit guarantee scheme in addition to creating an insurance scheme for our farmers. ….

Convergences and Divergences

In this section, we summarize the convergences and divergences identified by the participants during the Dialogue and further analyzed by the researchers (Fig. 6). The core present concerns *convergent* among all groups included the impacts of climate change, land degradation, food insecurity, inadequate governance, inadequate infrastructure, low level of financing and issues related to technology (including the dichotomy between Western and indigenous knowledge), and youth migration/brain-drain. Furthermore, the overall vision of a peaceful and prosperous Africa capable of feeding itself and the world emerged convergently across the groups. Other *convergent* themes that emerged across all groups were: a strong emphasis on education/skills, youth, women and population empowerment, the consolidation of cooperatives and cooperation between farmers, the need for infrastructure, generation and sharing of reliable data, structuring of local to global markets, financing and insurance for agriculture, independence from foreign donors, regional cooperation, transparency and accountability of governments – and not least, political will.

Finally, the participants acknowledged and explicitly discussed in the final plenary, the enormous challenges for implementing an African agricultural transformation, considering current societal and power structures, vested interests, the power of elites, rising inequalities, etc. Another key aspect that emerged from the discussion was a need to recognize the multiple uncertainties related to the impacts of disruptive technological changes in the near future, including those related to democracy. Table 3 presents a synthesis of convergences, grouped into three large interdependent categories: Empowerment, Partnerships for change and Knowledge sharing. Such actions can be understood as the backbone for transformation towards the desired futures (Fig. 6), being necessary to the achievement of several SDGs in a holistic way. Table 3 also brings examples of existing 'seed' initiatives discussed in the groups.

Table 3. Common actions to support multiple pathways derived from the convergence analysis of the four pathways.

	Convergences (backbone actions in all pathways)	Some examples of good seeds
Empowerment (youth, women and population)	Investment in education and adequate skills for agriculture that combines traditional and innovative knowledge (essential for the population empowerment and transformation of the sector). Mechanisms for guaranteeing youth participation in politics. Involvement of communities in decisions: bottom-up and top-down balance. Addressing gender issues -a constant theme in all pathways- including land tenure, finance access and political representativeness for women. Structured markets and incentives to transform agriculture in an attractive sector for the youth (addressing the concern of out-migration).	RWEE (Rural Women Economic Empowerment) Joint Program UN-Women, WFP, IFAD and FAO. Mastercard Foundation: Youth Africa works initiative In Rwanda: young people (engaging) in the political system.
Partnerships for change	Political will at different levels. Proactive approaches to change among all actors and parts of the society, not relying solely on governments to initiate changes. Consolidation of small farmers' cooperatives (from production to markets). Investments in physical infrastructure (roads, energy, irrigation, agro-processing, climate resilient solutions, etc.) and finance infrastructure (easy access to credit and insurance for farmers). Adequate trade agreements and development of local to global markets. Regional and Continental cooperation and planning (markets, governance, infrastructure, technology), including environmental concerns (conservation, climate change adaptation/mitigation). International compromise (aligned to regional plans, alliance against corruption, aiming at independence from donors).	Land consolidation and crop intensification program in Rwanda. Government of Uganda has initiated E-voucher system invested in agro-processing facilities and distribution of inputs to farmers for increased production. Kenyan government invests in large- and small-scale irrigation systems to reduce dependence on rain fed agriculture (1.2 million acres to date).
Knowledge, technology and data sharing	Data collection for natural resources monitoring, (agroecological) spatial zoning and regional planning. Creation of collaboration platforms/hub for sharing best-practices. Improvement of extension systems focusing on context-specific solutions embedded in collaboration networks. Research and development combining traditional values and modern techniques (seeds, climate resilient practices).	Mobile tech-based payment/ transfer systems (similar to Kenya's MPESA, a mobile phone-based money transfer service launched in Kenya) applied to agricultural production may help farmers attain higher shared values.

Several **divergences** were also identified inside the groups and across them (Table B.1 in Appendix). These relate to different perspectives concerning, for example, urbanization, population growth, consumption changes, agricultural practices (sustainable intensification, agroecology), the role of different actors and agricultural systems in the future (community-oriented farming, market-oriented small-holder farming, large-scale industrial agriculture) and the role of the agriculture sector in the African Economy. Such branching points can be understood as points to be deliberated at different levels and across diverse geographic contexts, by multiple societal actors and decision makers, and according to their different socioeconomic, institutional and cultural characteristics.

The discussions in the groups also challenged some of the basic assumptions of existing global sustainability scenarios (including massive urbanization, very low population growth, reduced area for agriculture due to the expansion of biofuels and large scale forest restoration for carbon absorption, land-sparing approach, drastic reduction in meat consumption), indicating the importance of these types of cross-scale dialogues for improving the design of scenarios (Table B.2 in Appendix). Box 1 presents an example about how a divergence can shed light on multiple perspectives, and is represented with systems thinking tools, Fig. 5.

Population growth

The issue of population growth (and measures to control it) caused divergences in all the groups. Some viewed population growth as a threat to the natural resources and food security, while others emphasized it as an opportunity to create new markets, a larger work force and innovative youths – reflecting the different angles of this debate in society. The *Prosperous and Peaceful East African* pathway story mentions this as an open issue*: "… whether we should limit population or find ways to see it as an asset"*. Dialogue participants highlighted population as an asset in rural and urban areas, and consumption levels in rich countries as the real threat to the natural resources and food security. On the other hand, the narrative underlying the sustainability-focused Shared Socioeconomic Pathway 1 (SSP1) aligns to the former

perspectives, and proposes a drastically low growth of population as a key premise to a sustainable future.

Fig. 5 illustrates an influence diagram representing both perspectives. In blue arrows the view that an increased population contributes to a greater 'work force' that can bring 'innovations' and 'efficiency' that could lower the 'consumption footprint' and hence 'natural resource use'. The brown arrow represents the view that a greater population causes a bigger 'consumption footprint'. Based on such divergent perspectives, one could build alternative assumptions in relation to population growth in alternative scenarios to the SSP1 assumptions, as discussed in Aguiar et al. (2020).

Fig. 5. Influence diagram illustrating alternative causal relationships between population growth and food security emerging from the Dialogue. The '+' signs at the arrowhead indicate that the effect is positively related to the cause (e.g., an increase in production causes the material throughput to rise above what it otherwise would have been). The '–' signs at the arrowhead indicate that the effect is negatively related to the cause (e.g., a social-ecological disruption causes production to fall below what it otherwise would have been).
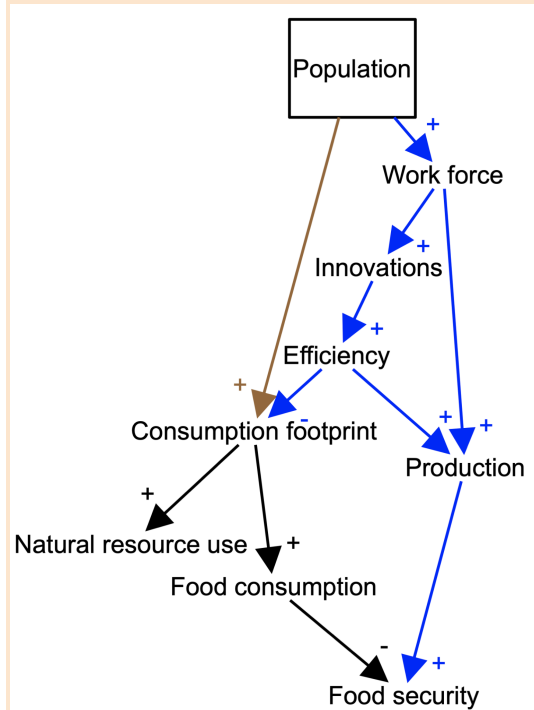

Table B.3 in Appendix synthesizes the divergences grouped into seven categories (Urbanization, Population growth, Agricultural intensification and practices, Actors in agriculture, Alternative diets, Markets for agricultural products and Land-based climate change mitigation), discussing their implications for societal decisions at different political and geographical levels, and also for future scenario design. In Aguiar et al. (2020), we further explore how the identified divergences can be used to create the narratives for alternative target-seeking scenarios, as this is out of the scope of this paper.

Fig. 6. Schematic representation of the resulting convergences and divergences. Source: prepared by the authors based on Aguiar et al. (2020) that was based on Fazey et al. (2016) and Roy et al. (2018).
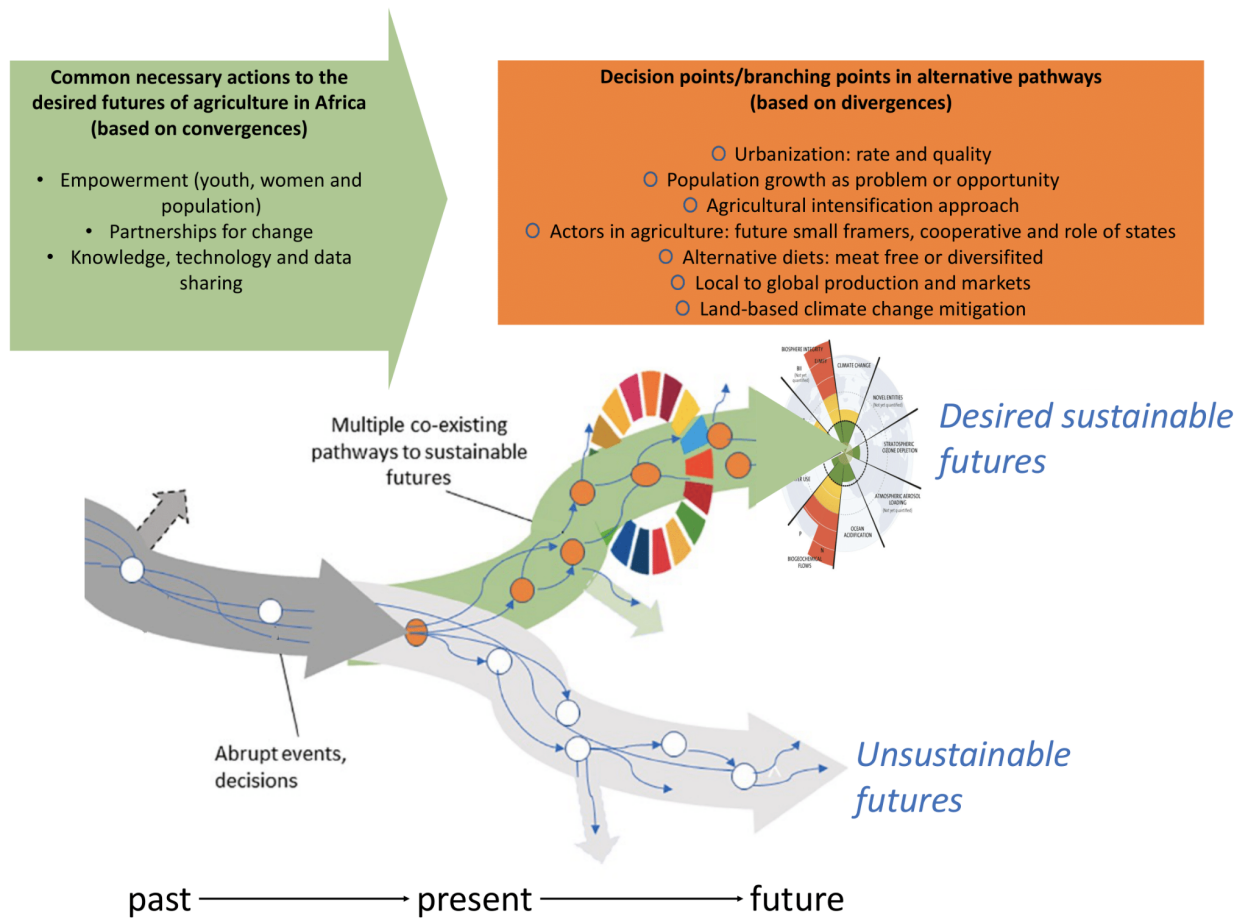
Participants' evaluation

An evaluation of the Dialogue (Appendix C) in the form of a written survey was submitted by 58 % of the participating stakeholders (submitted replies available on: https://osf.io/prj8v/). Some participants had to leave early and could not participate in the evaluation, and this may have skewed the results. The results nevertheless indicated that the approach was received positively and perceived as useful, discussing relevant questions and worth applying in different contexts

(median 4 on a scale between 1 and 5 in the survey). Most of the respondents would also recommend the process to be used by others (median 5 on a scale 1 to 5).

In the following subsections, we detail selected qualitative details of the participants' responses, related to the three above-mentioned premises of the study: Systems perspective and SDG integration, multiple perspectives and participants' ownership of the pathway narratives. It should here be noted that evaluating participatory approaches is challenging and there is a risk of over-focusing on quantitative measures. In addition, when assessing the outcomes of participatory approaches, the complexity of the context makes it difficult to trace the causal relationships between actions and outcomes (see a further discussion on this in Norström et al. 2020).

Systems perspective and SDG integration

Throughout the overall case-study process, the colored post-it notes assisted the coverage of various sustainability dimensions. This facilitated the integration of diverse issues in the explored pathways. Participants emphasized the value of 'holistic' and 'multi-sectoral approach' (indicated by the answers to the survey question 'What was the most important moment(s) for you during this workshop?', including *"Holistic approach in addressing SDGs; Interdependence of SDGs"*).

The uncovered pathways succeeded in maintaining an integrative perspective and not over-focusing on specific details at the cost of losing the broader picture. This is well in line with our premisse, as well as the Bennich et al. (2020) call for SDG interaction studies to engage stakeholders in integrated perspectives.

In support of the integrative perspective, participants also noted that agriculture can enable transformations of other sectors (responses to the evaluation question *"What ideas or insights do you look forward to share at work?"* included: *"Pathways [...] to sustainable social-economic transformation through modernizing agriculture"* and *"That transforming agriculture requires a*

multi-sectoral approach"). This wider focus on linkages across sectors has been argued to be missing in SDG interaction studies to date (Bennich et al. 2020).

Multiple perspectives

The approach not only strives to represent a diversity of stakeholders, but also to make it explicit for the participants that including multiple perspectives is beneficial for the exploration of pathways towards SDGs.

In this respect, the systems lens central to the 3H4SDG approach represents a beneficial addition because it can facilitate an overarching view of systems and allow for explorations of multiple perspectives, which in turn can reveal novel future alternatives. In future iterations of the 3H4SDG approach, an explicit focus on power relations, both in the design of the process and in terms of the focus on power as a factor influencing decisions and actions in systems, may provide useful insights into which and whose perspectives are more likely to be represented.

A systems lens, combined with a diversity of participant backgrounds, incorporated innovative thinking about change and transformations in the process. This may be exemplified by the widespread use of the scope and details of the future regional pathways, and was a recurring theme in the evaluations. Participants highlighted this in their answers to the question 'What ideas and insights do you take home from this workshop?' with the following responses: *"Embracing our diversification;..."*; *"The group work was nicely formed with a different range of expertise which helped the discussion among the group members."*; *"It is possible to achieve something tangible if we bring people together"*.).

Participant's ownership of the pathway narratives

The participants' evaluations also suggest that the alternative futures were not felt as imposed from outside but as emerging from the realities experienced by the participants (as an example, one respondent in the evaluation referred to the dialogue as a *"People-led initiative"*). Participants' ownership of the resulting pathways was facilitated by the fact that the futures emerged from a participatory process (one participant referred as the main insight to bring from

the dialogue that "*communities need to be empowered [through participative processes]*"). Participants further highlighted deliberations of the future as important because it created shared understanding among participants. (Similar sentiments are discussed in Voinov and Bosquet (2010); Voinov et al. (2016); for instance, one of the participants answered the question 'What was the most important moment(s) for you during this workshop?' by stating "*All the interesting discussions and sharing knowledge"*). The aspects focusing on creativity may have increased participants' feeling of ownership (several of the participants mentioned the letters from the future as main highlights). To facilitate the ownership, participants were invited to read and comment on the workshop report before it was published to ensure that it captured the process well.

METHODOLOGICAL CONTRIBUTIONS

The 3H4SDG approach facilitates explorations of (a) alternative pathways to reach the SDGs in an integrated way; and (b) convergences and divergences between the pathways and across scales. The convergence analysis points out to broader, integrative, changes necessary. The divergences point to alternative tensions and options that need to be further explored, by the use of complementary methods.

The approach brings an explicit recognition of conflict and tension and thereby avoids assuming a pre-determined consensus. This is in line with the 'opening up' of possible futures, also emphasized in the sustainability pathways approach (Leach et al. 2010). Therefore, conflicting problem framings are allowed to co-exist, even promoted and made palpable (see also Pereira et al. 2021). Simultaneously, a significant strength of the 3H4SDG approach that was noted by the facilitator team is that it is effective even when participants' perspectives differ, in line with earlier literature on the Three Horizons approach (Sharpe 2020).

The politics of transformations

Pathway development and discussions on transformations, including such where the 3H4SDG is applied, involve power relationships, as systemic changes create winners and losers. Transformations are therefore not apolitical but rather underpinned by political processes

(Patterson et al. 2017, Blythe et al. 2018). Linnér and Wibeck have framed it in the following way: "We share the same boat - planet Earth - but are not on the same deck geopolitically or in political-economic terms" (Linnér and Wibeck 2019 p. 187). Conflicting paradigms, for example around the use of various agricultural technologies in the context of various international assessments such as the IAASTD, are often situated within uneven processes of deliberation where resourceful actors take part besides less resourceful actors, shaping the discourses (Vanloqueren and Baret 2009). Conflicting paradigms also play out in 'the politics of anticipation', e.g. around choices over the inclusion of negative emission technologies by the IPCC (Beck and Mahony 2018), as well as competing framings and discourses within the context of global discussions on biodiversity within IPBES (Borie and Hulme 2015).

Furthermore, as earlier emphasized, values and paradigms influence the behavior of global models. There is in global modeling a continuous risk that this is not acknowledged (see Saltelli et al. 2020, that also points to the need to acknowledge stakeholders and multiple views in model formulation). In the case of the 2030 Agenda, this risks the production of overly technocratic outlooks that do not incorporate the possibilities for radically different futures, of which some are already emphasized and desired by communities (see Wyborn et al. 2020). The 3H4SDG approach explicitly highlights divergences and thereby gives room for alternative perspectives. However, dialogues such as the 2018 African Dialogue on the World in 2050 do not take place in a vacuum but are inevitably affected by surrounding power relations, paradigms and perspectives. We have compared the outcomes from the 2018 African Dialogue on the World in 2030 with other sustainability pathways in a separate paper (Aguiar et al. 2020). The paper points towards the potential of 3H4SDG to bring a diversity of considerations to the front (Aguiar et al. 2020).

Limitations

Reaching a desirable level of diversity of pathways that are explored may prove difficult due to various constraining factors, including time, financial capacity, geographic representation, language barriers, etc. (Turcotte and Pasquero 2001, Reed 2008).

Although the 2018 African Dialogue participants' group covered different parts of the African continent (across eleven countries) and was diverse when it comes to participants' origin, residence and home organization, East Africa was overrepresented, and Southern Africa was underrepresented. This occurred despite a conscious strategy and targeted invitations. This implies that the sub-regional representativeness of the resulting pathways may not represent a diversity of all sub-regions in Africa. Thus, in future case studies, a better design of the invitation process and more considerations of who to invite would be recommended (this has been emphasized in earlier participatory literature, see e.g. Pereira et al. 2018). Alternatively, the process can be repeated in different locations (or regions if the aim is regional representation), later synthesizing the convergences and divergences across multiple Dialogues from these locations. Future case studies would also benefit from including follow-up workshop(s) in connection to the dialogue, in which the results can be presented and further discussed and related to existing governance processes.

We see the overarching frame and systems perspective as a strength of the approach as called for elsewhere (e.g. Bennich et al. 2020). It facilitates the visualization of alternatives to the prolongation of societal trends - which has been identified as an asset in future studies (Andersson and Westholm 2019). From another perspective, however, this strength can be seen as a weakness as there is no clear receiver that will implement the suggestions, and the impact is difficult to measure, and often results in 'small wins' (Turcotte and Pasquero 2001). Nevertheless, we argue that the proposed approach is versatile enough to be possible to target in a particular decision-making context.

Future use of the 3H4SDG approach

A question that still remains is how the implementation phase of the 2030 Agenda can be an inclusive process grounded in the prevalent narratives. The 3H4SDG approach can serve as a meaningful way to provide stakeholder inputs and visioning to implementation that not only offers advice on a detailed level but enables a systems view of development. The approach can also open the debate about the adequacy of targets contributing to desired sustainability visions (and even critically assess sustainability visions put forward), as opposed to sustainability visions

imposed top-down. We see the approach as adaptable to different circumstances and with different themes and questions, and it has already been taken up and adopted in different settings by the Dialogue participants (Graziani 2019).

CONCLUSIONS

The Three Horizons for the SDGs (3H4SDG) democratizes visioning, brings convergences and divergences to the forefront, and can be adapted to a variety of contexts. The approach combines the Three Horizons framework with multi-scale scenario and systems thinking approaches. The approach contributes with a focus on both alternative pathways to reach the SDGs in an integrated way; and convergences and divergences between the pathways and across scales.

The approach has proved to have multiple assets. First, it facilitates deliberation, collaboration and shared understanding and visioning in a diverse group of stakeholders. Second, it provides a novel way of looking at the SDGs from a systems perspective in which the agenda is seen as a coherent whole, as a direction for the uncovering of sustainability pathways, while integration is being placed at the core. Third, it fosters ownership and creativity as it motivates participants to develop different forms of syntheses (including artistic ones). Finally, it can benefit practitioners and policy makers by promoting a systems perspective and a bird's eye view of uncovered pathways.

The identification of convergences and divergences can be used to deliberate alternatives among diverse voices and for further specification of sustainability pathways. Furthermore, it allows for comparisons with global pathways and facilitates their integration at sub-global scales. The 2018 African Dialogue case study provides examples of both convergent and divergent topics.

We envision 3H4SDG to be used as a strategic tool that allows for inclusive discussions in the direction towards not only sustainable, but also just, futures.

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