



Matches, mismatches and priorities of pathways from a climate-resilient development perspective in the mountains of Nepal

Avash Pandey^{a,*}, Anjal Prakash^{a,b}, Saskia E. Werners^{c,d}

^a International Centre for Integrated Mountain Development, Nepal

^b Indian School of Business, India

^c Wageningen University & Research, The Netherlands

^d Institute for Environment and Human Security, United Nations University, Germany

ARTICLE INFO

Keywords:

Climate change adaptation
Climate-resilient development
Climate-resilient development pathways
Stakeholder cooperation and coordination
Community engagement
Mountains

ABSTRACT

The Hindu Kush Himalayan region is a documented climate change hotspot. The region is also known for its ongoing development challenges including those arising from reconstruction in the aftermath of natural disasters. Incepting the idea of climate-resilience in development planning has, therefore, become a necessity in this poverty-ridden region. To identify the strategies that have been envisaged by the stakeholders in terms of climate-resilient development, this paper singled out the stakeholders who are responsible for local-level development in the mid-hill region of Nuwakot which lies in central Nepal. Data was collected through the visioning and back-casting method and included interviews with community members, NGO experts and regional representatives. The study identified the activities and priorities of stakeholders based on different time horizons illustrating climate-resilient development pathways. The study found that community pathways address mostly current needs and climate variability and that future challenges do not play a central role in the selection of adaptation measures. Although a majority of the actors recognized climate-resilient development as a priority, it tends to be planned in silos without cooperation and coordination among themselves. The results reveal that the risks and vulnerabilities encountered by community members, who are at the receiving end of climate change, have not been incorporated into the development plans of the policymakers. The study concludes that development priorities should be formulated based on the identification of a need and proposes that future cooperation mechanisms for stakeholders should be brought under one umbrella and include a discussion of climate-resilient development pathways that incorporates more community engagement so as not to lose the connection between country aspirations and community voices.

1. Introduction

The glacier- and snowpack-dependent river systems of the Hindu Kush Himalayan (HKH) region, with an estimated 54,000 glaciers, is one of the documented climate change hotspots in the world. These glaciers cover an area of 60,000 sq. kilometres and serve as a major source of water in the ten river systems of the region. The river systems directly support the livelihoods of 240 million mountain people (Bajracharya and Shrestha, 2011; De Souza et al., 2015; Tucker et al., 2015; Sharma et al., 2019). These already economically weak societies, dependent mainly on subsistence and semi-commercial farming, have been hit hard by the unfolding climate events and face future climate uncertainties. Even if attempts are made to limit global temperature to 1.5 °C above

the industrial level as per the Paris Agreement (UNFCCC, 2015), the HKH region will still experience additional warming of 0.3–0.7 °C. This will further accelerate the melting of the glaciers and, according to climate projections, by 2030, 1/3rd mass of the HKH glaciers will be lost (Immerzeel et al., 2019; Krishnan et al., 2019). Thus, warming and rapid melting of glaciers, along with other hydro-meteorological variabilities, are posing a serious threat to the population who are dependent on the water resources in the upstream and downstream reaches of the glacier- and snowpack-dependent river basins (Siderius et al., 2016; Kraaijenbrink et al., 2017; Pandey et al., 2020).

How to adapt to climate challenges is becoming a major concern around the world as the rate of climate change is exceeding the adaptive capacity of many systems (Schneider et al., 2007). For instance,

* Corresponding author.

E-mail addresses: avash.pandey@icimod.org (A. Pandey), Anjal_Prakash@isb.edu (A. Prakash), saskia.werners@wur.nl (S.E. Werners).

<https://doi.org/10.1016/j.envsci.2021.08.013>

Received 22 December 2020; Received in revised form 1 July 2021; Accepted 24 August 2021

Available online 11 September 2021

1462-9011/© 2021 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

adaptation or coping mechanisms implemented may not be relevant in a few years down the line, with the possible outcome being maladaptation (Niemeyer et al., 2005; Berrang-Ford et al., 2011). This is a major concern in the HKH region as well with the rapid expansion in multiple types of physical infrastructure for agricultural and economic development (Hussain et al., 2019; Kovács et al., 2019) and the introduction of development policies into various tiers of governance. There are risks that the benefits of these interventions will not reach the most vulnerable population and system, hindering and opposing the ‘leaving no one behind’ commitment of the Sustainable Development Goals (SDGs). Countries have already made global pledges on achieving climate ambitions and the SDGs. Therefore, to achieve the desired sustainable development goals envisaged by nations, the implementation of a climate-resilient development strategy is decisive. We, along with Engle et al. (2014), characterize resilience towards climate change as the capacity and potential to absorb and cope in the short-term and to learn, reorganize and redevelop adaptation decision-making for the long-term, and climate-resilient development as a new paradigm where socioeconomic development is safeguarded against climate change, through equitable multilateral stakeholder partnerships (Mitchell and Maxwell, 2010; Singh and Chudasama, 2021). To incorporate flexibility into decision-making and to account for future uncertainties, the pathways approaches have been proposed, which connect short-term actions with longer-term objectives, whilst anticipating changing conditions over time (Haasnoot et al., 2013; Wise et al., 2014; Bosomworth et al., 2017; Werners et al., 2021). Therefore, climate-resilient development pathways, for this study, are understood as those sets of measures, choices and actions along different time horizons that meet the sustainable development objectives, address social inequity and are, in addition, responsive to current climate variability and projected climate change (Denton et al., 2014; O’Brien et al., 2015).

According to Butler et al. (2016), developing and least developed nations (LDCs) are facing challenges in mainstreaming climate change and future climate uncertainties into rural development planning and are facing an uphill task in implementing climate-resilient development. Further, the focus on fulfilling international frameworks of global climate targets and sustainable development goals, countries should also focus on local level planning for adaptation, which is normally not the case (e.g. Turner-Walker et al., 2021). This is over and above the social inequity that the Himalayan nation of Nepal faces (Devkota and Bagale, 2015; Dong, 2016; Drucza, 2015). Caste based inequalities, social exclusion (Pyakurel, 2021) and gender discrimination (Misra, 2019) are some of the striking features of Nepali society. These social inequality gets superimposed on climate change induced vulnerability (Bhattarai et al., 2015) leading to multiple forms of inequalities that are socially reproduced (Sapkota et al., 2016).

Alliances of various stakeholders such as communities, individuals, governmental and non-governmental organizations are essential to ensure collective action to shape future adaptation and bring about transformative actions towards climate-resilient development. This integration of social, economic, political and institutional processes ensures that actions to reduce vulnerability are not solely technical focused rather more holistic in nature enabling the solution space for adaptation providing a wider perspective to act and insights on the available options in various time frames (Haasnoot et al., 2020; Leal Filho et al., 2021). In such a scenario, decisions and actions taken should incorporate both short and long-term time horizons as well as the perspectives of different actor communities. But how the relevant actors see the future and what actions they propose to support their livelihoods is largely unknown. Similarly, which actions and strategies would contribute to long-term climate resilience remains unclear. This paper, thus, focuses on eliciting climate-resilient development pathways for the mid-hill region of the Nuwakot district of Nepal in the Gandaki river basin of the HKH. In line with this objective, the paper presents and assesses the actions that are proposed by relevant stakeholders on a short-term, medium-term, and long-term basis.

Nuwakot lies in the hilly district located to the northwest of Kathmandu, the capital of Nepal, in the Bagmati province. The district, which has historical significance, is surrounded by Sindhupalchowk in the east, Kathmandu and Dhading in the south, Rasuwa in the north, and Dhading in the west. With Bidur as its district headquarters, the district covers an area of 1121 km² and is divided into 61 VDCs and a municipality. The present study was undertaken as a part of the Himalayan Adaptation Water and Resilience (HI-AWARE) project which conducted a field study on the upstream, midstream, and downstream reaches of four river basins of the HKH region. The location for the study was Charchare ward no.6 which lies in the Bidur municipality. It has 781 households (HHs) with a total population of 3628 individuals. Most of the population of the Nuwakot district rely on agriculture and forest products (DCC, 2017; Table 1).

The research adopted the case study method and data for the present study was collected through the visioning and backcasting workshops and interviews with communities, non-governmental organisations (NGO) experts and regional representatives. The different stakeholders (community members, non-governmental organizations, government officials and elected political bodies) were interviewed to elicit their views on priorities for the future of Nuwakot and the challenges they either face now or may face in the future. A normative backcasting process was adopted which was based on and formulated in line with the future goals desired by the stakeholders. Vervoort et al. (2014) have defined backcasting as a process that starts with identifying a goal and working on what needs to be done to achieve the goal. Based on this and identifying concerned actors apart from community members, we conducted a backcasting exercise. The actors were chosen based on the illustrations of Quist and Vergragt (2006) which offers an integrated approach to ensuring system innovations and achieving sustainability of the system.

In Section 3, we present the results from the various stakeholders’ points of view. They range from immediate needs to long-term actions. Although developed in response to different visions, it is encouraging to find that the pathways elicited from the different actor groups are complementary rather than mutually exclusive. For example, economic and infrastructural development was the top priority for all the stakeholders. Although climate issues were recognized by all stakeholders, we observe a gap between the elicited development pathways and what the adaptation research suggests is needed for climate-resilient development. So, while adaptation studies in the case area recommend spring restoration as the pathway to the problem of the drying up of springs (Lamichhane et al., 2020), which are the communities’ main source of drinking and irrigation water, spring restoration is not part of the development pathways reported by stakeholders. Pathways presented by community members raise concern as they emphasize on identifying and approaching relevant agencies for climate resilient development which clearly presents the governance struggles on planning and implementing development programmes (Nightingale, 2017). Moreover, the opportunities offered for integrating adaption into development and reconstruction efforts after disasters such as the 2015 earthquake remain unexplored.

Table 1
Income sources of HHs.

Income sources	%
Agriculture & forest products	83.5
Remittances	10.0
Formal salary/wages	1.5
Casual labour/piece work	1.0
Rent & business	0.5
Transfer payments or subsidies	0.5
Others	0.5

(source: HI-AWARE, 2018)

2. Methodology

Development in Nuwakot is happening at a rapid pace and against a backdrop of vulnerability to climate change. The observed impacts in the district are felt in water resources, agriculture, and forest and biodiversity sectors (Joshi and Joshi, 2017). Our investigation, although not explicitly mentioned to the interviewed stakeholders to reduce biases, overlooks primarily at the solutions that revolve around these impacts. According to Haasnoot et al. (2020) the solution space, although contested, could be applied at any administrative levels, climate impacts, actor groups and evolves over time. The discussions focus on determining solution space and opportunities over timeframes to achieve desired future development objectives. For development priorities and development projects to be sustainable over time, climate choices and actions must take into consideration the changing climate and its impacts (Werners et al., 2018). The main aim of this case-study-based research is to identify whether the development needs and priorities are included in the future that the stakeholders visualize in Nuwakot. A backcasting and visioning approach following Quist and Vergragt (2006) is used in this study, which is elaborated in the following steps (Werners et al., 2018):

- Step 1: Identification of actors and scope of development pathways;
Objective: To recognize the drivers of change that the community members are encountering;
Method: Kick-starting the discussions with open-ended questions and flip charts backed by the quantitative data collected through the household (HH) surveys on climate change perceptions
- Step 2: Identification of a desired future/development objectives;
Objective: To understand the future scenarios that they and their children would like to live in;
Method: Mixed group method consisting of men's and women's groups.
- Step 3: Backcasting process and eliciting pathways for climate-resilient development;
Objective: To identify the actions needed to achieve the desired future goals or environment;
Method: Actions mapped according to temporal priority in the form of short, medium- and long-term actions.
- Step 4: Pegging the pathways of actions against the elements of climate-resilient development;

Objective: To test the climate-resilient adequacy of the actions;

Method: Utilization of elements of climate-resilient development from the IPCC's Fifth Assessment Report (Denton et al., 2014).

Following these steps and based on past studies on the drivers of change, which are mainly related to climate change, we identified the actors in Nuwakot responsible for climate change adaptation actions, among them, community members and other actors from the District Development Committee, District Administration Office, District Agriculture Office, municipalities, and local government. They are aided by technical input from various international/non-governmental organizations (I/NGO). All these stakeholders work on various development agendas relating to disaster risk reduction, climate change adaptation, economic growth, and social-awareness-related issues such as sanitation and hygiene. The communities' perception on future goals, plans and actions across time horizons are included in the research based on focus group discussions with male and female community members and key informant interviews.

In the case of institutions, open-ended questions were asked on the following: the short-term, medium-term and long-term agenda and the vision that their institutions foresee. For community members, open-ended questions were asked regarding the future that they envisioned and the short-term, medium-term and long-term actions that were needed to achieve the desired future. Data collection was done through qualitative means mainly via focus group discussions and key informant

interviews with people at different levels of governance including civil society actors and researchers and planners at the higher levels. The names of the respondents have been withheld to protect their identity based on their request.

3. Matches and mismatches between agendas: perception mapping of different groups

Eliciting climate-resilient development pathways require constant engagement with the different bodies responsible for development in the district. Instead of planning for the current situation, the pathways approach enables the implementation of adaptation measures sequenced over time. Climate-resilient development pathways involve a series of adaptation measures over time with short-term and long-term goals and accommodate new knowledge. Further, emphasis needs to be placed on horizontal and vertical interactions and coordination both among farmers as well as between farmers and researchers, policy-makers, and those in the private sector and civil society (Denton et al., 2014; Lipper et al., 2014; Mitchell and Maxwell, 2010).

3.1. Identification of actors and scope of development pathways

The impact of local governing bodies is beginning to be felt in Nuwakot district after a long hiatus due to the federal restructuring of Nepal after the promulgation of a new constitution in 2015. The district is also in the process of restructuring the administrative bodies with a change in administrative duties. It is posing a challenge for planning effective local-level climate change adaptation. Therefore, identification of pressing issues in the region, as well as perspectives on a long term vision on the region from actors across the various levels of governance (local, municipal, district) with support from related stakeholders, is essential (Glass et al., 2010; Carsson-kanyama et al., 2013).

A network of actors were selected to define and identify the scope of climate-resilient development pathways. To ensure that we capture the visions and perceptions from the most marginalized groups, we selected the site of the HI-AWARE project where community members are disadvantaged, marginalized with a higher rate of poverty and are vulnerable to various impacts of climate change (Dandekhyia et al., 2017).

Identification of institutional actors was done after careful consideration of their responsibilities towards managing the efforts to subdue the impacts of climate change through socioeconomic, agricultural, and infrastructural development and strategy formulation in the district (Fig. 1). Actors chosen are as follows: the Local Development Officer (LDO), who is responsible for the overall development of the district as it comes within the purview of the LDO-led District Coordination Committee Office; newly-elected Ward Chairperson (WC) for Ward no.6, Charghare, of Bidur municipality; the District Agriculture Development Officer (DADO), who is responsible for the development of agriculture in the district; representatives of the International/Non-governmental Organizations (I/NGO) who are known to assist in addressing regional issues of development, governance, and community empowerment (Talcott et al., 2019); and community members (male and female), including a semi-commercial farmer. Table 2.

To identify drivers of change the community members are facing, discussions indicate that the changes in rainfall variability, average temperature, the increase in incidence of crop pests, visibly heightening, thereby, the vulnerability of communities to climate change. The community members are also deprived of basic socioeconomic development infrastructures (both hard and soft measures) making livelihood further challenging and aiding overall vulnerability. HH surveys conducted in the area outlines the absence of government services (e.g. for agriculture, irrigation, forests, water, etc.), identified by 85% of the total respondents (HI-AWARE, 2018). For this study open-ended questions on the challenges that the communities are currently facing were asked and the responses were not that different from the data collected during the

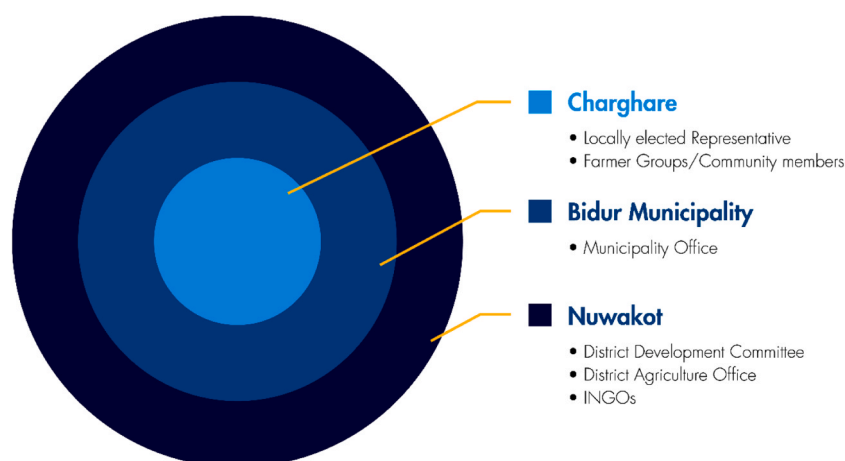


Fig. 1. Layers of institutions responsible for development planning.

Table 2
Overview of participants.

Groups	Participants and interactions
Communities	Focus group discussion with the female (20 participants) and male (12 participants) and one in-depth interview with a semi-commercial farmer
Regional and local-level representatives	Interviews with the Local Development Officer, District Agricultural Officer and elected local representative
NGO/research experts	Experts on Water, Sanitation and Hygiene (WASH) and livelihood programme

perception study (see Table 3). However, the drying up of freshwater resources, especially natural springs, which was highlighted as a major concern in the perception study, was not brought up explicitly in the FGDs.

3.2. Identification of a desired future/development objectives

Following the open-ended questions on the challenges faced, the next part focused on more structurally formatted questions on the future vision that the community members envisage. Participants were asked to sort the visions within a time horizon of short-term (<3 years), medium-term (3–5 years) and long-term (>5years). The community

Table 3
Community perception of climate change.

Indicators attributed to weather variability & climate change (Current situation compared to 10 years ago)	% reporting households			
	No change	Increased	Decreased	Not applicable
Average temperature	13.5	84.0	2.5	0.0
Erratic rainfall events	4.5	58.0	37.5	0.0
Average rainfall	3.5	14.0	82.5	0.0
Number of dry days	5.0	84.0	9.5	1.5
Water availability for crops and animals	7.5	33.0	59.0	0.5
Water availability for domestic use	7.5	21.0	70.0	1.5
Drying up of fresh water sources	15.0	77.0	8.0	0.0
Crop productivity	16.5	34.5	46.0	3.0
Livestock productivity	71.0	6.5	15.5	7.0
Incidence of crop pests	11.5	81.5	1.5	5.5
Incidence of livestock diseases	56.5	34.0	1.0	8.5

(source:HI-AWARE, 2018)

members, male and female separately, were asked open questions on the desired future that they wanted for themselves or their children to live in (see Fig. 2). They were subsequently asked about the actions needed in different time horizons to achieve the desired future.

The desired future envisioned within the short-term time horizon by both the male and female members of the community is the maintenance of the present infrastructure in the form of roads and drinking water pipes. Both groups explicitly mentioned the desire for better health services and higher educational institutions. In the medium time horizon, they desired the construction and upgrading of roads and irrigation canals. Their longer time horizon featured both increasing and creation of production capacity through training of community members in various livelihoods skills.

Since the community members are all dependent on subsistence agriculture, one semi-commercial farmer who was involved mainly in raising livestock was also chosen for the interviews. A migrant returnee, the farmer was happy with his business prospects, which highlighted the smooth value chain for dairy products. However, he faced a challenge in getting balanced feed for his livestock which is currently purchased from the neighbouring districts. Therefore, strengthening the dairy value chain and easy availability of feed was the future desired by the farmer. Other stakeholders' (government and non-government organisations) future desires were mainly directed towards economic and infrastructure development related to their respective fields of work. The activities presented in their timeline are coherent with the future they desire unlike in the case of community members. Therefore, a separate analysis and description of them is not presented here.

3.3. Backcasting process and eliciting pathways for climate-resilient development

Based on the backcasting methodology, stakeholders were presented with the actions on a time horizon to identify the pathways needed to arrive at the future that they desire. This exercise enabled the community members to understand and identify the activities needed to fulfil their desires regarding development in future. The futures are grouped under the headings of general, infrastructures (health, education and others) and economic empowerment (see Fig. 3). Both male and female members, by and large, were capable of identifying the right agency from those presented to fulfil their development desires except in some instances when they seemed unsure of the responsible agency for certain development goals. For the medium and longer time horizons, community members positioned economic empowerment as a top priority through various livelihoods focused training.

The Local Development Officer (LDO) who is in charge of the District Development Committee (DDC) is responsible for the overall

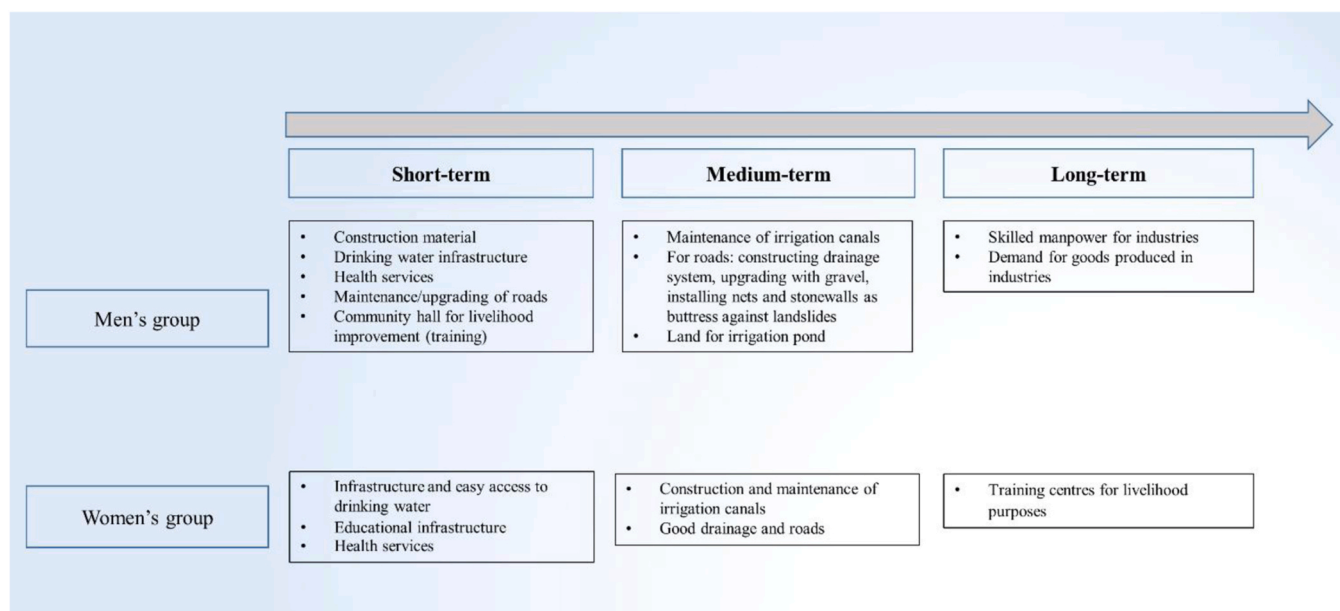


Fig. 2. Future envisioned by the community members based on time horizons.

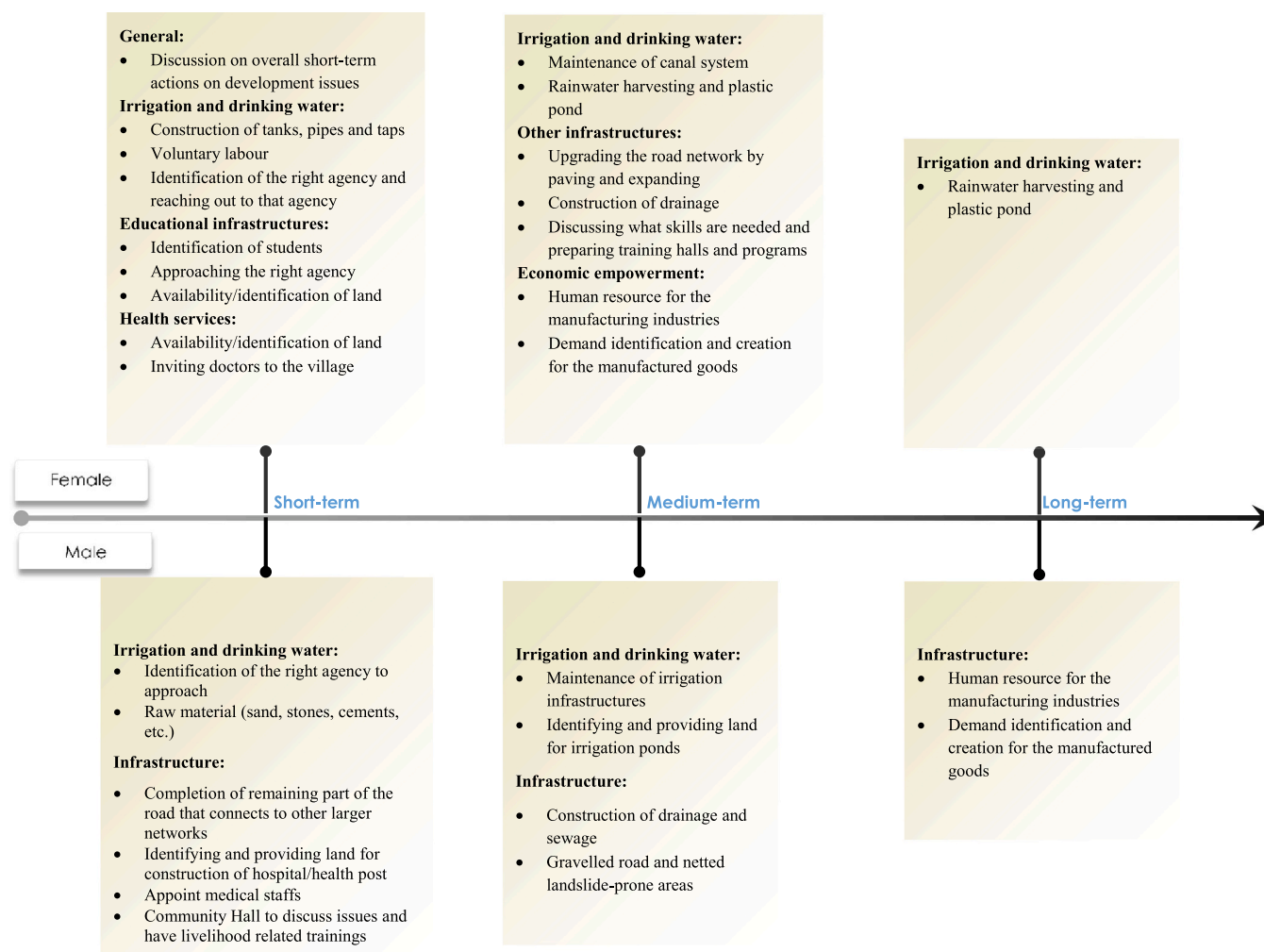


Fig. 3. Actions compatible with the future visions of the community members.

development plan of the district and is the focal point of the district as well as the federal government (TAF, 2012). In the interview, the LDO prioritised reconstruction as the major target of the DDC after the devastating earthquake that struck the region through April and May 2015. The LDO identified extraction of natural resources for reconstruction (e.g., timber, sand, stone, etc.) as posing a major challenge to sustainable natural resource and emphasized the availability of funds for Environment Impact Assessment (EIA) and Initial Environmental Examination (IEE). The LDO's focus was on the development and reconstruction of physical infrastructures to support sanitation, accessibility to roads and energy security issues, which further supports the hypothesis of rapid infrastructure development in the region. Fig. 4 presents the results of the backcasting exercise.

The District Agricultural Development Officer (DADO), who is responsible for the development of agricultural methods and technologies to improve production, was another actor chosen in the study for backcasting. The DADO identified the major challenges that are hampering agricultural development in the entire district. Labour shortage due to the decreasing interest in agriculture among youth, hydro-meteorological events, drying up of springs, and lack of a market and profitability for agricultural products were the major challenges highlighted by the DADO. To overcome these challenges, the DADO presented strategies that were mainly focused on improving agricultural methods and productivity. Further, research in innovative and climate-smart agriculture was also stressed by the DADO during the interview. Fig. 5 lists the activities based on the time horizon as illustrated below.

Similarly, the local elected representative, or the Ward Chairperson (WC), had a vision regarding the enhancement of economic development as well as the health and educational services of the region. Emphasis was placed on agricultural development, the establishment of technical educational institutes, and tourism development as well as upgrading the road infrastructures as Nuwakot lies within the Belt & Road Initiative (BRI) of China. The representative identified new diseases in livestock and crops as a major challenge in the case of agricultural development and a lack of professionals to mitigate these impacts. This shortage of technical professionals is forcing the residents to travel as far as Kathmandu (about 60 km) to seek help. WC was, however, not aware of the concept of climate change and displayed no awareness of hydro-meteorological adversities of the ward. Fig. 6 presents the results of the backcasting exercise.

I/NGOs are working in multiple districts in Nepal and are a major player in the development of the district of Nuwakot, providing technical as well as financial resources to community members and government officials. Therefore, two technical professionals from the I/NGO sector were interviewed whose work is in the areas of water, sanitation and hygiene (WASH) and livelihood programmes. According to them, the challenges for community development were mainly the hydro-meteorological events of drought and drying up of springs, which were attributed to the 2015 earthquake. Conflicts on usage and ownership of these natural springs among the community were also highlighted as a challenge. The backcasting exercise with these professionals yielded the following activities as illustrated in Fig. 7.

3.4. Climate resilience of the development pathways (CRDPs)

This section discusses to what extent the development pathways identified by the actors in the previous section contribute to climate resilience. The development pathways and the visions of all the actors interviewed emphasized economic, infrastructural, and agricultural development over different time horizons. To enhance the economic, social and climate resilience, strengthening and evaluation of future actions targeted is needed so that proper measures can be taken depending on the evolution of the pathway. To measure the climate resilience of the pathways identified by the stakeholders, we use five elements, as put forward by Denton et.al. (2016), namely, whether they [i] foresee risk/vulnerability, [ii] decrease climate change impacts, [iii] respond rapidly to unpredictable, uneven and extreme events, [iv] include a considerable amount of proactive adaptation and [v] evolve in support of societal advancement and balanced environmental management. Apart from these, we have also taken into account, some of the challenges in envisioning the climate-resilient developmental pathways. Gajjar et al. (2019), through two case studies from urban and rural India, shows how CRDPs could bring in irreversible lockins and trade-offs that can reproduce inequalities. Watkiss (2015) calls for identifying low-regret options that can help in mapping iterative adaptation management pathways. These pathways do not focus on immediate and short term benefits but long term actions and transformations (Rose-nzweig and Solecki, 2018). Table 4.

Surveys done in the Gandaki basin reveal that community members are aware of climatic changes and the consequent disruptions that are

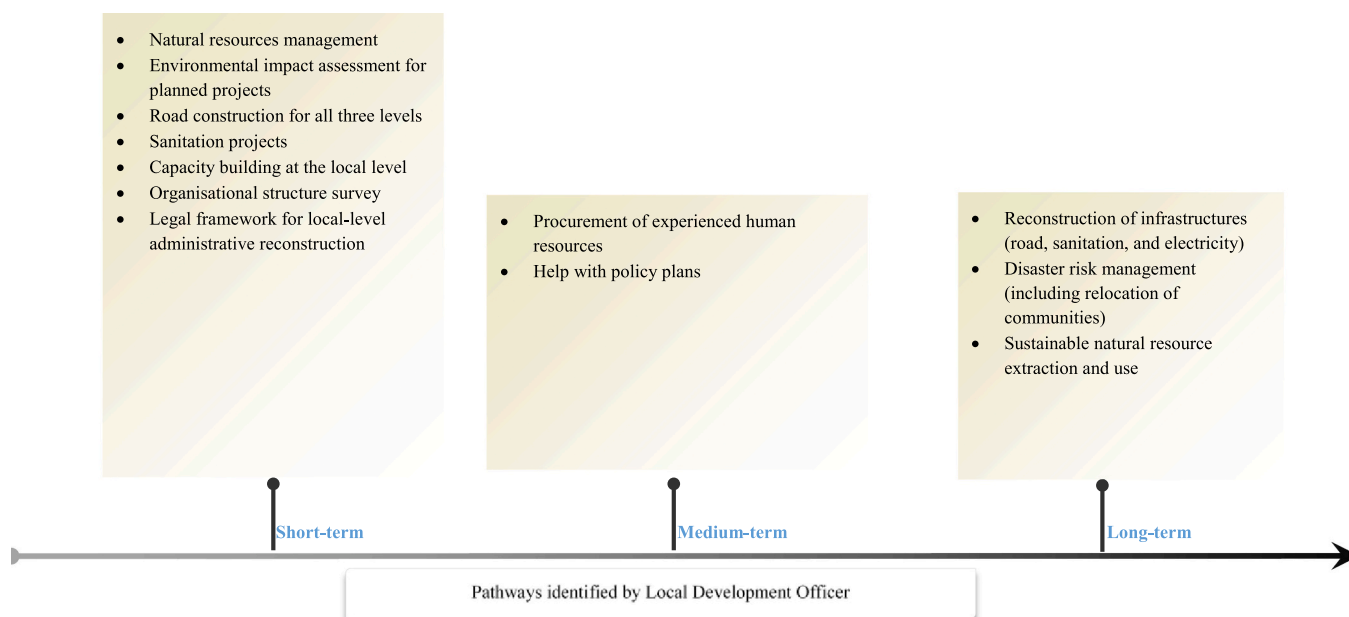


Fig. 4. Pathways identified by the LDO on different time horizons.

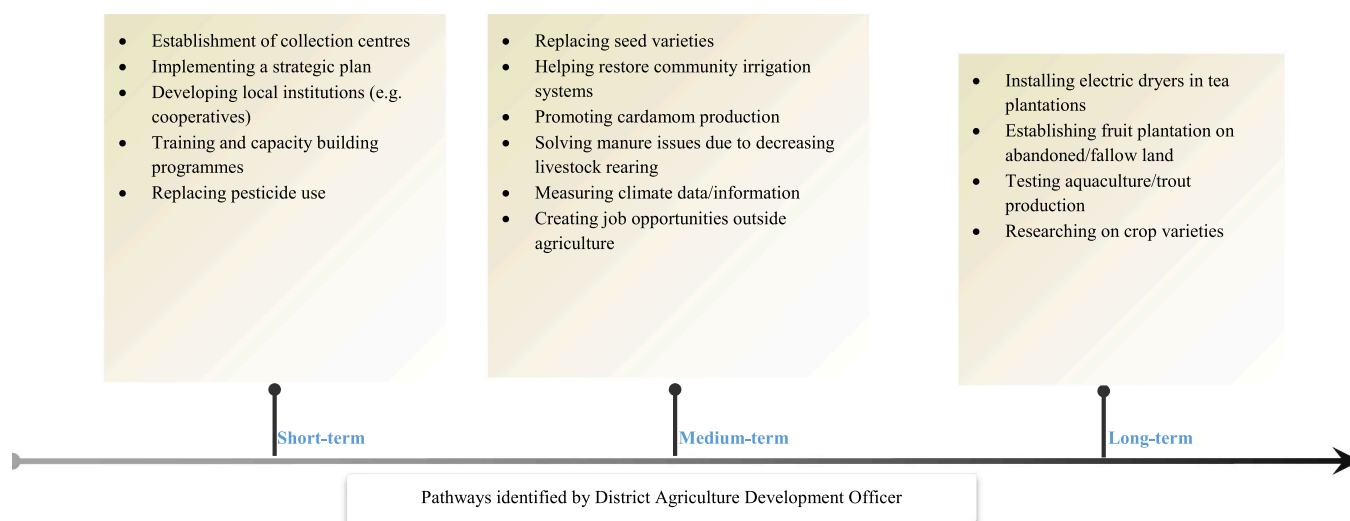


Fig. 5. Pathways identified by the DADO on different time horizons.

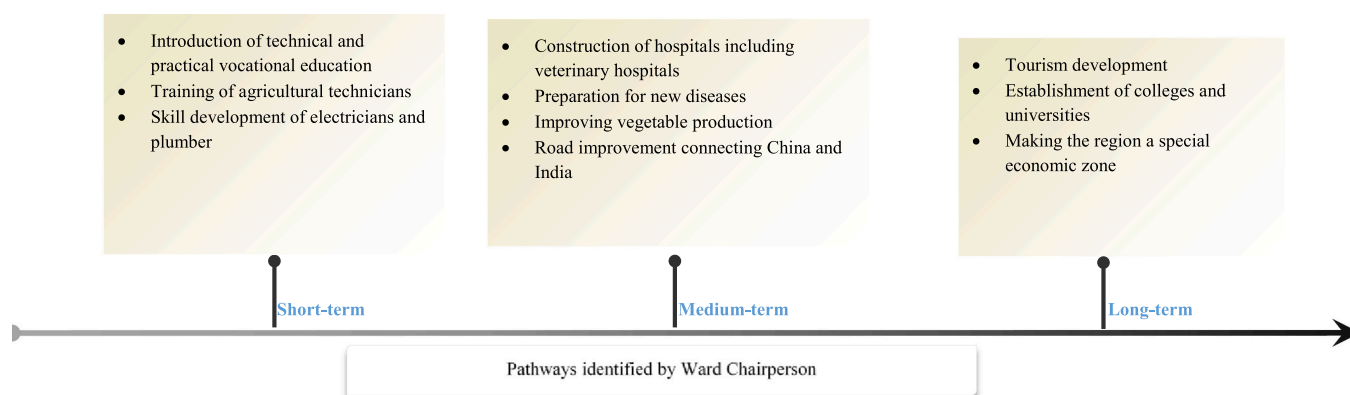


Fig. 6. Pathways identified by the WC on different time horizons.

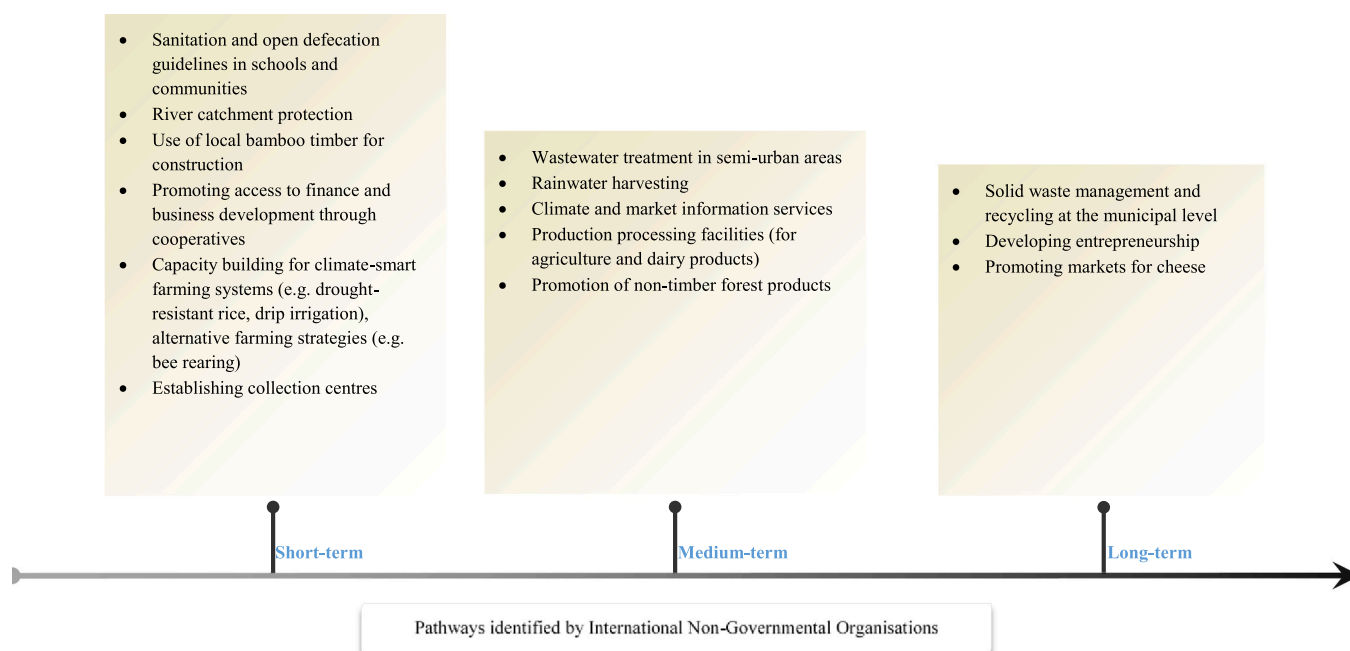


Fig. 7. Pathways identified by the I/NGO based on different time horizons.

Table 4
Elements and pathways identified by actors for climate-resilient development.

Elements for climate-resilient development pathways	Measures identified by the stakeholders	Identified by
Foresee risk/vulnerability	Weather station setup Climate and market information services	DADO I/NGO
Decrease climate change impacts	Preparation for new diseases Maintenance of irrigation and drinking water infrastructure such as canals, taps, tanks and pipes Modern agricultural techniques such as plastic ponds, rainwater harvesting, drip irrigation and water recycling	WC Male and female community members Semi-commercial farmer and I/NGO
Respond rapidly to unpredictable, uneven and extreme events	Relocation of communities living in a disaster-prone zone	LDO
Include a considerable amount of proactive adaptation	Identification of climate suitable seeds Weather station set-up Climate-smart farming systems Access to finance and markets Alternative livelihood strategies Capacity building for climate smart agriculture	DADO I/NGO
Evolve in support of societal advancement and balanced environmental management	Seeking support from responsible agencies for economic as well as infrastructural development Upgrading subsistence farmers to semi-commercial farmers Training on the use of pesticides Sustainable extraction of natural resources	Community Members DADO LDO

happening in the region (see Table 3). IPCC (2014) defines “risks” and “vulnerability” as follows: risks refer to probable consequences in terms of economic or social value and where the outcome is uncertain in nature while vulnerability refers to susceptibility to harm or lack of adequate measures to cope and adapt. Concerning the first element, i.e., foreseeing risk and vulnerability, DADO identified setting up weather stations and the WC stressed on identifying and combating new diseases occurring in crops and livestock and the I/NGO presented the importance of climate and market information as tools to foresee risk and vulnerability in the district. Maintenance of irrigation and drinking water infrastructure was emphasized by the community members to decrease climate change impacts. This is an adaptation option to drought identified also by Regmi and Pandit (2016) for the Gandaki River Basin. Further, adoption of modern agricultural strategies, in addition to irrigation infrastructure, were identified by the I/NGO and semi-commercial farmer as adaptation strategies to decrease climate impacts. None of the stakeholders seemed prepared for unpredictable extreme events except for LDO who envisioned the scenario of relocating communities as an alternative adaptation strategy. It is worth mentioning that relocation of communities was an action that was identified following the 2015 earthquake recognizing the risks to communities living in landslide-prone zones, a response proposed for non-climatic extreme events. However, a majority of the actions identified by community members as a means of coping with climate change were short-term in nature while they seemed to have little idea about how to address long-term impacts. The officials, on the other hand, had long-term strategies such as climate-smart agriculture and access to finance. The problem seems to lie concerning the interaction (or lack thereof) between community members and officials. Community

members are still not able to identify which agency to approach to gain the benefit of the strategies that these agencies had put forward. Although these strategies at first glance seemed aimed at building infrastructure to cope with various climate-related risks and stresses, they also appeared to help with societal development as well. In addition to these, the DADO shared the Agriculture Development Strategy (MoAD, 2015), the objective of which is to uplift the status from subsistence farming to semi-commercial farming. The DADO also emphasized the importance of providing training to farmers on the sustainable use of pesticides to avoid hampering soil quality and fertility. Similarly, for environmental sustainability, LDO highlighted the work that they are already doing on the sustainable extraction of natural resources through conducting various environmental impact assessment studies.

4. Discussions: multiple stakeholder priorities and pathways for climate-resilient development

Our understanding of climate-resilient development in the study aligns with fulfilling elements of various social and environmental components mainly towards climate change adaptation, socioeconomic development, access to development infrastructures, social equity, and enabling governance and institutional mechanisms. Hence, the main aim of this study was to analyse and understand the development priorities and pathways of various stakeholders in the climate-vulnerable mountain regions and to understand whether these pathways lead towards climate-resilient development. For this purpose, the Nuwakot district, in Nepal, was chosen as the case study where a majority of the population depend on agriculture, and climate change has been a major factor affecting agricultural production and deepening vulnerability. Different social groups and stakeholders were interviewed as part of this study to map their understanding of developmental pathways which subsequently was analysed to test compatibility with climate resilience. The actors chosen for the study, in addition to the community members, were the DADO, LDO, WC and I/NGOs representatives. Upon eliciting the pathways for climate-resilient development from the stakeholders, the study attempted to understand how the various actors perceive and plan suitable strategies to overcome these challenges in future. We used a four stepped methodology, identification of actors and their future objectives through the backcasting process and finally used elements of climate-resilient development (see Section 2), to conduct this study.

In this paper, through the visioning and backcasting exercise, we singled out multiple stakeholder priorities and pathways for climate-resilient development. Interestingly, although the community pathways and the organizational development pathways complemented each other, their priorities were rather incompatible and elusive. Our findings point out the mismatches between agendas and lack of coordination between the various actors we interviewed. The formal actors (DADO, LDO, WC and I/NGOs representatives) viewed climate and development differently and were unable to integrate them in the development planning and processes. Issues of addressing social inequity through the identification of marginalized and vulnerable groups of people and understanding their differentiated vulnerabilities were found to be largely neglected. The majority of the community members we interviewed were of the *Dalit* caste, regarded as lower caste in the caste hierarchy system prevalent in Nepal. Thus, their voices are often found to be subdued, are left out from development projects and are economically exploited (Bishwakarma, 2004). However, the interview with the semi-commercial farmer, of *Brahmin* caste group, showed a clear advantage on access to resources over other caste groups as his future objectives and strategies were closely linked with the development strategies of the relevant agencies. This finding clearly illustrates the gap on inclusion and the need to accommodate complex settings and situation in which the marginalised population operate (Leal Filho et al., 2021). Our findings also strongly show the future desires of community members towards economic empowerment and capacity building through producing skilled human resources and training centres for

livelihood diversification. This desire of community members, along with strategies of formal agencies on relocation of vulnerable community, shifting to non-agricultural/ non-farm livelihoods could be seen as a transformative approach for climate resilient development. Further, our findings also suggest that the community members are politically and administratively marginalised as they seem to focus their action towards identifying the appropriate (formal) agency to approach for development needs.

Correspondingly, community members were more concerned about the immediate issues that concerned them such as irrigation, water supply, education, and health. These are primary needs which communities struggle to access and hence, understandably, they are at the top of their agenda. The community members do not yet feel alarmed about climate change. Although they have perceived and felt the change (see Table 3), their willingness or sense of urgency to adapt is far less compared to the interest that they profess in infrastructural and economic development. Male members were especially in favour of entirely quitting agriculture in favour of the manufacturing labour force given the support extended by the responsible agency. It was the same in the case of the women's group who too favoured association with the development of handicrafts and small-medium enterprises. The people of Nuwakot, who understand that agriculture alone cannot sustain their livelihoods, have also started relying on other off-farm livelihood options such as short and long-term migration for labour. Through these results we can sense the urgency and call from community members, especially the marginalised and disadvantaged, on designing and implementing pathways for climate resilient development and achieving the sustainable development objectives envisaged by the nation.

The formal actors, on the other hand, had fragmented visions towards future development. Strictly, development practitioners, the I/NGOs representatives had broader views on identifying climate-resilient development pathways. Their pathways towards building climate resilience through the introduction of financial mechanisms and economic empowerment through entrepreneurship development strategies corresponded to the community's future desires. The agricultural development strategies presented by DADO mainly focused on uplifting subsistence farmers to the level of semi-commercial farmers and create agriculture-based off-farm activities. These are, however, in coherence with the Agricultural Development Strategy of the Government of Nepal (MoAD, 2015). The LDO, on the other hand, spoke of the intensification in structural development efforts in the aftermath of the 2015 Nepal earthquake and focused his pathways mainly towards infrastructural development. However, sustainable use of natural resources and conducting environmental impact assessment was also prioritized without going into further details on the processes. Using the elements in climate-resilient development (Denton et al., 2014), we then pegged the development visions identified by stakeholders with these elements. As per the framework setting up weather information system, training on climate-smart agriculture and upgrading to semi-commercial farming were the strategies mentioned by the DADO. Similarly, maintenance of irrigation infrastructure and introduction of modern agricultural techniques were among strategies mentioned by the community members including the semi-commercial farmer. Introduction of alternative livelihood strategies, climate-smart farming and access to finance and market were among those explicitly mentioned by the I/NGOs. The LDO focused more on the relocation of communities and the sustainable extraction of natural resources. These are, though, in response to the rebuilding efforts that are going on after the 2015 earthquake and according to the guiding principles of the National Reconstruction Authority, mandated to mobilise agencies at all levels for reconstruction. In contrast, the WC, the elected local representative, seemed unaware of the effects of climate change on the region and its populace although economic development priorities were explicitly mentioned. However, preparation for new pests and diseases was a strategy that complied with the element to foresee risk and vulnerability. The WC focused more on trade connectivity with China and setting up a vocational educational

institute and a veterinary hospital. According to Murton et al. (2016), connecting with China has been a priority of the political bodies in Nepal and is bringing about a significant reorientation in the political economy of the country. The activities and future plans' coherence, thus, could be more against the backdrop of the manifesto presented for the elections. The views of different actors, therefore, are socially or politically motivated and outcome of any particular activity might have the capacity to construct or compound problems for another (Haasnoot et al., 2020). Consideration of such unintentional outcomes are also largely absent in the actors' visions.

The medium and long-term activities reported by stakeholders partially match the planned adaptation measures reported in Regmi and Pandit (2016) for the Gandaki River Basin, where these measures are meant to address issues related to climate resilience. Yet, they found that these adaptation practices were not easy to implement because they were more oriented towards development than addressing actual climate risks and were not sufficient to meet future adaptation needs. However, combining development and planned adaptation strategies while fostering autonomous adaptation through scientific and local knowledge can help ensure successful adaptation strategies in the region. Adaptation literature, further, identifies governance as key to climate-resilient development (Adger, 2003; Jordan et al., 2015; Brunner and Lynch, 2010). The study found communication and coordination gaps between the stakeholders, both of which are presented as major elements for implementing successful adaptive governance (Sharma-Wallace et al., 2018). The exclusion of marginal communities in decision making, misunderstanding of differentiated risks and vulnerabilities can be seen as a manifestation of unsuitable governance approaches. Studies in the past (e.g. Nightingale, 2017) have also identified the lack of clear authority and line management, ultimately creating a vacuum for climate change responsibilities. For instance, discussions with the WC showed that climate change or adaptation was nowhere near the top of the agenda. Nevertheless, the climate risks and vulnerabilities faced by the community members are evident from the past survey results (see Table 3). Further, inability to integrate social inequity and marginality in development plans further divert attention away from the immediate actions needed to protect the communities from the risks and vulnerabilities that may arise. Identifying development priorities and planning for them in silos seems more the case in the present instance, for example, the WC's vision of industrial and infrastructural development with a long-term objective of connecting the district with China; LDO's focus on resource extraction for reconstruction; DADO's single-minded focus on agriculture development will all hamper efforts for climate-resilient development. Therefore, the priority of stakeholders was not on integration and cooperation amongst themselves but rather on separately conceived development priorities. The research also confirms the need for integrating adaptive governance, which is currently largely lacking. Although methods such as community empowerment and capacity development are present in the pathways mentioned by the stakeholders, a majority of the methods for integrating adaptive governance especially on collaboration and coordination across actors and scale, social network analysis, community empowerment and engagement (Sharma-Wallace et al., 2018), are lacking in the region. A shift to a more multi-institutional adaptive governance mechanism can enhance the role of multiple stakeholders. The co-production of pathways as initiated in this study provides important leverage for a flexible governance arrangement that can facilitate truly transformative adaptation options and strategies at various levels.

5. Conclusions: towards a climate-resilient development pathway for Nuwakot

The HKH region is a hotspot to the effects of climate change and to understand the climate-resilient development pathways of the Nuwakot district, in the Gandaki River Basin, we conducted interview with

multitude of actors. Apart from the community members who are experiencing the first-hand effects of climate change, other stakeholders were chosen based on their involvement in developing policies and implementing actions for climate resilience in the region. The back-casting exercise presented different visions the stakeholders envisage for development of the region. The community members' focus was on immediate structural interventions such as education, health and economic development, all of which could be longer-term social measures that may help adaptation and shift local development pathways. The community members also focused strongly on capacity building and economic empowerment highlighting the marginality and social exclusion they are facing. The formal agencies' focus was on technical intervention which largely ignored the social inclusion aspect for designing and implementing climate resilient development pathways. Lack of coordination and collaboration between actors is clearly seen on the pathways they have presented. The governing bodies, thus need to be in constant communication with community members to elicit their adaptation needs and requirements. Awareness of climate change in the communities also plays a vital role in developing these pathways. There is much scope in the area to synergize development with climate resilience. However, this synergy will bring forth further complexity which can be addressed by an integrated approach to implementing the development agenda.

The community selected is from an area that is comparatively more developed than other rural areas of the district but the community members interviewed were marginal, disadvantaged with clear illustration of them being left behind. The choice was dictated by the desire to understand the status of climate-resilient actions that had entered the development pathways in an area where development priorities take precedence. However, to fully understand the development pathways of the entire district, additional interactions with stakeholders in more rural areas and their development priorities are necessary though that was outside the scope of this research. In addition, the views of other stakeholders who are indirectly responsible for the development of the district should have been sought as their inclusion could have helped to compile a more comprehensive picture. Despite a few limitations, this kind of exercise highlights the degree of coherence between climate-resilience and development priorities of the stakeholders so corrective action can be taken by those responsible where necessary. Communication of the results to policymakers will aid in collaboration and co-ordination across the relevant actors and scales, thus fulfilling the fundamental principles of adaptive governance for climate-resilient development.

In future, integrating the pathways of different actor groups and encouraging more engagement of communities in the development vision of the region are recommended. This will help retain the connection between policy aspirations and community voices thereby facilitating communities to anticipate regional development visions. There also needs to be a discussion on how participatory development of adaptation pathways can help actors to visualize what strategies and actions can now be pursued, which would contribute to moving toward resilient pathways of social and economic development in future.

CRediT authorship contribution statement

Avash Pandey: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **Anjal Prakash:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Saskia Werners:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

Acknowledgements

This work was carried out by the Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAS) with financial support from the Department for International Development, the U.K. and the International Development Research Centre, Ottawa, Canada. This work was also partially supported by core funds of International Centre for Integrated Mountain Development, Kathmandu, Nepal (ICIMOD) contributed by the governments of Afghanistan, Australia, Austria, Bangladesh, Bhutan, China, India, Myanmar, Nepal, Norway, Pakistan, Switzerland, and the United Kingdom. The authors would like to thank Dr Philippus Wester of ICIMOD for his valuable comments and guidance during the entire process. We would also like to acknowledge the Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP) and Bharti Institute of Public Policy, Indian School of Business, for supporting professional time and resources in the preparation of this manuscript.

Disclaimer: The views expressed in this work are those of the creators and do not necessarily represent those of the UK Government's Department for International Development, the International Development Research Centre, Canada or its Board of Governors.

References

- Adger, W.N., 2003. Social capital, collective action, and adaptation to climate change. *Econ. Geogr.* 79 (4), 387–404.
- Bajracharya, S.R., Shrestha, B.R., 2011. The Status of Glaciers in the Hindu Kush-Himalayan Region. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal. Accessed on December 11, 2018, at: (<http://lib.icimod.org/record/9419>).
- Berrang-Ford, L., Ford, J.D., Paterson, J., 2011. Are we adapting to climate change? *Glob. Environ. Change* 21 (1), 25–33.
- Bhattarai, B., Beilin, R., Ford, R., 2015. Gender, agrobiodiversity, and climate change: a study of adaptation practices in the Nepal Himalayas. *World Dev.* 70, 122–132.
- Bishwakarma, P. (2004, May). The situation analysis for dalit women of Nepal. In National Seminar on Raising Dalit Participation in governance Centre for Economic and Technical Studies.
- Bosomworth, K., Leith, P., Harwood, A., Wallis, P.J., 2017. What's the problem in adaptation pathways planning? The potential of a diagnostic problem-structuring approach. *Environ. Sci. Policy* 76, 23–28.
- Brunner, R., Lynch, A., 2010. Adaptive Governance and Climate Change. American Meteorological Society, Boston.
- Butler, J.R.A., Suadnya, W., Yanuati, Y., Meharg, S., Wise, R.M., Sutaryono, Y., Duggan, K., 2016. Priming adaptation pathways through adaptive co-management: design and evaluation for developing countries. *Clim. Risk Manag.* 12, 1–16.
- Carsson-kanyama, A., Carlsen, H., Dreborg, K., 2013. Barriers in municipal climate change adaptation: results from case studies using backcasting. *Futures* 49, 9–21.
- Dandekhy, S., England, M., Ghate, R., Goodrich, C. G., Nepal, S., Prakash, A., Shrestha, A., Singh, S., Shrestha, M.S., Udas, P. B. (2017) The Gandaki Basin – Maintaining livelihoods in the face of landslides, floods, and drought. HI-AWARE Working Paper 9. Kathmandu: HI-AWARE.
- DCC, 2017. District Profile of Nuwakot. Bureau of Statistics, Nuwakot, Nepal, Nuwakot.
- De Souza, K., Kituyi, E., Harvey, B., Leone, M., Murali, K.S., Ford, J.D., 2015. Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience-building research. Accessed on 11/05/2020 at Reg. Environ. Change 15, 747–753. <https://doi.org/10.1007/s10113-015-0755-8>.
- Denton, F., Wilbanks, T.J., Abeysinghe, A.C., Burton, I., Gao, Q., Lemos, M.C., Masui, T., O'Brien, K.L., Warner, K. (2014). Climate-resilient pathways: adaptation, mitigation, and sustainable development. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M. D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., and White, L.L. (eds.)]. Cambridge University Press: Cambridge and New York, pp. 1101–1131.
- Devkota, S.P., Bagale, S., 2015. Social inequality in Nepal and right of education. *J. Poverty Invest. Dev.* 8, 1–4.
- Dong, T.B., 2016. Social inequality in the civil service and a review of affirmative action in Nepal. *South Asian J.* 4 (2).
- Druza, K., 2015. Social protection policymaking in Nepal. *J. Soc. Res. Policy* 6 (2).
- Engle, N.L., de Bremond, A., Malone, E.L., Moss, R.H., 2014. Towards a resilience indicator framework for making climate-change adaptation decisions. Accessed on 03/03/2019 at Mitig. Adapt. Strateg. Glob. Change 19 (8), 1295–1312. <https://doi.org/10.1007/s1027-013-9475-x>.

- Gajjar, S.P., Singh, C., Deshpande, T., 2019. Tracing back to move ahead: a review of development pathways that constrain adaptation futures. *Clim. Dev.* 11 (3), 223–237.
- Haasnoot, M., Kwakkel, J.H., Walker, W.E., ter Maat, J., 2013. Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. *Glob. Environ. Change* 23 (2), 485–498.
- Haasnoot, M., Biesbroek, R., Lawrence, J., Muccione, V., Lempert, R., Glavovic, B., 2020. Defining the solution space to accelerate climate change adaptation. *Reg. Environ. Change* 20 (2), 1–5.
- HI-AWARE. 2018. *Climate Change Critical Moments Survey 2018* (unpublished). Himalayan Adaptation, Water and Resilience (HI-AWARE) Initiative, the Consortium of the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA). Kathmandu.
- Hussain, A., Sarangi, G.K., Pandit, A., Ishaq, S., Mamnun, N., Ahmad, B., Jamil, M.K., 2019. Hydropower development in the Hindu Kush Himalayan region: Issues, policies and opportunities. *Renew. Sustain. Energy Rev.* 107, 446–461.
- Immerzeel, W.W., Lutz, A.F., Andrade, M., Bahl, A., Biemans, H., Bolch, T., Hyde, S., Brumby, S., Davies, B.J., Elmore, A.C., Emmer, A., Feng, M., Fernández, A., Haritashya, U., Kargel, J.S., Koppes, M., Kraaijenbrink, P., Kulkarni, A.V., Mayewski, P.A., Nepal, S., Pacheco, P., Painter, T.H., Pellicciotti, F., Rajaram, H., Rupper, S., Sinisalo, A., Shrestha, A.B., Viviroli, D., Wada, Y., Xiao, C., Yao, T., Baillie, J., 2019. Importance and vulnerability of the world's water towers. *Nature* 577 (7790), 364–369.
- IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117–130.
- Joshi, L.R., Joshi, K.R., 2017. Understanding the climate change adaptation needs of communities: a case study from Nuwakot District, Central Nepal. *J. Environ. Sci.* 3.
- Jordan, Andrew J., Huitema, Dave, Hilden, Mikael, Van Asselt, Harro, Rayner, Tim J., Schoenefeld, Jonas J., Tosun, Jale, Forster, Johanna, Boasson, Elin L., 2015. Emergence of polycentric climate governance and its future prospects. *Nat. Clim. Change* 5 (11), 977–982.
- Kovács, E.K., Ojha, H., Neupane, K.R., Niven, T., Agarwal, C., Chauhan, D., Dahal, N., Devkota, K., Guleria, V., Joshi, T., Michael, N.K., Pandey, A., Singh, N., Singh, V., Thadani, R., Vira, B., 2019. A political ecology of water and small-town urbanisation across the lower Himalayas. *Geoforum* 107, 88–98.
- Kraaijenbrink, P.D.A., Bierkens, M.F.P., Lutz, A.F., Immerzeel, W.W., 2017. Impact of a global temperature rise of 1.5 degrees Celsius on Asia's glaciers. *Nature* 549 (7671), 257–260.
- Krishnan, R., Shrestha, A.B., Ren, G., Rajbhandari, R., Sanjay, J., Syed, M.A., et al., 2019. Unravelling climate change in the Hindu Kush Himalaya: rapid warming in the mountains and increasing extremes. In: Wester, P., Mishra, A., Mukherji, A., Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham.
- Lamichhane, N., Dandekhya, S., Shrestha, K., Shrestha, R. (2020) Springshed research: A study from Charchare Village Development Committee in the mid-hills of Nepal. HI-AWARE Working Paper 25. Kathmandu: HI-AWARE.
- Leal Filho, W., Stringer, L.C., Totin, E., Djalante, R., Pinho, P., Mach, K.J., Wolf, F., 2021. Whose voices, whose choices? Pursuing climate resilient trajectories for the poor. *Environ. Sci. Policy* 121, 18–23.
- Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottle, R., Jackson, L., Jarvis, A., Kossam, F., Mann, W., McCarthy, N., Meybeck, A., Neufeldt, H., Remington, T., Sen, P.T., Sessa, R., Shula, R., Tibu, A., Torquebiau, E.F., 2014. Climate-smart agriculture for food security. *Nat. Clim. Change* 4 (12), 1068–1072.
- Misra, M., 2019. Women and the perpetuation of caste system in Nepal. *Dhaulagiri J. Sociol. Anthropol.* 13, 11–19.
- Mitchell, T., Maxwell, S., 2010. Defining climate compatible development. CDKN ODI Policy Brief. Climate Development and Knowledge Network.
- MoAD, 2015. Agriculture Development Strategy (ADS) 2015 to 2035, 1. Government of Nepal, Singhdurbar, Kathmandu, Nepal. [https://doi.org/10.1016/S0022-3913\(12\)00047-9](https://doi.org/10.1016/S0022-3913(12)00047-9).
- Murton, G., Lord, A., Beazley, R., 2016. 'A handshake across the Himalayas': Chinese investment, hydropower development, and state formation in Nepal. *Eurasia Geogr. Econ.* 57 (3), 403–432.
- Niemeyer, S., Petts, J., Hobson, K., 2005. Rapid climate change and society: assessing responses and thresholds. *Risk Anal.* 25 (6), 1443–1456.
- Nightingale, A.J., 2017. Power and politics in climate change adaptation efforts: struggles over authority and recognition in the context of political instability. *Geoforum* 84, 11–20.
- O'Brien, K., Eriksen, S., Inderberg, T.H., Sygna, L., 2015. Climate change and development: adaptation through transformation. In: Inderberg, T.H., Eriksen, S., O'Brien, K., Sygna, L. (Eds.), *Climate Change Adaptation and Development: Transforming Paradigms and Practices*. Routledge, Abingdon and New York.
- Pandey, A., Prakash, A., Barua, A., Syed, A., Nepal, S., 2020. Upstream-downstream linkages in Ganges-Brahmaputra-Meghna basin: the hydro-social imperatives. *Water Policy* 22 (6), 1082–1097.
- Pyakurel, U., 2021. Reproduction of Inequality and Social Exclusion: A Study of Dalits in a Caste Society, Nepal. Springer Nature.
- Quist, J., Vergragt, P., 2006. Past and future of backcasting: the shift to stakeholder participation and a proposal for a methodological framework. *Futures* 38 (9), 1027–1045.
- Regmi, B.R., Pandit, A., 2016. Classification of adaptation measures in criteria for evaluation: Case studies in the Gandaki River Basin. HI-AWARE Working Paper 6. HI-AWARE, Kathmandu, Nepal.
- Rosenzweig, C., Solecki, W., 2018. Action pathways for transforming cities. *Nat. Clim. Change* 8 (9), 756–759.
- Sapkota, P., Keenan, R.J., Paschen, J.A., Ojha, H.R., 2016. Social production of vulnerability to climate change in the rural middle hills of Nepal. *J. Rural Stud.* 48, 53–64.
- Schneider, S.H., Semenov, S., Patwardhan, A., Burton, I., Magadza, C.H.D., Oppenheimer, M., Pittock, A.B., Rahman, A., Smith, J.B., Suarez, A., Yamin, F., 2007. Assessing key vulnerabilities and the risk from climate change. *Climate change 2007: impacts, adaptation and vulnerability*. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, pp. 779–810.
- Sharma, E., Molden, D., Khatriwadsa, Y.R., Zhang, L., Singh, S.P., Yao, T., Wester, P., 2019. Introduction to the Hindu Kush Himalaya assessment. In: Wester, P., Mishra, A., Mukherji, A., Shrestha, A. (Eds.), *The Hindu Kush Himalaya Assessment*. Springer, Cham.
- Sharma-Wallace, L., Velarde, S.J., Wreford, A., 2018. Adaptive governance good practice: show me the evidence! *J. Environ. Manag.* 222, 174–184.
- Siderius, C., Biemans, H., Van Walsum, P.E.V., Van Ierland, E.C., Kabat, P., Hellegers, P., J.G.J., 2016. Flexible strategies for coping with rainfall variability: seasonal adjustments in cropped area in the Ganges basin. *PLoS One* 11 (3), 1–23.
- Singh, P.K., Chudasama, H., 2021. Pathways for climate change adaptations in arid and semi-arid regions. *J. Clean. Prod.* 284, 124744.
- The Asia Foundation (TAF), 2012. A Guide to Government in Nepal: Structures, Functions and Practices. The Asia Foundation. Himal Kitab Pvt. Ltd., Kathmandu.
- Tucker, J., Daoud, M., Oates, N., Few, R., Conway, D., Mtisi, S., Matheson, S., 2015. Social vulnerability in three high-poverty climate change hot spots: what does the climate change literature tell us? *Reg. Environ. Change* 15 (5), 783–800.
- Turner-Walker, S., Anantasari, E., Retnowati, A., 2021. Integration into development: translating international frameworks into village-level adaptation. *Climate Change Research, Policy and Actions in Indonesia*. Springer, Cham, pp. 53–77.
- United Nations Framework Convention on Climate Change (UNFCCC) (2015) Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations.
- Vervoot, J.M., Thornton, P.K., Kristjanson, P., Förch, W., Ericksen, P.J., Kok, K., Ingram, J.S.I., Herrero, M., Palazzo, A., Helfgott, A.E.S., Wilkinson, A., Havlik, P., Mason-D'Croz, D., Jost, C., 2014. Challenges to scenario-guided adaptive action on food security under climate change. *Glob. Environ. Change* 28, 383–394.
- Watkiss, P., 2015. A Review of the Economics of Adaptation and Climate-resilient Development. Accessed at (<https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/09/Working-Paper-205-Watkiss.pdf>). Date of access June 19, 2021.
- Werners, S., Bhadwal, S., Pandey, A., Prakash, A., Wester, P., Mamnun, N., Hassan, T., Ishaq, S., Ahmad, B., Dahri, Z.H., 2018. Towards climate-resilient development pathways for the people in the Hindu Kush Himalayan region. HI-AWARE Working Paper 19, HI-AWARE, Kathmandu, Nepal.
- Werners, S.E., Wise, R.M., Butler, J.R., Totin, E., Vincent, K., 2021. Adaptation pathways: a review of approaches and a learning framework. *Environ. Sci. Policy* 116, 266–275.
- Wise, R.M., Fazey, I., Stafford Smith, M., Park, S.E., Eakin, H.C., Archer Van Garderen, E., R.M., Campbell, B., 2014. Reconceptualising adaptation to climate change as part of pathways of change and response. *Glob. Environ. Change* 28, 325–336.