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Laying foundations for transformation: Insights from local government engagement on climate-resilient rural water services in Nepal

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Abstract

Transformative change in how local governments support rural water services is required to accommodate the increasingly extreme effects of climate change on water service systems. This study explores the potential for contextualised soft systems thinking activities to prepare local government officials with responsibilities pertaining to rural water services in Nepal to shift towards more transformative thinking. First, the study presents the findings of focus group discussions in two rural districts of Nepal that identified common climate-related problems for rural water access including water shortages, contamination, and unequal burden of impacts. Second, we facilitated workshops with local government and non-government stakeholders, drawing on the focus group findings to frame the challenges for rural water linked to climate change that require local government response. We designed the workshops drawing on 'transformative spaces' concepts and included soft systems thinking activities to foster systemic perspectives. Participants learned about worldviews, leverage points, rich pictures, root cause analysis, and theory-of-change based action planning. Following the workshops, the study team participated in reflective sensemaking in which they deliberated on their experiences and notes from facilitating the workshops to assess the extent to which the participants demonstrated transformative thinking about rural water systems. The workshop approach showed promise in shifting how local government participants think about rural water services beyond technical fixes towards addressing deep-seated issues. However, further work is required to foster new relationships necessary to support transformation and grapple with ethical dilemmas pertaining to power dynamics at community and government levels. Nevertheless, the approach presented here is a replicable, low-cost way to prepare local government stakeholders in Nepal for transforming their thinking and systems to ways that enable sustainable rural water service delivery under threats of climate change.

paper. Qualitative data from focus group discussions and notes from workshops are not publicly available due to institutional restrictions on the sharing data that includes potentially identifying information. The Institute for Sustainable Futures Ethics Committee may be contacted with inquiries about the data at ISF-Ethics@uts.edu.au.

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Author summary

Addressing climate change impacts on rural water services in Nepal requires local governments in Nepal to drastically re-think water services. Strategies and tools that support actors to transform how they think about complex situations exist, but actors have to be ready to engage in transformation processes. The strategies and tools must also be contextualised. This study presents a process for facilitating local government staff in Nepal to take steps towards transforming how they consider problems and solutions for climate impacts on rural water services. We first conducted focus group discussions (FGDs) with community members, gaining insight into current climate impacts on water services across two local government areas. We then facilitated workshops with local governments, presenting FGD findings and using well-established systems thinking and transformations tools to prompt and inspire thinking about problems and solutions in new ways. The approach shows promise in supporting governments to engage in transformation processes, but more work is needed to build new relationships and create space for diverse participants to drive ethical transformations.

1 Introduction

Climate change is significantly disrupting hydrological patterns in Nepal. Historical climate and disaster trends show that the average temperature in Nepal has risen 1.0˚C– 1.3˚C since 1900, and the intensity and frequency of extreme rainfall events, droughts, and incidences of glacial lake outburst floods, have increased significantly in different areas of the country since 1960 [1,2]. Projections indicate that Nepal will experience an increase in extreme rainfall events and a reduction of rainfall in dry winter seasons over the course of the 21st century [1,2]. Although there is significant uncertainty surrounding the projections of long-term precipitation trends [2], it is imperative to consider the potential impacts of these changes on households and water resources.

Dramatic changes in rainfall will worsen risks for household access to safe drinking water in rural areas of Nepal. Changes in hydrometeorological patterns and land uses may already be contributing to the drying of spring sources commonly used by communities in hilly areas for drinking water [3,4]. Over the next two decades, the frequency of river flooding is expected to increase throughout South Asia due to an increase in heavy rainfall events [5,6], which can contribute to contamination of shallow groundwater sources and/or cause people to use alternative unsafe water sources when their primary water becomes damaged by extreme weather [7,8]. Other climatic impact drivers, such as landslides, windstorms, hailstorms, fires, and glacial lake outburst floods, also have potential to disrupt drinking water services in Nepal [9].

The compound challenge of ensuring safe water services for households in the context of climate change requires institutional responses at multiple levels, especially at the local/district scale. Local governments are the primary duty-bearers responsible for progressive realisation of the human right to water for their constituents [10]. In low- and middle-income countries, responsibility for delivering water services is often decentralised to local governments that are financially under-resourced to carry out their mandate [11]. Yet, long-term local government support and oversight are critical to the success of water supplies that are commonly managed by communities in rural areas of low- and middle-income countries [12]. Hence, strategies that strengthen local governments' capacity to carry out their mandates to oversee water service delivery in settings where they are poorly resourced are required. For Nepal, these strategies must improve local governments' capacity to understand and respond to climate-related

risks because, while the coverage of households with access to a basic water service is high [13], water scarcity and contamination due to variable rainfall threaten the quality and reliability of these services [14], which undermines the achievement of the safely managed water target of Sustainable Development Goal 6.

To address the climate-related water scarcity and contamination risks in Nepal, researchers suggest technological, environmental and social interventions, that are challenging for local governments to implement. Suggestions include promotion of rainwater harvesting and re-use of household greywater [15], water source protection and siting of latrines a safe distance from water abstraction points [16], and watershed-scale spring rejuvenation [3]. As other researchers point out, women and marginalised groups are likely to be disproportionately affected by the impacts of climate change on water, and call for raised awareness and action to address social exclusion and marginalisation [17,18]. However, capacity at the rural municipality and provincial levels to deliver effective climate resilience responses is constrained, due in part to their poor financial position and recent governance reforms that are still overcoming confusion and uncertainty about the new roles of officials at different levels of government [16,19]. Further, national policies and laws relating to climate change have scantly addressed rural water services [9], hence there is little coherent guidance for local governments to follow. To effectively implement actions to reduce climate-related risks to rural water services, Nepal must address the deep-seated institutional and resourcing deficits of its local government.

The development and testing of novel approaches that strengthen local government efforts to advance climate-resilient rural water services can help overcome barriers to implementing adaptations in Nepal. Critically, water user and community experiences and needs must inform such approaches to ensure adaptations are appropriate and inclusive [20,21]. In particular, methods are needed that draw together community and scientific knowledge, grapple with the complexity of the systems in question, and inspire and shape actions in line with the profound governance shifts required to achieve climate resilience and broader sustainability.

One emerging approach is the creation of 'transformative spaces' that generate individual and collective learning towards sustainability transformations. These spaces are defined as "'safe-enough' collaborative environments where actors invested in transformation can experiment with new mental models, ideas, and practices that can help shift social-ecological systems onto alternative pathways" [22]. Transformative space-making sits at the interface of research and action, drawing from sustainability transformations scholarship and focusing on the 'how to' of achieving transformations in diverse Global South contexts [22]. A critical characteristic of transformative spaces is that they are conceived as ongoing engagement processes rather than discrete participatory events [22], as such, taking diverse shapes depending on context, intentions, and participants. Transformative space-making as an approach to driving positive change has been highlighted as a potentially powerful approach in the Global South, with opportunities for researchers to explore how this can catalyse change [23]. Yet, to avoid the risk of failure, it is important to avoid initiating change processes too early, which have a higher risk of failure, and take the time to develop commitment among relevant actors to transform systems they are part of [23].

This study contributes insights from a pilot process that demonstrates how local government stakeholders in Nepal can be 'warmed up' to the idea of transformative spaces that can lead to more sustainable rural water services under climate change. We describe how our focus group discussions (FGDs) in rural communities in Nepal characterise how community members experience the impacts of climate hazards on their water rural water services, and how we designed a workshop for local government and non-government representatives to raise the awareness of the participants about transformative change processes, drawing on theories and tools from transformative spaces and systems thinking. We then share our findings on how

the workshop approach influenced the participants' perspectives on development and explore further ways to fully mobilise transformative spaces in rural Nepal to enable transformative change.

2 Methods

The insights presented here draw from a qualitative, collaborative research process undertaken by a research institution (the Institute for Sustainable Futures, University of Technology Sydney) and a non-government organisation (SNV Nepal) supporting government achievement of area-wide water services in two rural districts in Nepal. The SNV Nepal project, entitled *Beyond the Finish Line*, aimed to use the opportunity of decentralisation in Nepal to develop inclusive, sustainable and resilient rural water supply services and hygiene behaviour change communication for households, schools and health facilities in two districts as a role model for inclusive water, sanitation and hygiene (WASH) services. Building on its experience in strengthening gravity-fed rural water supply services, SNV engaged with the new local bodies to address gender and social inclusion within WASH governance; equality, sustainability, and resilience in existing water supply services; and improved hygiene for women, men, boys, girls, and people with disabilities.

There were three aims of the research process. First, to facilitate participants (researchers, civil society and local government) to explore water service and climate-related issues from a systems perspective, grappling with complexity while charting action towards resilient, safely managed services. Second, to engage the participants in the transformative reflection and learning with the aim of generating the deeper shifts in thinking and action required to drive system change. And third, to develop a practical and replicable process for government and non-government actors to jointly accomplish each of the above aims that could enable transformative change processes on a wider scale.

Two methods were used to engage two participant groups:

1. A series of FGDs with community members from two rural municipalities to learn from their experiences of climate-related impacts on water services.
2. Systems-focused workshops with local government and non-government actors in two districts, designed for learning, deliberation, and inspiring action towards climate-resilient water services.

Each of these methods is presented in turn, including the rationale for their application, how they were implemented, and sensemaking processes involving research and practitioner members of the study team. Fig 1 summarises the data collection and analysis steps. The research design was reviewed and approved in line with the University of Technology Sydney Human Research Ethics Committee requirements (UTS HREC REF NO. ETH18-2599).

2.1 Community focus group discussions

FGDs were used to gather in-depth insights from community and water committee members about climate impacts on rural water access and responses. A body of research shows that, in addition to outside expert identification of climate risks (such as those listed in the introduction section of this paper), community-based perspectives on climate risks and impacts are critical to consider because of the unique ability of community members to 1) communicate the nuance of their lived experiences and 2) frame issues in social, environmental and physical terms that are important to them, both of which influence subsequent identification of appropriate solutions [24,25]. FGDs were chosen as a method to elicit multiple perspectives on a

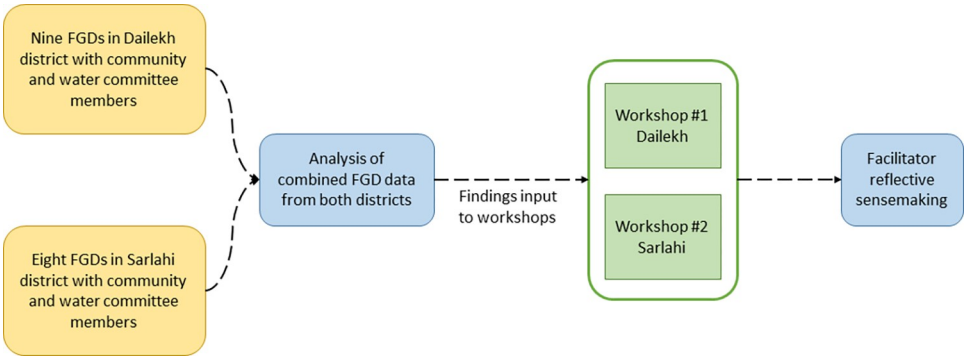

Fig 1. Flowchart of data collection and analysis steps.

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shared experience (e.g. a flooding event) and to enable the community members to hear stories and learn from their peers.

The FGDs were conducted in April 2021 within the two target districts of SNV Nepal's *Beyond the Finish Line* project: Mahabu Rural Municipality in Dailekh district (Karnali Province) and Ramnagar Rural Municipality in Sarlahi district (Madhesh Province). Mahabu and Ramnagar were purposively chosen as study sites because they are especially prone to climate hazards. Ramnagar is located in a flood-prone area situated between two rivers and was affected by major floods in 2017 and 2019. Mahabu is situated near the base of a hilly area and is exposed to flash and river floods.

The FGDs were conducted with separate groups of women, men, poor and marginalised people, people with disabilities, and water user committees. We held FGDs with women separate from men to learn about potential gendered differences in managing and accessing water under climate stress. Poor and marginalised people in Nepal often receive lower-quality water services and face discrimination in accessing waterpoints [26], so to represent poor and marginalised groups, we conducted FGDs that included householders from the poorest families in the municipality and people belonging to the lowest (Dalit) caste to further understand these inequalities. We further sought to better understand inequalities in water access for people with disabilities who also face discrimination in water access [27]. FGDs were also conducted with water user committees to learn about the operation and maintenance of water supplies.

Nine FGDs were held in Dailekh and eight were held in Sarlahi with seven to ten participants in each FGD. The FGDs generally lasted about one hour each. The FGD facilitators (SNV Nepal staff) were native Nepali speakers who used prepared FGD guides to ask questions pertaining to:

- types of climate hazards experienced locally and perceptions of how they were changing
- impacts of climate hazards on water supply functionality, access, and use
- impacts of climate hazards on well-being and health
- proactive preparation for expected climate impacts and reactive coping responses
- norms around household and community decision-making relating to water during extreme weather
- community cohesion and conflict about water management during extreme weather.

A COVID-19 safety protocol was followed to protect the health of FGD participants and facilitators. Facilitators travelled to the communities in Dailekh and Sarlahi when the national

government permitted travel to those areas. Facilitators also gained permission of Rural Municipality government officials to hold the FGDs. The FGD participants were provided with face masks and hand sanitizers. The FGDs were held outdoors in Sarlahi and indoors with social distancing and good ventilation in Dailekh. The FGD participants were informed of the purpose of the study, how their information would be used, and that the questions could potentially elicit painful memories. The participants were instructed to discontinue their participation if they felt the discussion was too upsetting for them.

The FGD data were analysed through thematic coding of the facilitators' notes. A dedicated note-taker attended each FGD and took detailed notes and quotes in Nepali. The note-takers later translated their notes into English. Researchers qualitatively analysed the notes in NVivo using a deductive coding method, with codes drawn from the analytical framework on responding to climate impacts on community-managed water systems developed by [28]. Excerpts from the notes were coded into the following parent codes: physical climate impacts on water supply functionality, physical climate impacts not directly related to water, climate impacts on access or use of water supplies, climate impacts on health and well-being, reactive coping responses to climate impacts, proactive adaptations, agency to respond climate impacts, access to resources for responding to climate impacts, and participation in household and community decision-making. Among the coded data, researchers looked for themes pertaining to how inequalities in access to resources, agency (e.g. holding knowledge and ability to influence decision-making), and social norms affected how people experienced climate impacts in line with the empowerment framework developed by [29]. These themes were explicated through writing findings into narratives that were reviewed and validated by SNV Nepal staff who conducted the FGDs and had experience working with the communities. Excerpts of the FGD notes and narratives are presented and discussed in this study.

2.2 Systems-focused workshops

The objective of the workshops was to create a space for participants to consider what changes could be made within local government to address climate change impacts on rural water services, with a focus on government systems and attitudes and values underpinning decisions and systems. Workshops–settings in which people are brought together to learn, problem-solve, and innovate with respect to a central topic–have a long history of serving a dual purpose of filling a need of the participants (e.g. providing knowledge or training on a subject of interest) and producing evidence or data to fill a knowledge gap [30]. The workshop design in this study was informed by transformative space-making concepts, albeit on a pilot scale, with the intent for researchers and civil society partners to learn together about the effectiveness of systems thinking tools in stimulating transformative thinking in the context of local governments in Nepal. The workshops further supported participants to: (a) learn about possibilities for creating deeper change in attitudes and governance using systems thinking tools, (b) consider how climate change affects water supply and access in their district, and (c) co-develop a vision and plan for changing government systems to strengthen water services in a changing climate. Section 2.2.1 explains the concepts and theories behind how the workshops were designed. Section 2.2.2 then describes how facilitators conducted the workshop activities.

2.2.1 Methodological foundations. Our process of engaging with local government officials drew on theories from transformative spaces and systems thinking. Transformative spaces provide an overall approach to engaging stakeholders (i.e. how the workshops should be run and the intended outcomes). Meanwhile, systems thinking–an approach to understanding the complexity of systems through examining the emergent properties and governing mechanisms of the relationships between system components [31]–provides a suite of practical

tools and activities to collaboratively explore different ways of thinking about the climate-related problems for, and solutions to, rural water services. The two are complementary because the theory of transformative spaces comes from sustainability transformations and transitions scholarship, which is founded on the need for systemic change articulated through systems thinking [32]. We chose transformative spaces and systems thinking theories intending to engage participants in thinking beyond implementing costly technical fixes that are the norm in discourses on climate-resilient water services [33]. We sought to create spaces that tapped into deeper questions of values, normative commitments, and plural ways of knowing–foundational considerations for driving societal shifts towards a more sustainable future [34].

Work to date on transformative spaces has highlighted their potential to be a starting point for institutionalising transformative change and, to achieve this outcome, the importance of assembling diverse methodological frameworks and tools [23]. The creation of transformative spaces can be distinguished as five design phases: (a) problem definition, (b) operationalisation, (c) tactical, (d) outcome, and (e) reflection [23]. Drawing on these phases, we designed the workshops as follows.

In the problem definition phase, the transformative space seeks to open up new ways of problematisation through the reframing of issues and lifting perspectives on the problem that often go unheard [23]. Prior to the workshop, the study team conducted the aforementioned FGDs to develop a picture of how different segments of society in Dailekh and Sarlahi districts experienced climate impacts on water access. Quotations from the FGDs were presented to the workshop participants and discussed in small groups. In particular, the participants were guided to consider the gendered dimensions of climate impacts, issues confronting people with disabilities, and their personal experiences with climate impacts. This discussion helped participants see the multi-dimensional nature of climate change impacts on water and learn from the experiences of diverse perspectives. The participants dug deeper in the problematisation phase through the 'rich pictures' and 'five whys' activities that are detailed further in the following phases.

The operationalisation phase involves deliberately designing in opportunities to hear a range of different perspectives [23]. We invited women and men from each local government area (rural municipality) in the district, non-government development organisations (NGOs), and organisations for people with disabilities (OPDs) to the workshop. The workshops facilitated knowledge co-production, which is "an iterative and collaborative process involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways towards a sustainable future" [35]. Knowledge co-production can foster self-reflection, shared understandings, and practical ideas towards sustainability transformations in the water service sector [36]. We facilitated co-production through mixing participants from different agencies in team-based problematising and problem-solving activities. Finally, during the workshop, the participants were guided to do a 'worldviews' activity to understand their own worldviews and those of others. Worldviews are a person's overarching system of meaning that influences how they "interpret, enact, and co-create reality" [37]. Shifting individuals towards 'pluralist' or 'strategist' perspectives, where they appreciate a diversity of perspectives about the world, may be an enabler for more transformative action on climate change [38]. This activity was held at the beginning of the workshop to support participants to appreciate how assumptions we make shape the way an issue is framed and how assumptions differ across diverse people.

The tactical phase comprises the activities that support the work that will be done because of the transformative space [23]. Here, we used systems thinking tools to guide workshop participants towards modes of thinking that could lead to actions with transformational outcomes. Many sustainability interventions target tangible, short-term changes that are easier to

implement, but have limited potential for bringing about transformational change [39]. Hence, we developed the 'leverage points' activity that utilised the leverage points framework to guide participants to consider activities or feedback processes in a system where a small change could lead to an eventual overall change in the system's behaviour [40]. The leverage points framework encourages decision-makers and stakeholders to consider broader and higher-level (paradigmatic) factors, as well as lower-level inputs and parameters when deciding where to focus efforts when trying to create positive societal change [39,40]. A second systems thinking tool used was rich pictures [41,42]. In the rich pictures activity, participants use pictures and draw their ideas related to a particular question or problem to represent what is included, important, and what the relationships are between the elements. The benefit of this approach lies in the combination of creative and visual expression, being able to see connections between the elements, and the conversations and explanations associated with the process. Data is obtained not only from the picture itself but also from the way the picture is then explained by the creator(s). Follow-up deliberations by participants also helped to illustrate the alignments and divergence in the understanding of a particular problem. Finally, the five whys activity was used to help reveal underlying causes of issues or problems [43]. In this activity, participants considered the layers of causality for a particular problem and were encouraged to go beyond superficial cause and effect. When used carefully, the five whys can play a powerful role in helping to illustrate the need for depth of inquiry into causes of a particular issue and in analysing complex problems [44].

In the outcome phase, the outcomes of the activities from the transformative space are considered [23]. To understand the immediate effect of how the workshop influenced the thinking of the participants, we facilitated a 'theory-of-change based action planning' activity. A theory of change is "A particular approach for making underlying assumptions in a change project explicit, and using the desired outcomes of the project as a mechanism to guide project planning, implementation, and evaluation" [45]. Theories of change are commonly used in the development sector to plan out course of action, linked to anticipated changes and outcomes [46]. Hence, participants were asked to create a theory of change to encourage them to articulate their newfound assumptions and desired outcomes for the group to reflect upon.

Lastly, the reflection phase involves reflecting on what worked and what did not in enabling transformative change [23]. 'Sensemaking' refers to the process through which people come together to understand issues or events together [47]. Through this process, actors create and shape a shared meaning of the issue or event [48]. The study team took part in a 'sensemaking and practice reflection' to consider whether the workshop showed promise in reshaping how the participants viewed the climate change problem for rural water access and the possible solutions.

2.2.2 Workshop activities. Two workshops were facilitated by SNV Nepal staff in April and May 2022 with participants from local governments, NGOs, and OPDs. One workshop was held in Sarlahi district with 14 participants, and one was held in Dailekh district with 19 participants. Local government staff invited to the workshops were those who had technical or planning responsibilities related to water service provision and were working in rural municipalities that were included in the SNV *Beyond the Finish Line* project. NGO and OPD staff invited were those from organisations that were working with SNV on the *Beyond the Finish Line* project in Sarlahi and Dailekh.

The workshop activity design was informed by the intent to foster a systemic perspective. To achieve this, we drew on soft system methodologies and related approaches. Soft systems thinking sees the world as complex and confusing and influenced by worldviews and human values. Through the process of inquiry and exploration, a learning system emerges [49]. The tools we chose were Worldviews [50], Leverage Points [40], Rich Pictures [41], Five Whys [43]

Table 1. Systems-related activities of workshops.

	Activity	What was involved and how it was conducted	Reference to literature
(a) Problem definition	**Focus group discussions**	Elicitation of experiences from rural community members about climate-related impacts on water access, use and management.	
(b) Operationalisation	**Worldviews**	Introduction to concepts and theory, modified worldviews quiz, discussions about four worldviews, and self-reflection.	[37,50]
(c) Tactical	**Leverage points**	Introduction to concepts and theory, group ordering of leverage points, discussion, and reflection.	[39,40]
(c) Tactical	**Rich pictures**	Responding to focus group discussions findings through drawing rich pictures in groups, presentations, and discussion.	[41,42,49]
(c) Tactical	**Five whys**	Participants chose a challenge identified in focus groups, and then conducted a five whys worksheet to more deeply consider the root causes of the issue, including the social/cultural, environmental, economic and political underpinnings.	[43]
(d) Outcome	**Theory-of-change based action planning**	Participants were asked to consider "what rural water services in your district should be like in the future" to develop an action plan based on what they had learned and discussed during the workshop, based on theory-of-change thinking and processes.	[46]
(e) Reflection	**Reflective sensemaking**	The sensemaking process we employed for this project was between SNV partners themselves, and also with the UTS-ISF research team through a number of facilitated workshops.	[47]

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and theory-of-change enablers and causal thinking processes [49]. The workshop incorporated additional activities related to climate change, such as a video on the impacts of climate change on WASH and water management, and a presentation of the FGD findings. This study, however, focuses on the systems thinking activities of the workshops as summarised and described in Table 1.

Worldviews. We developed a modified version of Hedlund-de Witt's worldviews questionnaire [37], in a printed format, asking participants to circle the responses that best matched their view. Participants completed the exercise privately, and were not required to share their results. After they conducted the survey, participants were asked to read the four types of worldviews as defined by [37]. They were then asked to discuss which worldviews category they felt best reflected themselves and what they thought of the different worldview categories. Finally, the participants discussed in plenary what revelations this activity invoked for them. The worldviews activity aimed to raise the awareness of participants about the existence of different perspectives on climate change, which researchers argue can be foundational for transformative climate action [38].

Leverage points. We gave participants an overview of the purpose of the Meadows' Leverage Points framework–a framework indicating 12 leverage points that can identify specific activities or feedback processes in a system where a small change could lead to an eventual overall change in the system's behaviour [40]–then provided them with twelve cards including pictures and simple text relating to each of the 12 leverage points. Participants in small groups were then asked to order the cards from what they believed would be the lowest impact leverage point to the highest impact leverage point. Participants then reflected on the order that they placed their cards, considering how Meadows orders them, and discussed the similarities and differences in their opinions about the ordering. The cards were placed on the wall and could be easily seen and engaged with by participants, generating robust and inspiring discussions. The leverage points were used to consider how interventions in a system can create transformations for sustainability [51].

Rich pictures. We presented quotations from the FGDs to the participants and asked them to draw out climate-related impacts on WASH in Nepal, based on the quotations and their own experiences. In small groups, participants drew symbols and pictures on a flip chart to represent what they had heard and the connections between the ideas, objects, feelings, and

concepts. After the pictures were drawn by the groups, a title was given to each picture and a representative explained the picture to the group. This helped participants to draw out diverse causes of a problem and subsequently diverse solutions that go beyond the most apparent fixes [52].

Five whys. We asked participants to choose one of the major problems that they heard from the FGDs and write that problem or challenge at the top of their worksheet. We then asked people individually to think about what the cause was for that particular problem and write that in the line below the title issue. Participants were then asked to repeat the process so that they had a sequence of five whys. Reflecting on the cause they identified at the bottom of their list, we then asked them to consider what might be the social/cultural, economic, political, and the environmental 'why' underpinning the list. This helped participants to think through some of the root causes of the challenges or issues they identified from a range of perspectives (to avoid too narrow or single causal pathways), which supported thinking beyond financial or physical barriers. The five whys tool is helpful for theorising the root causes of a problem, challenging unsubstantiated assumptions, and considering multiple entry points for solutions [53].

Theory-of-change based action planning. We introduced participants to the concept and processes related to developing a theory of change, drawing from examples of our work in a range of contexts. We demonstrated that overarching goals were clearly and logically linked to outcomes, which were linked to activities based on a power analysis and understanding of how change happens within a particular context. Participants were then asked to develop an action plan based on what they had learned and discussed during the workshop, responding to the question "what should rural water services in your district should be like in the future?" and based on theory-of-change processes. Participants were provided a template to note their ideas and link various actions to intermediate and higher-level outcomes. Overall, this process helped the participant to articulate the outcomes they believed their actions will achieve [46].

2.2.3 Reflective sensemaking. Workshop data were analysed through a qualitative collaborative analysis approach [54]. Particularly, results of the workshop were analysed through discussion of written notes and interviews with the workshop facilitators. Workshop facilitators were provided templates showing what kinds of data needed to be collected for each activity. Facilitators in Nepal took notes, collected worksheets, and wrote-up the results of the workshops into two reports that they then shared with the research partners. A sensemaking session was held with the Nepali facilitators and Australian researchers to discuss and interrogate the results reported in the workshop reports, and to draw out key findings. During the session, the researchers interviewed the facilitators to understand what changes they observed in participants, how the work process impacted on the facilitators personally, and their reflections on the content and process of the workshops. Specifically, the facilitators were asked:

- How local governments usually discuss rural water supply issues and if this changed after the workshops.
- If participants demonstrated an appreciation of the need for deeper understanding to change to how water systems are supported and governed, and how this can be achieved.
- Which activities, tools, or concepts were especially effective during the workshops, and what made them effective.
- Reflections on power dynamics during the workshop, and how that affected participation.
- If there were any cases of resistance to the ideas and concepts introduced in the workshop.
- Recommendations for improving the workshops and to help participants think about deeper transformations they could make to support climate-resilient water services.

The interviews were conducted in pairs (one researcher as an interviewer and one workshop facilitator as an interviewee) and responses were documented in a template. Interviewers also asked probing questions to support the facilitators to elaborate on their responses and further explain why they perceived effects (or lack thereof) on the mindsets and attitudes of the workshop participants.

3 Results and discussion

This section is divided into a presentation and discussion of the results of each method: the community-based FGDs and the ensuing systems-focused workshops.

3.1 Common impacts of climate hazards on water access in Mahabu and Ramnagar

The FGDs involved community members from two different geographic and water supply contexts. The Mahabu Rural Municipality is in a mountainous area. The primary water supplies for drinking and domestic purposes are usually gravity-fed piped schemes that source water from springs or streams found at higher elevations. Water taps from the piped scheme may be on the household premises or at public standpipes shared by multiple households. The piped schemes are usually operated and maintained by volunteer community water committees. The Ramnagar Rural Municipality is in a flat, lowland region. Community members in Ramnagar usually get water for drinking and domestic purposes from private or public handpumps that are typically maintained by the households that used them.

Community members expressed that, in the dry season, water shortages occurred in Mahabu and Ramnagar because the yield of the water source was less than demand. This forced community members to arduously seek out alternative water sources, some of which were owned by other community members who restricted their usage (for example, when the owner's family was eating at the compound on which the water point was located:

> In the summer, water does not come regularly from the pipe. We have to bring water from a well which is far from home. It takes two to three hours. (Female poor and marginalised group participant, Mahabu)

> Sometimes we go at 1.00 AM to collect water. We must search for water from three or four wells due to lack of water in the wells. . .whoever can go first, they get the water. (Female poor and marginalised group participant, Mahabu)

> We have to go to another hand pump to bring water in the dry season. If family members are eating there at that time then we have to wait until the person finishes eating. Then only are we permitted to take water from their hand pump. (Women's group participant, Ramnagar)

Community members, particularly those from Mahabu, shared that water supplies became contaminated when there was heavy rainfall. Participants described the water as becoming turbid or malodorous and, in Mahabu, participants sometimes observed dead animals in the water supply. Wealthier households could afford to buy packaged water during such contamination events, while relatively poorer households continued to use the degraded water:

> In the rainy season mud and dust get mixed in water supply and the water quality is very dirty. Sometimes worms, frogs, and snakes die in the water and we have to drink such dirty water. (Female poor and marginalised group participant, Mahabu)

People with disabilities were often disproportionately burdened by these climate impacts. They may have been dependent on family members or neighbours for accessing water when the primary water supply was not working due to a climate hazard, or otherwise had to access an alternative water source with great difficulty:

> Kids are not always available at home so we request to our neighbour to bring water. If nobody is available, we go by crawling on hands and legs to bring water in the dry season. (Woman with a disability, Mahabu)

> I don't have sufficient water to wash clothes, take a bath, go to the toilet. . .we have to go to the river for these purposes which is very difficult for me. Sometimes, even when I feel so thirsty, I can't get water to drink when family members are not available. (Woman with a disability, Mahabu)

Water shortages during dry spells could create conflict over water access, especially in Ramnagar where some householders competed for scarce water or resisted others from accessing handpumps that they perceived to own:

> When there is a water shortage, there is conflict within the community over accessing water. . .women throw other's water pot, fight, use rude words to each other at the water source. . .neighbours stop speaking to each other. (Female poor and marginalised group participant, Ramnagar)

> On hot days, many hand pumps are dry. I have to bring water from the neighbour's hand pump and they usually call me [a pejorative nickname for a person with a disability]. If we send the children to bring water, the neighbour scolds the children and does not allow them to take water. (Man with a disability, Ramnagar)

Local governments in Nepal are on the frontline of supporting the resolution of these climate-related issues. Community-based water committees are frequently challenged to sustain rural water supplies [55] and climate change heightens the risks of water supply failure [56]. Hence, local governments in Nepal will need to have an increasingly greater role in supporting communities to overcome the hydrological and technological impacts of more extreme weather. Our findings on the burden of climate impacts on water access for marginalised groups, and the contribution of climate hazards to water conflict and competition, aligns with research on climate and water use elsewhere in Nepal [17,18]. As duty-bearers of the human rights to water and sanitation, local governments must take policy, financial and institutional measures to fulfil everyone's right to water, notwithstanding the stresses of climate change [57]. This includes the implementation of laws, regulations and policies that enforce affirmative action for marginalised individuals and groups [58]. The following section explores the extent to which the workshop activities contributed to changing how local government participants perceive their role in ensuring water access is protected against climate hazards and how they imagine solutions.

3.2 Engaging local government in transformative processes: promising outcomes and unresolved questions

The workshop approach has shown promise in supporting local government officials to engage with transformative modes of thinking, but further work is needed. One such further need that was beyond the scope of this study is the documentation of subsequent actions taken to understand and provide evidence for how supporting transformative modes of thinking translates

into further processes of transformation and, eventually, real-world impact. In this section, we discuss some of the progress made in gaining buy-in from local government on transformative processes, the need to foster new relations with people not present at the workshop to expand opportunities for change, and ethical dilemmas relating to power dynamics that will need to be addressed along the way.

3.2.1 Laying foundations for transformational thinking. A core aim of the workshops was to influence local government staff in Nepal to shift how they thought about supporting rural water services towards systemic changes that will enable water system transformations towards sustainability under climate change. Catalysing actors to take pathways to transformation may be achieved through assembling diverse methodological tools and frameworks [23] that build the actors' knowledge and competences [59]. Our workshop approach that deployed a variety of adapted systems thinking tools shows promise in building the knowledge and competences of local government staff in Nepal regarding transforming water services.

Experimenting with multiple kinds of knowledge and ways of knowing can create the conditions for learning about and eventually enacting transformative change [60], which the workshop participants showed openness to. The participants were attracted to the idea of shifting mindsets to reimagine what could contribute to strengthening water systems against climate change. Participants in both workshops remarked that the worldviews and leverage points activities helped them understand the idea of looking at a problem from different perspectives. One participant remarked, "This was one of the best workshops I have ever participated in. The content was very insightful and encouraged us to brainstorm. . .honestly it forced us to think and think and think." The workshop facilitators later reflected that they felt the activities invoked more 'out of the box' thinking; local government staff usually focus on technological solutions to water supply problems, but the workshops generated energising discussions among the participants about a wider range of solutions. For example, participants proposed actions related to broader water resources management considerations and the need to collaborate with other government agencies. The facilitators also remarked they felt a change in the way they think about rural water supply sustainability. One facilitator said, "Through this workshop, I myself am transformed."

The workshop facilitators further reported that the participants showed an appreciation of some of the contributing root causes of the local governments' shortcomings in addressing climate impacts on water services. The facilitators stated that, in their experience, local government staff typically cite inadequate availability of funds as the primary culprit for their struggles in resolving climate-related issues for water services. However, the five whys activity prompted the participants to consider other drivers, for example, gaps in local policy and leadership challenges that contributed to an absence of direction for local government staff to address climate-related issues. One benefit of realising these other root causes was that some of them are more in the sphere of control of the local government staff compared to funding shortfalls. The workshop participants and facilitators agreed that advocating for policy changes and stronger leadership to address climate change impacts was more actionable for local government staff than requesting a higher budget for infrastructure upgrades.

While the five whys activity helped participants to identify practical leverage points that create bigger changes in the management and governance of rural water supplies, the workshop approach itself could be a way of acting on leverage points. In her Leverage Point framework, Donella Meadows argues that the power to question, reflect upon and transcend paradigms is generally the most effective leverage point for driving deeper systems change [40]. Above all else, our workshop approach aimed to shift the thinking of the participants by making them aware of their ability to view the problem of climate change for water services in different ways

and reimagine what they could feasibly do to affect systems change. The appropriate framing, discussion, and communication of systems thinking concepts are a pathway to achieving this.

Another common mechanism for paving a path to sustainability transformations is the co-creation of knowledges about the state of the system, the desired future development, and the changes needed to reach the desired future [61]. Each workshop culminated in the final activity in which participants worked together to create an action plan based on a theory-of-change process that included co-creating a goal, reaching desired outcomes, and designing practical activities to support the outcomes. One participant reflected, "We all are a mixture of different worldviews and have to work together in a team for a common mission, sometimes it is easy and sometimes challenging." The facilitators noted that the action plans incorporated elements of the workshop discussions, such as activities to shift the mindsets of local decision-makers, which were distinguished from usual government project planning documents. The facilitators were confident that the workshop was effective at influencing the participants to think more systemically about climate-related issues for water services, although further work is needed to follow-up on the action plans developed, in order to translate this into action on the ground.

A barrier that we sought to overcome was making systems thinking and sustainability transformation concepts accessible, relevant, and useful for local government staff in Nepal. Much of the literature and discourse on these topics are academic and at a level of abstraction that can be difficult for newcomers to the topics to grasp. Our experience suggests that the approach of using simple, participatory activities for facilitating the discussion of where to place energy and action to change a system, as well as what sits behind our assumptions, holds promise for shifting thinking in this context. The workshop facilitators felt that local government participants were challenged to understand new concepts like leverage points and worldviews, but through discussions, developed a comprehension and appreciation of them. Local government participants were also enthusiastic about replicating the workshop activities with their leaders at the rural municipality and provincial levels. Although more work is needed to translate discussions and new insights into sustainable action, shifts in perceptions and thinking are a necessary prerequisite.

3.2.2 Fostering new relations to catalyse change. Transformative spaces can form opportunities for establishing, strengthening or repositioning social networks that enable new ways of working and build collective agency for creating transformations [23,59]. Although, as an exploratory process, our workshops did not fully facilitate the interrogation and re-negotiation of social relationships, we learned about the current state of rural water management relationships that informs further work to support systemic change.

Engagement of local government decision-makers in the workshop approach is key to affecting real change given the power and influence they have over WASH systems in their context. The workshop participants and facilitators agreed that the local government participants have limited influence to steer department strategies within their hierarchical institutions. The workshop participants stressed the importance of holding a similar workshop for rural municipality and provincial leaders who decide about budgeting and strategising on rural development. These leaders are elected representatives and do not necessarily have training or high-level awareness of water and climate issues, so the workshop approach would need to be tailored accordingly. There is also often a high turnover of elected leaders at local government levels in Nepal that makes it challenging to institutionalise new ways of thinking. The workshop participants suggested they could advocate to their leaders, who have many responsibilities and therefore may be reluctant to join a full-day workshop, to give attention to responding to climate impacts on water. Future transformative spaces should carefully consider the recruitment of influential participants and accounting for power dynamics (discussed further in the following section).

Collective actions that deliberately aim to change systems at scale are important for transformative adaptation to climate change [62]. Hence, any approach to shift local governments in Nepal towards transformative change ideally would be scalable so that a wide range of actors could be reached, and new relations established. Our workshop approach has the potential to be replicated or transferred into other local government contexts. Each of the workshop activities was low-cost and did not require any sophisticated technical skills or resources for facilitators. However, the process required experienced facilitators who were comfortable working with systems thinking concepts and translating them into local languages and teaching modalities. For example, the workshop facilitators drew on a local story of an insect emerging from a pond and turning into a butterfly to communicate the concept of transformation. Building the capacity of local experts to facilitate such processes is critical for reaching a critical mass of collective action.

Crucially, people may not transform the way they think about a problem because of a single workshop, and changing knowledge or thinking does not automatically lead to behaviour change. Although paradigm shifts in individuals could happen rapidly in response to a new insight or epiphany, the local government participants of this project would probably require sustained engagement with facilitators to continue to reshape how they problematise and think about solutions to climate impacts on a day-to-day basis. While local government participants appreciated the systems thinking concepts, the workshop facilitators noted that some workshop participants still struggled at times to think of creative new ways of addressing problems. There is also frequent staff turnover within local governments in Nepal, so refresher activities may be needed over the time it takes to actualise proposed new and innovative solutions that go to the heart of the problems.

3.2.3 Ethical dilemmas. Ethical dilemmas can arise from attempts to cultivate transformative change that involve challenging the status quo of dominant systems and in the decision of who to invite to deliberations about systemic change [23]. Power dynamics within institutions and communities must be better addressed to enable sustainability transformations for water services in Nepal. The participants of the workshops were overwhelmingly male, which reflects the overall local government workforce in rural Nepal. Representatives from local OPDs joined the workshops, but the workshop facilitators noted their level of participation in discussions was less than their government counterparts. Given that people's experiences of climate impacts are strongly shaped by their socio-economic status [63], the meaningful inclusion and participation of diverse people in problem framing and proposing solutions is critical for a comprehensive identification of key challenges and solutions that provide equitable benefits. Our workshop approach could be improved to better incorporate spaces for rights-holders organisations representing women, people with disabilities, and marginalised groups to join the activities and contribute to the discussions. For example, meeting with these groups individually before the workshop and familiarising them with the concepts and language could help to build their confidence during workshops with local government representatives in attendance.

Further, as the focus group discussion results presented in this study showed, power dynamics within communities influences climate responses, for instance, in terms of competition over water during times of scarcity. The local government participants, who were primarily technical staff with responsibilities pertaining to infrastructure provision and maintenance, were not trained to deal with community conflict, equality and inclusion issues that crucially must be addressed to reduce the vulnerability of marginalised groups to climate change. Handling complex social matters requires another dedicated line of training and support to institutionalise social remediation within local governments in Nepal, which would complement and

enhance efforts related to systems thinking approaches to climate change and water management.

Workshop participants and facilitators raised the need to engage government decision-makers with more influence in such workshops. Introducing participants from varying levels of power within an institution, and across organisations that each might have their own agendas, could make equal and honest deliberation on desired changes and recognition of power imbalances difficult to achieve. Again, capacitating local experts to facilitate these difficult discussions, through the creation of safe spaces for people to speak and explicitly gaining the agreement of participants upfront to reach consensus [23], is critical.

4 Conclusions

This study presented an approach for influencing local government staff in Nepal to shift their thinking towards transformative changes that would support the sustainability of rural water services under climate change. It laid out a low-cost workshop methodology that could be practically implemented in rural areas of Nepal through local facilitators. Our initial experience with this approach showed promise in stimulating local government participants to appreciate concepts that elsewhere have demonstrated potential to lead towards transformative change. Yet, more work is needed to build upon this approach.

Systems must be adequately 'ready' to be changed, otherwise there is a higher risk of failure if change processes are initiated too early and resistance is met [23]. Our approach was an attempt to prime local government staff to engage with more intensive transformation processes, such as those that seek to form transformative spaces that fully deal with establishing and renegotiating relationships, navigating political dynamics, and building new competences on the path towards creating real changes in systems [59]. The practice of warming up institutions to transformative change processes raises the likelihood that they will succeed.

The systemic change needed to achieve transformative adaptation to climate change is unprecedented [64]. More work needs to be done to re-think how rural water services are delivered to ensure they will provide sustainable and equitable benefits under climate change. Practicable approaches that gain the buy-in of critical actors to reimagining what development of rural water services could look like will lay the foundation for the transformative change that is desperately needed.

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