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The relevance of international restoration principles for ecosystem restoration practice in Rwanda

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The restoration of degraded ecosystems is considered a key strategy to contribute to ecological integrity and human well-being. To support restoration practice, 10 "Principles to guide the UN Decade on Ecosystem Restoration 2021–2030" were conceived through a consultative process and put forward by a group of leading international restoration actors. The extent to which these principles can inform successful restoration activities on the ground, however, remains largely unknown. Using a combination of qualitative and quantitative data collection methods, we probed 32 stakeholders who plan, manage, and implement restoration in Rwanda to elicit which factors they perceive as most important for successful restoration based on the UN Decade principles. Using the Q-methodology, we discovered that participants overall agreed that the UN Decade principles are relevant to inform successful ecosystem restoration in the study area. Further, the Q-study revealed three distinct groups of stakeholders with different priorities in terms of opinions on restoration aims, stakeholder involvement, and relevant spatial scales. Based on semi-structured interviews, we identified four considerations for successful restoration that require special attention in future restoration interventions in the study area: (1) restoring historical conditions, (2) collecting baseline data, (3) increasing local communities' sense of ownership, and (4) pursuing a long-term vision for restoration activities. To address these considerations and thereby harvest the potential of ecosystem restoration to benefit both people and nature in the long run, diverse stakeholders with different priorities for restoration need to come together to discuss possible differences in their perceived priorities, perspectives, and approaches.

Key words: ecosystem restoration, forest landscape restoration, Q-methodology, social-ecological systems

Implications for Practice

- The "Principles to guide the UN Decade on Ecosystem Restoration 2021–2030" can be a basis for reflection and exchange among stakeholders on restoration approaches and priorities.
- In Rwanda, approaches to restoration differ among key restoration stakeholders with respect to (1) the envisioned goal of restoration, (2) the motivation for involving stakeholders, and (3) the spatial scale at which restoration interventions are carried out.
- Sound knowledge on ecological conditions, communities' sense of ownership of restored sites, and a long-term vision for restoration activities are key for successful restoration in the study area and most likely beyond.

Introduction

Ecosystems that safeguard biodiversity contribute to human well-being and provide resilience against global threats such as climate change are key for securing a safe and sustainable foundation for life on Earth. Ecosystem restoration can significantly contribute to maintaining or reinstating such systems by "halting and reversing [their] degradation" (UNEP 2021). Around the world, restoration is gaining momentum: it is one of 23 global targets defined by the Kunming-Montreal Global Biodiversity Framework (CBD 2023) and central to achieving the Sustainable Development Goal (SDG) "Life on Land" (Sachs et al. 2022). In addition, the United Nations declared 2021–2030 the "Decade on Ecosystem Restoration" (hereafter "UN Decade"). To date, 115 countries have put forward quantitative, area-based commitments to restore various portions of their territory as part of the UN Decade (Sewell et al. 2020).

In practice, however, ecosystem restoration still faces many challenges. For example, on the ecological side, many restoration projects fail to restore complex ecological functions and processes (Jones et al. 2018; Holl et al. 2022). In many cases, unsuitable species are selected for planting

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(Coleman et al. 2021; Naia et al. 2021), which can result in low biodiversity of restoration-dominated landscapes (Holl et al. 2022). On the social side, inflexible or short-sighted governance structures can slow restoration activities or promote misplaced restoration goals (Jepson 2022), and restoration projects face complex questions surrounding equity and inclusive participation (Elias et al. 2021; Osborne et al. 2021). Finally, a lack of adaptive capacity and resilience to complex social-ecological threats can jeopardize the long-term sustainability of restoration efforts (Dudney et al. 2022; Frietsch et al. 2023). These and other challenges related to restoration raise an important question: what do the people who plan, manage, and implement restoration interventions perceive as most important for successful restoration?

A myriad of principles exist that can guide restoration practice. Over the past decade, multiple partially overlapping restoration guidelines have been put forward focusing, for example, on the restoration of protected areas (Keenleyside et al. 2012), ecological restoration in general (McDonald et al. 2016; Gann et al. 2019), or forest landscape restoration in particular (Gichuki et al. 2019). For the UN Decade, through a consultative process and by synthesizing existing work, a group of key international restoration actors including the Food and Agricultural Organization of the United Nations, the International Union for Conservation of Nature, and the Society for Ecological Restoration formulated 10 guiding principles to "underpin all of the restorative activities that are part of the continuum of ecosystem restoration defined by the UN Decade, and which are applicable across all sectors, biomes and regions" (FAO et al. 2021). However, principles alone do not necessarily translate into more effective and successful restoration on the ground: a possible gap between science and policy on the one side versus practical application on the other side is well-known in the context of restoration (Cabin et al. 2010; Heger et al. 2022). Hence, the extent to which global level principles such as the UN Decade principles are actually relevant to practitioners in local restoration contexts remains largely unknown (Tedesco et al. 2023).

In this article, we assess the perceived relevance of restoration principles in practice in a case study in Rwanda. We focus on Rwanda because it has made one of the most ambitious restoration pledges worldwide (Nash et al. 2020). Over the past decades, hundreds of individual sites were restored across the country in the form of woodlots, agroforestry patches, wetlands, and protective plantings (Nash et al. 2020). However, most restored sites exhibit low levels of biodiversity (Arakwiye et al. 2021) and are dominated by exotic species (Nash et al. 2020), with monoculture plantings being widespread (Ministry of Natural Resources Rwanda 2014). In addition, access to resources needed for restoration such as financial support and seedlings is limited in Rwanda (Buckingham et al. 2020). Rwanda's ambitious restoration efforts, combined with the broad range of challenges that restoration is facing in the country, provide an ideal setting to explore the relevance of international restoration principles.

Against this background, our overarching goal was to assess to what extent the 10 international restoration principles put forward for the UN Decade on Ecosystem Restoration are relevant to restoration practice among stakeholders in Rwanda. We sought to (1) elicit the perspectives of diverse ecosystem restoration stakeholders on the importance of different facets of each of the 10 principles, (2) assess to what extent these principles are being applied in practice, and (3) explore future priority features of successful restoration for Rwanda that emerged throughout the research.

Methods

Study Area

The study targeted national, subnational and local stakeholders in Rwanda. All stakeholders were involved in restoration projects in the central and western parts of the country, which are characterized by a hilly, high-altitude landscape and inhabited by a mostly rural population (National Institute of Statistics Rwanda 2021). Over the past 30 years, western and central Rwanda experienced a rapid decline in natural ecosystems due to high natural resource demand and armed conflicts (Kanyamibwa 1998; Nduwamungu 2011; Arakwiye et al. 2021). As a result, the vast majority of local ecosystems are now degraded, with negative consequences for biodiversity (Arakwiye et al. 2021), ecosystem functioning (Rwibasira et al. 2021), and human well-being (Nash et al. 2020). As a response to widespread degradation, the Rwandan government and NGOs have actively pursued restoration in the past decades.

Data Collection: Q-Methodology, Relative Weighting Exercise, and Interviews

Our data collection was structured into three components. We (1) used a quantitative ranking exercise to elicit perspectives and opinions of stakeholders on what makes restoration successful, (2) subsequently carried out a relative weighting exercise to explore the reality of restoration practice in the study area, and (3) complemented these two quantitative approaches with semi-structured, qualitative interviews (Fig. 1). Components (1) and (3) together are widely known in sociological studies as the "Q-methodology" (Brown 1996; Watts & Stenner 2012). Component (2) was developed by us as a specific complement for this study. Participants were surveyed individually and, depending on their availability, participated in all three components or in components (1) and (3) only.

The Q-methodology is a structured approach to explore the reasoning behind diverse perspectives on a particular topic and combines quantitative and qualitative methods (Brown 1996; Watts & Stenner 2012; Zabala et al. 2018). Data collection for the Q-methodology follows three main steps. First, different discourses around a given topic are identified and proxy statements that represent various aspects of these discourses are developed (known as Q-set) (Watts & Stenner 2012; Zabala et al. 2018). In our case, we aimed to portray the discourse around features that contribute to successful ecosystem restoration. We based our Q-set on the 10 UN Decade principles for restoration that were designed by leading international restoration actors. Because the principles have the ambitious aim to provide guidance for all types of restoration in all parts of the world, it is particularly interesting to explore their real-world relevance in specific

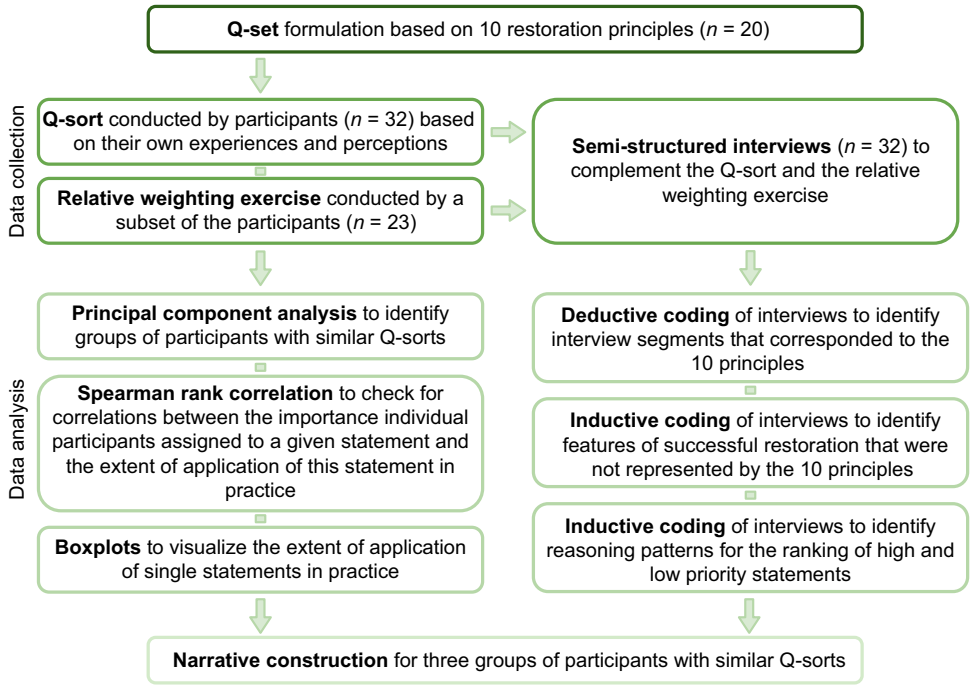

Figure 1. Study design. Data collection encompassed three steps: a Q-sort, a relative weighting exercise, and semi-structured interviews. The data obtained were subsequently analyzed using the "qmethod" package in R as well as deductive and inductive coding.

contexts such as western and central Rwanda. We developed two detailed proxy statements for each of the 10 principles and obtained a Q-set of 20 specific statements (Table 1). We carefully worded the statements based on the short explanations of each principle provided by the official document on the UN Decade principles (see FAO et al. 2021) and cross-checked these for intelligibility within the author team and via two pretests with other colleagues. Finally, the statements were numbered randomly to avoid biases in the sorting process while also enabling easy data collection, and subsequently printed on cards.

In the second step, we selected participants. Because the Q-methodology seeks to identify the diversity of perspectives on a given topic, the participants are usually a nonrandom, purposively sampled, diverse selection of individuals that are familiar with the topic of interest, who are likely to represent the range of viewpoints on the topic. Participant numbers typically range from 26 to 46 (Zabala et al. 2018). Notably, the Q-methodology is not primarily designed to reach general conclusions about how different demographic groups perceive a given topic, but rather seeks to illustrate more broadly the reasoning underpinning different types of perspectives—diversity in participants is therefore more important than balanced representation of particular demographic groups (Cairns 2012). In our case, we conducted the Q-methodology with 32 participants who were active in restoration projects as either researchers ($n = 8$), government officials ($n = 8$), or NGO staff ($n = 16$) in 12 districts in western and central Rwanda. For this study, we chose to speak to people with the agency to actively shape restoration interventions. Local people were not included in our study because at present, they are mostly the recipients of restoration interventions. Future research can (and should) pursue similar research questions to those presented in this paper but focus on local people instead. We interviewed five women and 27 men who had been involved in restoration between one and 18 years. In the following, interviewees will be referred to by their role as either researcher (R), government official (G), or NGO staff (N) and numbered consecutively within these categories.

In a third step—the so-called Q-sorting—participants were asked to rank the proxy statements according to their own experiences and perspectives (Zabala et al. 2018). We first asked participants to read all statements and initially presort them for their own convenience into three categories, namely "most important," "medium important," and "least important" for successful restoration. Next, we provided respondents with a scoreboard showing 20 empty fields along a gradient from most to least important for successful restoration with a few boxes at the extremes (i.e., very important or not very important) and the majority of boxes in the middle (i.e., medium important) (Fig. S1). We then asked participants to place the statement cards on the scoreboard according to their importance for successful restoration. Finally, after completing the Q-sort, participants were given time to re-arrange the statements until they were satisfied with their order.

The application of the Q-methodology generated data on the features that were deemed more or less important for successful restoration according to participants' perspectives. As a second part of our study, we explored the extent to which these features were actually applied in restoration practice within the study

Table 1. The 10 guiding principles and the derived Q-set. For each principle, two statements were developed resulting in a Q-set with $n = 20$. The z-scores are weighted averages of the values that Q-sorts of a given group assign a statement; high z-scores indicate that a statement was considered very important for successful ecosystem restoration. G1 = group 1; G2 = group 2; G3 = group 3.

Principle	*#*	*Statement*	z-*Score G1*	z-*Score G2*	z-*Score G3*
Principle 1: Global Contribution	1.1	Restoration projects should help to safeguard biodiversity and combat climate change.	0.12	0.88	0.17
Principle 1: Global Contribution	1.2	Successful restoration should contribute to the 17 Sustainable Development Goals.	0.00	1.62	−2.25
Principle 2: Broad Engagement	2.1	Stakeholders should be integrated throughout the whole process of a restoration project, from planning to monitoring.	1.28	0.13	0.43
Principle 2: Broad Engagement	2.2	Inclusive participation of stakeholders is necessary for achieving the desired outcomes of restoration over the long term.	1.22	0.01	0.05
Principle 3: Many types of activities	3.1	Restoration projects should encompass a wide range of activities.	−1.71	−2.24	−1.99
Principle 3: Many Types of Activities	3.2	Different approaches and measures should be part of restoration projects.	−0.91	−1.65	−1.21
Principle 4: Benefits to Nature and People	4.1	Restoration should aim to achieve the greatest gains possible for both nature and people.	0.52	1.43	0.17
Principle 4: Benefits to Nature and People	4.2	Restoration should support natural recovery processes and increase ecological integrity.	0.05	−0.72	0.44
Principle 5: Addresses Causes of Degradation	5.1	Restoration projects should help to eliminate causes of ecosystem degradation	−0.52	0.51	0.67
Principle 5: Addresses Causes of Degradation	5.2	During the planning phase of restoration projects, the causes of degradation should be identified.	1.94	0.11	0.12
Principle 6: Knowledge Integration	6.1	Restoration projects should facilitate learning and knowledge-sharing among stakeholders and practitioners.	−1.16	−0.40	0.57
Principle 6: Knowledge Integration	6.2	Restoration projects should integrate all types of knowledge such as traditional, local, and scientific knowledge.	0.33	−0.24	0.88
Principle 7: Measurable Goals	7.1	Goals of restoration projects should be based on a shared vision of desired outcomes.	−0.14	0.44	−0.85
Principle 7: Measurable Goals	7.2	Restoration planning should include the establishment of realistic and measurable goals.	0.92	−0.77	−0.65
Principle 8: Local and Landscape Contexts	8.1	The ecological, cultural, and social setting should be taken into account when planning a restoration project.	0.82	−0.23	1.96
Principle 8: Local and Landscape Contexts	8.2	The goals of restoration projects should be aligned with the local context and local needs.	0.83	1.52	1.19
Principle 9: Monitoring and Management	9.1	Restoration projects should be monitored to adapt activities as a response to changing conditions over time.	−1.03	−1.12	0.22
Principle 9: Monitoring and Management	9.2	Restoration projects should be monitored beyond their lifetime to capture longer-term impacts.	−0.99	−0.10	0.16
Principle 10: Policy Integration	10.1	Laws and regulations on restoration should support the planning and implementation of restoration projects.	−0.16	0.27	−0.12
Principle 10: Policy Integration	10.2	Successful restoration activities should influence the design of laws and policies to help prevent ecosystem degradation.	−1.43	0.54	0.04

area. To this end, we conducted a relative weighting exercise with some of the participants ($n = 23$). We asked these participants to build towers using 60 LEGO bricks and place them on the 20 statement cards to indicate to what extent each statement had been applied in one specific restoration project they had been involved in (Fig. S1). The higher the tower on a given card, the more the ideas represented in the statement had been applied in the restoration project. We asked participants to use all 60 LEGO bricks. Participants had the option of putting zero LEGO bricks on a card in case a statement was not at all reflected in the restoration project. Again, participants were given time to re-arrange the LEGO towers until they were satisfied.

To complement the quantitative data collection based on the Q-sorting and the LEGO exercise, we conducted semi-structured interviews (Supplement S1). Right at the beginning of these interviews, that is, before handing out the Q-set, we asked participants to define successful ecosystem restoration in their own words and name contributing features to obtain their initial, unbiased perspective on restoration success. Next, as part of the Q-methodology, we asked participants why they chose the three most and the three least important statements to understand the reasoning behind participants' Q-sorts. Finally, we asked follow-up questions on the LEGO exercise about the distribution of the towers, especially in the case of discrepancies between the statements a participant sorted as most or least

important versus the height of the LEGO tower they built on these statements. We did not tell participants that the Q-set was based on the UN Decade principles until after the interviews were completed; most participants stated that they were not familiar with the principles.

Data Analysis: Statistics and Interview Coding

As a first step, to synthesize the Q-methodology data and identify groups of participants with similar perspectives on successful restoration, we performed a multivariate analysis of Q-sorts using principal component analyses with the "qmethod" package in R software. The "qmethod" package was specifically designed to analyze data obtained from Q-studies that typically have small sample sizes (Zabala 2014). The principal component analysis allowed us to compare the collected Q-sorts, group them by similarity, and summarize shared views in the form of idealized sorting patterns of the statements. These sorting patterns are called "factors" in the Q-methodology and reflect shared viewpoints of groups of participants (Zabala 2014; Zabala et al. 2018). To improve readability, we will use the term "groups" instead of "factors" in this article. Following the initial exploration of two- to six-group solutions, we decided to extract three groups that explained the variation in prioritizing features of successful restoration based on their high eigenvalues.

For the analysis of the LEGO exercise, we used Spearman rank correlation to check for correlations between the importance individual participants had assigned to a given statement (i.e., the statement's position on the scoreboard) and the extent of application of this statement in practice (i.e., the height of the LEGO tower for the statement). We also generated boxplots for the LEGO towers pertaining to each statement to check if certain statements were applied in practice to a particularly high or low extent.

Finally, to analyze the qualitative data obtained from the semi-structured interviews we transcribed all interviews and conducted three rounds of iterative content analysis. First, we deductively coded all responses following the 10 UN Decade principles to identify interview segments that corresponded to the principles. Second, we inductively coded all responses to identify features of successful restoration that were not represented by our statements summarizing the 10 principles. Third, we inductively coded all responses to identify different types of reasoning for the classification of high and low priority statements given by participants. In addition to these three rounds of coding, we also integrated the results of the principal component analysis of Q-sorts and the interview data by synthesizing general narratives for the three resulting groups.

Results

Overview of Q-Sorts and LEGO Exercise Results

Participants referred to all 10 principles throughout the interviews and the majority of participants expressed that all principles were important in the context of restoration. This was captured by one participant's comment stating that prioritizing the statements was "like choosing between your Mom and your Dad" (R5). There were no strong correlations between the position of a given statement on the scoreboard and the height of the respective LEGO tower for the vast majority of participants (i.e., only three rho values >0.6, for participants N5, N7, and N9). The average heights of LEGO towers on the 20 statements representing the degree of application in practice did not differ significantly across all statements, with a mean height of 2.95 LEGO bricks per statement.

Based on the 20 Q-statements, the principal component analysis identified three distinct perspectives on what stakeholders perceived as important for successful restoration (Fig. 2). Together, the three groups of participants explained 53% of the total variance in rankings. Correlations among the three groups were generally low (Pearson correlation values of 0.39, 0.34, and 0.21, respectively), such that they could be seen as genuinely different perspectives. The composite reliabilities of the three groups were high (0.98, 0.97, and 0.96, respectively). The three groups captured the priorities of 26 out of the 32 participants; the remaining six participants did not load significantly on any of the three groups.

There were five statements that clearly distinguished all three groups from one another (Fig. 2). Here, different perceptions on the importance of SDGs for restoration most strongly distinguished the three groups. Repeated reasons given for ranking statements at the bottom of the scoreboard were that the approach or idea represented in that statement was (1) not necessarily needed for successful restoration at particular scales or in particular contexts (18 participants) or (2) not as important as other steps that are part of the restoration process (14 participants). For particularly highly ranked statements, participants repeatedly stated that the reason for prioritization was that the approach or idea represented in that statement (1) was the foundation of good restoration (11 participants) or (2) constituted the main goal of restoration (10 participants).

Three Different Perspectives on Successful Restoration

Group 1: "You Can't Treat a Disease If You Don't Know the Cause" (G5). The first group had 12 significantly loading participants. Two of the loading participants were researchers, six worked for NGOs and four were government staff. This group explained 21% of the total variance and had an eigenvalue of 6.4.

Participants who loaded highly on the first group viewed *ecosystem restoration as a process*. The first step of this process was the identification of root causes of degradation to then develop "context-appropriate solutions" (G5) because you "can't plan without knowing cause and effect" (R3). This "combination of problem assessment and planning" (N13) included understanding the local context and setting realistic, measurable goals to guide the project. Participants who loaded highly on this group valued the involvement of local stakeholders because they "depend on and shape ecosystems" (N12). Local knowledge was thus indispensable to understand root causes and establish successful projects because "technicians tend to think they know all they need, but local knowledge gives context" (N4).

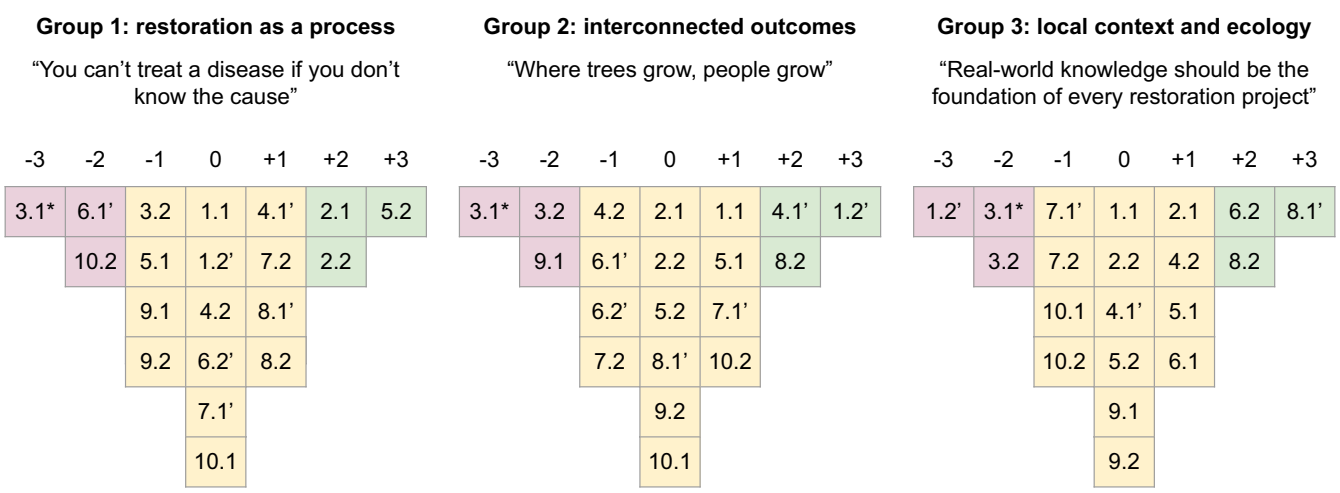

Figure 2. Idealized Q-sorts of the three groups. Each group brings together participants with a shared perspective on what is needed for successful restoration. The quotes summarize the essence of these groups' perspectives and were extracted from the semi-structured interviews. The 20 Q-set statements are represented by numbers indicated in Table 1. The gradient from −3 to +3 indicates the position of a statement on the scoreboard ranging from perceived low importance (red) over perceived medium importance (yellow) to perceived high importance (green) for successful ecosystem restoration. * = consensus statement that showed no significant difference in ranking between groups; ' = distinguishing statements that showed a statistically significant difference in ranking between groups ($p \leq 0.001$).

In addition, stakeholder involvement could "prevent conflicts" (N4), "increase ownership and make [stakeholders] part of the team" (N12), and "help overcome degrading processes" (G5) to ultimately "increase the strength of the project" (N12). Finally, participants who loaded highly on this group focused on restoration itself and did not prioritize possible flow-on effects such as knowledge-sharing or influencing laws because these were seen as the "last step" (N9) of the restorative process and were therefore considered "less important than other [steps]" (R3).

Group 2: "Where Trees Grow, People Grow" (G8). The second group had eight significantly loading participants. Four of the loading participants worked for NGOs and four were government staff. This group explained 17% of the total variance and had an eigenvalue of 5.2.

Participants who loaded highly on the second group were *outcome-oriented and adopted a social-ecological systems perspective* to restoration by acknowledging that natural and social "systems are interconnected" (G8). According to this group of participants, the overarching goal of restoration was to benefit nature and people at all scales. This included to "contribute to the well-being of people and ecosystems" (N1) and restore "nature and natural values of the landscape" (N7). To this end, it was considered necessary to "think and act long-term" (N16) and include "the biophysical setting, the policy setting [and] the socio-economic capacities of communities" (N16). Envisioned outcomes of this integrated form of restoration were to bring back "productive and functional ecosystems" (G8), "support livelihoods of dependent communities" (N16), and promote "transformation and inspire others" (N10). Participants who loaded highly on this group additionally sought to connect local restoration activities with the "worldwide vision" (G2) of the SDGs and highlighted that restoration would need to span multiple scales where local "actions contribute to global goals" (G2). Although outcomes were the main focus of this group of participants, applying a diversity of restorative activities was not considered a high priority because successful restoration "can just consist of some key activities" (N7).

Group 3: "Real-World Knowledge Should Be the Foundation of Every Restoration Project" (R5). The third group had six significantly loading participants. Four of the loading participants were researchers and two worked for NGOs. This group explained 15% of the total variance and had an eigenvalue of 4.8.

Participants who loaded highly on the third group *strived to restore ecological integrity and anchored restoration activities in their local context*. According to this group of participants, the "ultimate goal" (N3) of restoration was to restore "biodiverse and functional ecosystems" (R1). To achieve this, restoration projects needed to be embedded in the "local social and ecological context" (R1): "sound knowledge on the baseline of biodiversity, ecosystem integrity and ecosystem services" (N3) was needed to "see what existed before and get inspired by it" (R1). This is why participants who loaded highly on this group assigned high "importance [to] local knowledge and skills" (R2) and valued "conversations between all stakeholders to share knowledge and grow from there" (R5). To this end, it was considered important to "respect [local communities'] cultural connections to the landscape" (R5) and "engage stakeholders in all steps of the project in a bottom-up" (N3) and "participatory approach" (N15). In addition, the integration of local stakeholders was seen to contribute to the long-term sustainability of restoration efforts because "communities only maintain what they want" (R8). These local processes were only

loosely connected to larger scales: "restoration should be focused on the local and regional scale" (R5) because "global level goals are too general" (N15) and are "for politicians but are not known to local communities" (R2).

Priorities for Ecosystem Restoration in Rwanda

Four features of successful restoration were repeatedly mentioned in the interviews but did not directly correspond to the statement cards developed for this paper. Seven participants expressed the importance of *restoring historical conditions*, including "functionality" (G8), "biodiversity" (G3), and "ecosystem services" (N12). Five participants highlighted the necessity of systematically *collecting baseline data* on "biodiversity, ecosystem integrity and ecosystem services" (N3) to "understand what is needed" in terms of restoration (N15). Five participants advocated *increasing local communities' sense of ownership* of restored sites by "giving them decision making power" (N14) and making sure that projects created "assets for communities" (N1). Finally, 10 participants emphasized the importance of a *long-term vision* for restoration actions which requires "patience" (R6) and "long-term thinking" (N3) to "focus on growing trees, not planting them" (N7).

Discussion

"Different Interests for Different Stakeholders" (R7)—Approaching Restoration from Diverse Perspectives

Although participants appreciated the general relevance of all statements, participants prioritized different aspects of what they felt was especially important for successful restoration. The resulting three groups were linked to different ways of approaching restoration interventions in relation to (1) the envisioned goal of restoration, (2) the motivation for involving stakeholders, and (3) the spatial scale at which restoration interventions were carried out. Participants who loaded highly on the first group ("restoration as a process") were mostly concerned with how to best go about restoration, with the precise definition of aims considered relatively less important, or perhaps assumed as obvious. In comparison, participants who loaded highly on the second group ("interconnected outcomes") and third group ("local context and ecology") focused more on the ends they wanted to achieve by using restoration as a means. With regard to stakeholder involvement, the second group expressed an intrinsic motivation for stakeholder participation because stakeholders were viewed as important in their own right, whereas groups 1 and 3 mainly viewed stakeholder engagement as a tool to secure better ecological outcomes. Finally, participants who loaded highly on the first group did not position themselves with regards to spatial scales, whereas group 2 sought to connect different scales from local to global, and group 3 explicitly focused on local and regional scales.

In addition to a lot of general agreement, our findings thus also illustrate subtle differences in the beliefs and approaches underpinning restoration in Rwanda. Group 1 ("restoration as a process") might best be described as a process-oriented, linear management approach to restoration. Tedesco et al. (2023) argue that approaching restoration as a process was useful to practitioners to think beyond single projects and could help to achieve multiple synergistic restoration objectives. However, this requires the consideration of diverse social-ecological dimensions across different scales (Tedesco et al. 2023), which were typically not accounted for by the first group. Although the restoration approach displayed by group 1 understands restoration as a process, it lacks the notion of learning while implementing restoration practices. In fact, the linear way of thinking displayed by this group runs contrary to the principles of active adaptive management (Murray & Marmorek 2003; Keenleyside et al. 2012) which is widely considered crucial for restoration (Fischer et al. 2021; Dudney et al. 2022).

Group 2 ("interconnected outcomes"), with its vision to benefit people and nature across multiple scales, is closely related to the rationale underpinning *Forest Landscape Restoration* (Dudley et al. 2005; Mansourian et al. 2021). As such, the logic put forward by this group faces the same challenges as the approach of Forest Landscape Restoration in general: balancing competing interests of stakeholders (Chazdon et al. 2021; Stanturf 2021), aligning local with national goals (Stanturf 2021), and dealing with a possible lack of enabling conditions and implementation capacity (Chazdon et al. 2021; Mansourian 2021). In the study area, competition for space between the livelihood needs of a growing population and biodiversity (National Institute of Statistics Rwanda 2021), as well as limited access to resources needed for restoration (Buckingham et al. 2020) can pose challenges to restoration implementation.

Group 3 ("local context and ecology") followed an ecologically motivated approach to restoration more consistent with an *ecological restoration* logic that focuses on ecosystem composition and structure and is often oriented toward a historical reference state (Stanturf et al. 2014). A local focus on clearly defined criteria for ecological success is useful from a biodiversity perspective (Gann et al. 2019), and arguably, a well-defined ecological focus is sometimes lost in large-scale efforts of Forest Landscape Restoration. Yet, focusing primarily on one dimension of an intertwined social-ecological system—be it the social or ecological dimension—is bound to result in suboptimal outcomes for the system as a whole (Walker & Salt 2006). In addition, a strong focus on the local scale can lead to unintended negative interactions with processes occurring at larger spatial scales, because restored sites are connected to a global web of resource use, funding, and policies (Fischer et al. 2021; Osborne et al. 2021).

Despite differences, the three perspectives on how to best design and implement restoration interventions are rather complementary and thus do not have to result in conflict between groups. Integrating these different views can be an asset in restoration practice, for example, in a context of transdisciplinary mechanisms for deliberation and collaboration (Lang et al. 2012; Fischer et al. 2021). With appropriate platforms for exchange, different viewpoints can enrich each other and thus lead to more integrated restoration activities.

"That's the Change I Want to See in the Future" (N7)—Features of Successful Restoration

Four features were repeatedly mentioned in the interviews that did not directly correspond to one of the 20 statements of the Q-set. Participants emphasized that these features need to be considered when designing and implementing restoration interventions in Rwanda. Two of these features—*collecting baseline data* and *restoring historical conditions*—represent classical ecological priorities for restoration (Stanturf et al. 2014). In comparison, the feature of *increasing local communities' sense of ownership* is not at all ecological but political in nature, and is closely related to recent discourses on equity and justice in restoration (Erbaugh et al. 2020; Löfqvist et al. 2022). Finally, the feature *long-term vision for restoration* brings the other three features together—it highlights that it can take many years for ecological and social goals to be fully realized. In the following, we discuss these four features in the context of the UN Decade principles and current debates surrounding ecosystem restoration.

Collecting Baseline Data and Restoring Historical Conditions. Access to baseline data and an awareness of historical reference conditions are central to the paradigm of ecological restoration (Society for Ecological Restoration 2004), which dominated restoration science and practice before approaches such as Forest Landscape Restoration (Dudley et al. 2005) or social-ecological restoration (Fischer et al. 2021) entered the discussion. Baseline data on the historical state of an ecosystem before degradation (CBD 2016) as well as data describing ecological conditions at the onset of restoration (Society for Ecological Restoration 2004) can guide restoration activities and provide important reference points for monitoring and evaluation of restoration projects (Gann et al. 2019).

The UN Decade principles highlight the importance of baseline data (principles 7 and 9) and the associated "Standards of Practice to Guide Ecosystem Restoration" (FAO et al. 2023) describe in more detail what to consider when conducting baseline assessments. In the context of the Rwanda, baseline data remain scarce in many instances: participants reported that for many restoration projects there is not enough time and funding to assess baseline conditions before starting an intervention (N3, N15, R1). This knowledge gap can lead to restoration interventions "based on assumptions rather than hard data or proof" (N3) and result in the implementation of unsuitable restoration measures (Bond et al. 2019). Hence, while there is ample theoretical knowledge and guidance on how to effectively assess baseline data (e.g., (Gann et al. 2019; FAO et al. 2023), practical and financial capacity is urgently needed in order to facilitate baseline assessments. Solving the problem of data availability and access is critical for effective restoration, and national conservation actors must have a sense of ownership in biodiversity information and how it can be applied (Buschke et al. 2023).

When it comes to historical conditions, the UN Decade principles do not explicitly advocate for the restoration of past ecosystem structure and function. This is in accordance with critics of historical reference points, who have argued that their relevance could be limited: critics believe that restoration should focus on fostering desired future system characteristics instead of past conditions (Hobbs & Harris 2001; Corlett 2016). The usefulness of historic states as guidance might be especially reduced given inevitable large-scale changes such as global warming (Harris et al. 2006), the emergence of new abiotic and biotic conditions (Hobbs et al. 2009), and changing social preferences (Higgs et al. 2014). In line with this, the UN Decade principles do recognize that restoration can entail the recovery of an ecosystem "to the trajectory it would be on if degradation had not occurred" as long as environmental change is accounted for (principle 3). As such, knowledge on historical conditions can provide useful contextual understanding of ecosystem conditions that helps to assess the trajectory of restored sites (Higgs et al. 2014). Arguably, this contextual way of using historical reference points is more feasible than simply trying to "bring back ecosystems to [their] initial state" (R4). It means using historical knowledge as a guide rather than a rigid template (Higgs et al. 2014) as it is outlined in the UN Decade principles. In addition, it might open doors to integrate traditional ecological knowledge on historical conditions (Tengö et al. 2014), and may imply an explicit re-orientation away from species composition as the prime restoration goal toward a stronger focus on ecosystem function (Perring et al. 2015).

Increasing Local Communities' Sense of Ownership. The third feature of successful restoration that was repeatedly mentioned to be underemphasized in our Q-set—*increasing local communities' sense of ownership*—is tightly connected to political ecology discourses on justice in restoration. Many restoration interventions are shaped by unequal power relations that determine which activities are prioritized, whose knowledge is included in decision-making, and how resources, benefits, and opportunity costs are distributed (Mansourian 2018; Elias et al. 2021). This can result in restoration interventions that are not aligned with social and ecological local realities (Osborne et al. 2021) and that perpetuate the marginalization of local communities (Löfqvist et al. 2022). Such lack of accounting for local communities is problematic not only from a justice perspective, but can also lead to a lack of identification of local communities with the restoration project, which in turn can cause the unsustainable exploitation of restored sites as soon as those managing the intervention leave or funding runs out (N15).

In this context, both the sense of mental ownership as well as legal ownership matter. Mental ownership is the feeling of connection with a restored site and can be fostered by strengthening emotional connections between people and restored sites (Gottschalk Druschke & Hychka 2015). Valuing and integrating diverse local knowledge and practices is key for building on already existing forms of ownership (Osborne et al. 2021). To create and sustain connections between stakeholders and restoration projects, all stakeholder groups—that is, those who are affected by or can affect restoration (Freeman 1984)—need to be able to participate (Osborne et al. 2021; Elias et al. 2022). Here, to foster participation beyond simple information or consultation (Arnstein 1969), stakeholders need to be given actual

decision-making power (Ruano-Chamorro et al. 2021; Sigman & Elias 2021) which can be supported by inclusive governance models (Löfqvist et al. 2022), and effective mediation in stakeholder processes that accounts for power imbalances (Ruano-Chamorro et al. 2021). Legal ownership includes formal tenure rights as well as other regulated and reliable types of access to, management of, and control over resources (Schlager & Ostrom 1992). A degree of certainty that the efforts put into a restoration project will result in benefits is an important incentive for local communities' participation and investment (McLain et al. 2021). In practice, access rights and tenure are often messy, complex, and sometimes contested (Meyfroidt et al. 2022). This is why informal ways of legal ownership need to be considered (de Jong et al. 2018) to not exacerbate inequalities and strengthen marginalized groups (Elias et al. 2022).

The UN Decade principle 2 as well as the associated Standards of Practice refer to participation, different types of knowledge, tenure, and equity. As such, they go some way toward acknowledging the importance of generating a sense of ownership. However, because true ownership requires an interaction of these factors and is more than just participation, respondents in this study felt that ownership was not represented in the Q-set. Importantly, there is no one-size-fits-all solution to increase the sense of both mental and legal ownership because communities are embedded in different legal, political, and social contexts (de Jong et al. 2018) and encompass multiple actors with different interests, capabilities, and values that can change over time (Elias et al. 2022). Based on our interviews, to foster ownership in the study area (and most likely also in other restoration settings), ownership needs to be (1) more explicitly discussed, (2) move beyond superficial participation schemes, and (3) account for all types of legal ownership (sensu Schlager & Ostrom 1992).

Pursuing a Long-Term Vision for Restoration. The last feature highlighted by participants was the importance of *pursuing a long-term vision* for restoration projects. Although this might seem obvious, the long-term viability of restoration interventions is often neglected in practice (Frietsch et al. 2023). This is, among others, caused by limited funding (Höhl et al. 2020) and the project-bound design of many restoration interventions (Tedesco et al. 2023). Examples from around the world show how a lack of long-term thinking in restoration practice significantly limits the potential of restoration interventions and can even lead to more harm than good. In Rwanda, for example, *Eucalyptus* remains the dominant species in many restored woodlots (Arakwiye et al. 2021) even though experiments showed that this had long-lasting, undesirable impacts on soil properties (Rwibasira et al. 2021). Similarly, a case study from Northern India found no evidence that tree planting projects resulted in substantial benefits for carbon mitigation or livelihood support after decades of restoration efforts (Coleman et al. 2021). To avoid such unintended consequences and instead create restoration projects that are valuable now and in the future, restoration needs to better account for interacting social and ecological elements that together shape the restored system (Mansourian et al. 2020). The importance of the long-term vision for restoration efforts is also emphasized by the UN Decade principle 10, which provides a list of tangible activities to increase long-term benefits of restoration. These recommendations mostly focus on governance and socio-economic aspects of restoration projects and need to be complemented with context-specific approaches to maximize the ecological viability of restoration interventions.

"For Real Transformation, Restoration Should Be Inspiring" (R1)—Restoration Principles Sparking Exchange and Guiding Action

In conclusion, the 10 UN Decade principles encompass a wide variety of relevant tenets to guide successful ecosystem restoration. More specifically, we argue that their main value lies in their potential to inspire reflection and start conversations: During the interviews, many participants expressed how the Q-methodology exercise based on the 10 UN Decade principles as well as the LEGO exercise provided them with a structured way to reflect on what they feel is important for successful restoration, how their theoretical values differ from how projects they were involved in play out in practice, and what they want to pay special attention to in future restoration interventions. Moreover, following data collection, participants from different NGOs and government institutions reported that the Q-methodology and LEGO exercise sparked internal discussions about perspectives and values regarding restoration interventions in their institutions.

In the case of Rwanda, the Q-methodology exercise based on the 10 UN Decade principles revealed social and ecological features of restoration that require special attention in future restoration efforts. We acknowledge that ecologically sound knowledge on baselines and historical references is difficult to establish, questions surrounding ownership are complex and potentially politically problematic, and assuring the long-term viability of restored sites is resource intensive. Nevertheless, we argue that these features are central for successful restoration that not only fulfills short-term project goals but contributes to ecological integrity and human well-being in the long run. Here, both the UN Decade principles and the associated Standards of Practice provide tangible steps to better incorporate these features in practice. These recommendations need to be complemented with sound ecological knowledge. In addition, to integrate diverse needs, values, and knowledge, fostering an exchange of perspectives and approaches by bringing together diverse stakeholders with different priorities can support the long-term viability of restoration efforts. This holds true not only for our case study in western and central Rwanda but for restoration efforts worldwide.

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Supporting Information

The following information may be found in the online version of this article:

Supplement S1. The interview guideline directed the semi-structured interviews.
Figure S1. Participants were given a scoreboard with 20 empty fields along a gradient from least to most important for successful restoration to sort the Q-set according to their own priorities.

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