https://doi.org/10.3126/banko.v32i1.45476 Banko Janakari, Vol 32 No. 1, 2022 Pp 41–51

A Strategy for involving community forest managers in effective forest fire management in Nepal

A. Parajuli[1]*, A. P. Gautam[2], S. P. Sharma[3], P. Lamichhane[4], G. Sharma[1] B. S. Bist[5], U. Aryal[6] and R. Basnet[7]

Received: 14, February 2022 Revised: 23, April 2022 Accepted: 20, May 2022 Published: 31, May 2022

Each year forest fire causes enormous damage to Nepal's forest ecosystems and landscape. For an active community involvement at the landscape level, policymakers must take the interests of local forest managers into account to increase social acceptability. This research explores the perception of community forest managers, who are constantly managing forests at the grassroots level, to understand the relationship between their priorities, needs, and attitudes toward forest fire management. Eighty–eight key informants from six districts were interviewed using a structured questionnaire. The questionnaire was divided into three major sections, (i) forest fuel management and infrastructure, (ii) forest fire management strategies and actions, and (iii) public education and awareness on forest fire management. The data were analyzed using the Kruskal–Wallis test, where the respondents rated above 4.2 out of 5 for activities like increase of insurance mechanisms, providing training for firefighting volunteer groups, and provisioning firefighting equipment. The majority of the respondents agreed on the activities under the forest fire management strategies and actions section (Kendall's Tau = 0.8501), followed by forest fuel management and infrastructure (Kendall's Tau= 0.6757). We anticipate that the results of this study will be helpful for the local decision–makers in involving different communities and identifying their priorities while implementing various forest fire management activities in diverse landscapes or provinces of the country.

Keywords: Adaptation measure, community forest, landscape, local participation, perception

Forest fire frequency is increasing globally, with significant incidents occurring in Asia (Vadrevu *et al.,* 2019; Zong *et al.,* 2020). Forest fire frequency is also growing at an alarming rate in Nepal, suggesting that the current management practices and methods are inadequate to address the risk (Parajuli *et al.*, 2020). The humans' role and support in fire management can be considered as the first anthropogenic instrument to address the risk in the fire–prone landscapes (Doerr & Santín, 2016; Santín & Doerr, 2016). Unlike in the case of other natural hazards, the concerned stakeholders can avoid or reduce the forest fire risk (Donovan & Brown, 2007).

Many factors determine public attitude towards the measures taken for addressing natural resource management issues, but a key element is the social acceptance of the practices (Shindler *et al.,* 2009). Identifying current problems and future needs can be an effective tool for prioritizing

1. Ministry of Forests and Environment, Hetauda, Bagmati Province, Nepal *E–mail:saracaindica07@gmail.com;
2. Kathmandu Forestry College, Kathmandu, Nepal,
3. Department of Forests and Soil Conservation, Kathmandu, Nepal
4. Forest Research and Training Center, Ministry of Forests and Environment, Kathmandu, Nepal
5. The School of Forestry and Natural Resource Management, Institute of Forestry, Kritipur, Nepal
6. Ministry of Industry, Tourism, Forests and Environment, Butwal, Lumbini Province, Nepal
7. Kaligandaki Polytechnic Institute, Tanahu, Nepal

forest fire management strategies and actions in different landscapes (Ghasemi *et al.,* 2020; Kouassi *et al.,* 2020; Palaiologou *et al.,* 2021; Raftoyannis *et al.,* 2014). For effective forest fire management, the active involvement of the local forest managers is a must (Tshering, 2006). Furthermore, incorporating local knowledge and practices in forest fire management planning is crucial for effective forest fire management (Schultz *et al.,* 2019).

The community forestry program, a participatory forest management program, was started in Nepal in 1978. Since then, numerous community forest user groups (CFUGs) are managing their forests independently in the technical support of the Department of Forests. CFUGs are also playing a vital role in forest fire management but mainly in traditional ways. Some CFUGs seem to have concrete ideas about fire occurrences, the role of fire lines, the history of fire occurrences, and the fuel loading that they are using to suppress forest fires (Kunwar & Khaling, 2006). However, not all CFUGs have the required knowledge and experience and several users have lost their lives while fighting forest fires (Bhujel *et al., 2*017). Insufficient understanding of suppression techniques, limited or no availability of firefighting equipment, communication, and awareness could be the major reasons behind such losses.

Terai Arc Landscape (TAL) and Chitwan Annapurna Landscape (CHAL) are the two major landscapes in Nepal that contain Asia's important biodiversity eco–region and a fire–prone landscape of the country (Parajuli *et al.,* 2020). In recent years, global climate change has been recognized as a significant driver of ecological change. Accordingly, Solomon *et al.,* (2007) have predicted a higher rate of warming and increase in precipitation for the Himalayas in Nepal, which is bound to affect the ecosystems of the country (Thapa *et al.,* 2015) and subsequently the livelihoods, lives, and economic investments in the Himalayas (Eriksson *et al.,* 2009). Such changes are likely to affect the biodiversity of these landscapes resulting in multiple threats. In addition, the increase in anthropogenic activities have played a significant role in altering the different natural landscape and these activities have affected the local people by having direct contact with the forest fire (Dlamini, 2009).

To date, studies carried out by (Matin *et al.,* 2017; Parajuli *et al.,* 2020; Qadir *et al.,* 2021) in Nepal have focused on identifying forest fire risk areas but no studies have been conducted at the country or regional level about the forest user's preferences for managing forest fire. Only providing information related to the risk of forest fire to the public might not help increase awareness or undertake actions (Kumagai *et al.,* 2004; Slovic, 1999). A recent study stated that both experience and perception of the effective mitigation measures can determine the risk perception and their intention while implementing the measures (Spano *et al.,* 2021). Documenting the perceptions of community forest managers will provide essential insights into the state of knowledge and practice on the adoption of different plans and strategies related to forest fire management (Williamson *et al.,* 2005). Therefore, to understand the relationship between knowledge, needs, and attitudes toward forest fire management, this paper attempts to explore the perception of community forest managers on forest fire management, focusing on the planning and outreach process and management outcomes at the landscape level. This study also attempts to identify different forest fire management activities that are mostly preferred by the local community forest managers by ranking the different activities that were provided to the respondents to increase social acceptability and ownership. By doing so, the study intends to build knowledge on forest fire suppression that will be helpful in reducing the costs and the ecological disasters (Kalabokidis *et al.,* 2008).

Materials and methods

Study area

Among the five identified landscapes in Nepal (MFSC, 2016), Terai Arc Landscape (TAL) and Chitwan–Annapurna Landscape (CHAL) are the major landscapes (Figure 1). The TAL is located in southern part of Nepal between longitude (80° 15′ E to 85° 49′ E) and latitude (27° 14′ N to 29° 08′ N) whereas the CHAL lies in central

part of the country between longitude (82° 88' E to 85° 80' E) to latitude (27° 35' N to 29° 03' N). TAL that represents Asia's one of the most crucial biodiversity eco–regions of the Terai Duar Savanna and Grassland was declared a transboundary conservation landscape in 2001 (Wikramanayake *et al.,* 2010). CHAL that includes four WWF Global 200 eco–regions was declared a conservation landscape in 1999 to maintain north–south ecological connectivity (MFSC, 2016). More than 75% of the forests of the lowland Terai and Churia fall within the TAL boundary. The main natural ecosystems of the CHAL are forests and grasslands, with more than 38% of the landscape under forest cover. It serves as a habitat for many endangered and threatened flora such as Satisal (*Dalbergia latifolia*) and Bijayasal (*Pterocarpus marsupium*) (MFSC, 2016) as well as fauna like tiger (*Panthera tigris tigris*), greater one–horned rhinoceros (*Rhinoceros unicornis*), swamp deer (*Cervus duvaucelii* , asian elephant (*Elephas maximus*), clouded leopard (*Neofelis nebulosa)*, snow leopard (*Panthera uncia*), red panda (*Ailurus fulgens*), musk deer (*Moschus leucogaster*) and many other less charismatic species *(Thapa et al.,* 2015). However, most of the forests are highly fragmented (WWF Nepal, 2017). The total population of these two landscape is over 12.5 million people who are heavily dependent upon forests and ecosystem services for their livelihoods and wellbeing (MFSC, 2016).

Data collection

The main objective of this study was to get broad insights into issues related to forest fire management in Nepal based on the opinions of local resource managers, who are constantly implementing activities at the grass–root level. Secondary sources were used to obtain data on fire incidents. Data on fire incidents from 2001 to 2019 were acquired from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) satellite (Giglio, 2010). The districts within the boundaries of two study landscapes

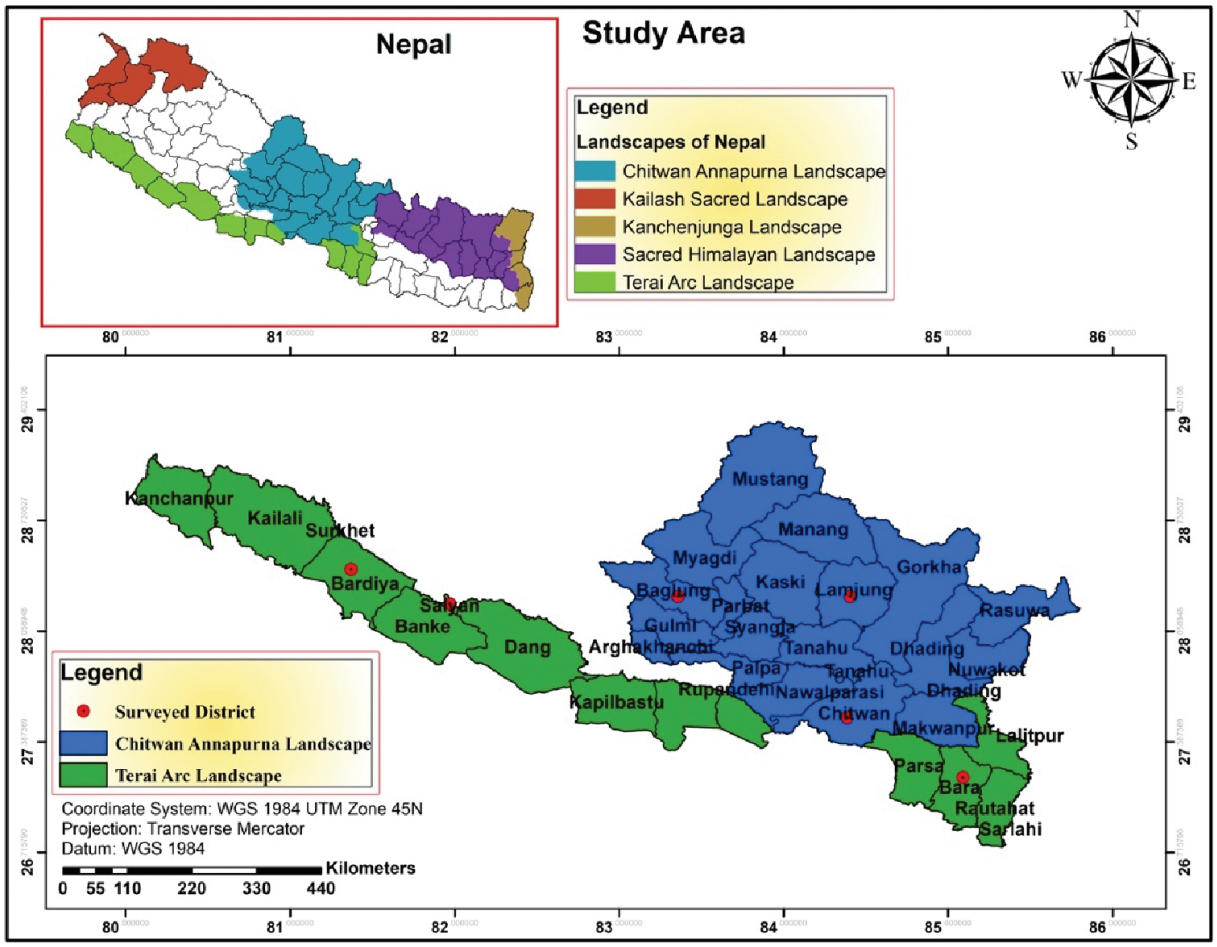

Figure 1. Map of the study area

were classified into high, medium, and low–risk districts according to the number of fire incidents of which, six districts two each from high, medium, and low fire risk districts were selected for the study i.e. Chitwan and Bardiya from the high–risk category, Bara and Lamjung from the medium–risk category, and Salyan and Baglung from the low–risk category as shown in Table 1.

Table 1 Selection of high medium and low–risk districts from the study district based on past fire records

T AL	Fire Counts	CHAL	Fire Counts
Bardiya	**3494**	**Chitwan**	**3333**
Kanchanpur	2799	Gorkha	1184
Parsa	2798	Dhading	840
Kailali	2577	Myagdi	711
Banke	2541	Tanahu	633
Dang	2480	**Lamjung**	**537**
Nawalparasi	1839	Rasuwa	364
Makwanpur	1465	Kaski	295
Kapilbastu	1137	Gulmi	263
Bara	**912**	Nuwakot	197
Rautahat	569	Syangja	195
Rupandehi	445	Manang	179
Palpa	221	Parbat	91
Arghakhanchi	83	**Baglung**	**84**
Salyan	**74**	Mustang	75

Eighty–eight key informants were sampled purposively based on their knowledge of forest fire management and awareness from the six study districts (Chitwan 10, Bardiya 18, Lamjung 17, Bara 13, Salyan 14, and Baglung 16). They were interviewed using a structured questionnaire. The structured questionnaire survey was carried out on those respondents who are in key positions (either president or secretary) of the community forest users committee assuming that the selected respondent has wider knowledge of their community forest and forest fire than other general forest users. There were 28 questions in the questionnaire, of which 16 questions were related to the following three major groups: (1) forest fuel management and infrastructure, (2) forest fire management strategy and actions, and (3) public education, coordination and awareness on forest fire management, and the rest were related to the general background of key–informants. Since the interviews were done face to face, the response rate was 100%. The majority of the key informants were males (73%) with agriculture as the primary occupation. The key informants were asked to rank the importance of each measure on a scale of 1 to 5, where 1=not important; 2=not so important; 3=important; 4=very important; 5=the most important.

Data analysis

We adopted the data analysis techniques used by Raftoyannis *et al.* (2014) for the data analysis. Keeping in mind the non–normal and heteroscedastic nature of the data, the Kruskal–Wallis test was used to identify the nature of homogeneity in the responses among different districts and three major groups as stated in the data collection section. Israel (2009) argues that this method does not need to fulfill the assumptions of normal distribution and interval data homogeneity of group variance and is one of the most powerful techniques comparable to ANOVA. This method was used to identify the differences in the responses of every measure of each three groups under each district assuming that community forest managers have different needs or priorities while mitigating or managing the forest fire. For example, the priority or need for certain measures under high–risk areas might differ in the low or medium–risk district. Therefore, each adoptive measure was analysed by comparing each risk district. The level of agreement between the district's responses to all three groups was also evaluated using Kendall's Tau coefficient of concordance.

Results

Kruskal–Wallis test was used to know the difference in acceptability between the three main groups. Most of the Kruskal–Wallis probability values are greater than 0.05 (Table 2) suggesting that there is no significant difference between the perceptions of the groups. Out of 16 measures, 5 measures mainly fire line development, reduction of fuels, identification of risk areas, insurance

mechanism for the firefighters and school–level knowledge were statistically significant. To know which districts are different from each other, Dunn's posthoc multiple comparison test was also conducted. For the fire line development, Bara–Bardiya and Lumjung–Bardiya had a difference in mean rank with the adjusted significance of 0.039 and 0.017 respectively. Similarly, in the insurance mechanism for firefighters, the mean ranks were different with Salyan–Chitwan, Salyan–Bardiya and Baglung–Bardiya. The remaining other three measures having statistically significant values had the major difference in the mean rank, especially between high risk and low or medium risk.

Table 2. District differences in the median ranks of each adaptive measure (normal rows) and a group of measures pooled together (rows in italic). A district with the same letter in a row indicates the significance. Higher mean ranks indicate the higher importance among different measures

Fire management measures	All districts pooled together	Median rank						Asymp. Sig	df	KW (H)
		TAL			CHAL					
		Bardiya	Bara	Salyan	Chitwan	Lamjung	Baglung			
(1) Forest fuel management and infrastructure										
Fireline development	**3.8**	4.2^{a}	3.5^{b}	3.6^{ab}	4.2^{a}	3.5^{c}	3.8^{bc}	0.0014	5	19.72
Fire Fighting Tools	**4.2**	4.3^{a}	4.1^{a}	4.4^{a}	4.2^{a}	4.0^{a}	4.4^{a}	0.4133	5	5.021
Control Burning	**3.8**	3.8^{b}	3.7^{b}	3.8^{b}	3.8^{b}	3.6^{b}	3.9^{b}	0.4983	5	4.364
Reduction of fuels	**3.8**	4.2^{a}	3.7^{bc}	3.6^{c}	4.3^{a}	3.6^{ab}	3.6^{b}	0.0114	5	14.76
Increase of fire fighting force	**4.4**	4.4^{ab}	4.2^{ab}	4.5^{ab}	4.6^{ab}	4.3^{ab}	4.4^{ab}	0.7563	5	2.633
Fire Fighter training	**3.9**	4.0^{b}	3.9^{b}	3.9^{b}	4.1^{b}	3.9^{b}	3.7^{b}	0.5013	5	4.342
Forest Fuel Management and Infrastructure Pooled	–	***4.1***	***3.9***	***4***	***4.2***	***3.8***	***4***			
(2) Forest fire management strategies and actions										
Identification of risk areas	**4**	4.4^{ab}	4.2^{b}	2.9^{c}	4.4^{ab}	4.1^{b}	3.9^{a}	0.0383	5	11.75
Improvement in information flow and warning system	**3.9**	3.7^{c}	3.9^{c}	4.0^{c}	4.0^{c}	3.9^{c}	3.8^{c}	0.8798	5	7.871
Insurance Mechanism for the firefighters	**4.5**	4.9^{b}	4.6^{b}	3.6^{a}	4.9^{b}	4.6^{b}	4.2^{b}	0.0002	5	24.69
Restriction of human activities in forests	**1.6**	1.5^{ab}	1.7^{ab}	1.6^{ab}	1.4^{ab}	1.7^{ab}	1.9^{ab}	0.6724	5	3.179
Improvement in law enforcement	**3.4**	3.7^{b}	3.2^{b}	3.1^{b}	3.7^{b}	3.4^{b}	3.2^{b}	0.1635	5	1.772
Forest Fire Management Strategies and Actions pooled	–	***3.6***	***3.5***	***3.1***	***3.7***	***3.5***	***3.4***			
(3) Public education and coordination on forest fire management										
Community Involvement in fire suppression	**4.1**	3.9^{a}	4.2^{a}	4.1^{a}	4.1^{a}	4.1^{a}	4^{a}	0.9358	5	1.291
Different forest fire awareness mechanism	**3.9**	4.2^{b}	3.8^{b}	3.7^{b}	4.2^{b}	3.8^{b}	3.9^{b}	0.1287	5	8.545
Stakeholder Involvement in Fire Fighting	**3.8**	3.6^{ab}	3.9^{ab}	3.9^{ab}	3.6^{ab}	3.9^{ab}	3.6^{ab}	0.677	5	3.149
Knowledge of fire fighting	**4**	3.9^{bc}	4.2^{bc}	4.1^{bc}	3.9^{bc}	4.1^{bc}	3.8^{bc}	0.46	5	4.651
School–level knowledge	**3.8**	4.4^{abc}	3.6^{ab}	3.5^{a}	4.5^{abc}	3.7^{b}	3.3^{ab}	0.0003	5	23.63
Public Education and Coordination on forest fire management pooled	–	***4***	***3.9***	***3.9***	***4.1***	***3.9***	***3.7***			

When the rating of the overall district was compared under the section of forest fuel management and infrastructure, high fire risk districts (Chitwan and Bardiya) have rated above 4 in all activities except control burning (3.8) compared to medium and low–risk districts. The topmost priority was given to the training of the fire fighting forces (4.4), followed by fire fighting forces (4.2). Public education and coordination were ranked as the subsequent essential following fuel management and infrastructure. As per se, commitment, collaboration, and coordination are highly required. Thus, from the survey, respondents emphasized community involvement in fire suppression (4.1) as the most crucial activity under this section, followed by knowledge of fire fighting (4.0). Activities like forest fire awareness, stakeholder involvement in fire fighting, and school–level knowledge were considered almost similar. In this study, forest users also agree uniformly that awareness and collaboration are required for the efficient performance of the strategy.

On the other hand, strategy and actions were found to be the least essential sections except for the activity of the insurance mechanism scheme. This section got the lowest rank because, the respondents were asked if there should be a restriction of human access inside the forest where most of the respondents do not want to restrict human access, with a mean answer of 1.6 among 5. Likewise, the lowest rating was also found in another question based on the improvement of law enforcement (3.4 out of 5).

Level of agreement between the respondents

The level of agreement or concordance between the district's responses to the different adaption measures within each of the three groups was evaluated by Kendall's Tau coefficient of concordance (Table 3). This method gives the level of agreement between the respondents or overall views on the perception of priorities among the respondents. Higher the level of coefficient of concordance, the higher is the level of agreement on the preferences of forest fire management measures.

Table 3. Level of agreement between the district responses. Pooled adaptation measure groups, Kendall's Tau and p–values are presented

Adaptation measures group (pooled)	Kendall's Tau	P–value
Forest Fuel Management and Infrastructure	0.6757	<0.01
Forest Fire Management Strategies and Actions	0.8501	<0.01
Public Education and Coordination on Forest Fire Management	0.2471	>0.05

The strongest agreement between district responses was found for forest fire management strategies and actions (Kendall's Tau = 0.8501, Table 3) as most of the rankings were similar for insurance mechanisms for firefighters, improvement in law enforcement, and restriction of human activities in forest (Table 2). Insurance mechanism was highly preferred by the respondents whereas improvement in law enforcement and restriction of human activities in the forest were felt unimportant. The second strongest agreement between district responses was found for forest fuel management and infrastructure (Kendall Tau = 0.6757, Table 3) as most of the rankings were similar for firefighting tools and infrastructure and fuel reductions mechanism (Table 2). The lowest agreement between district responses was found for public education and coordination (Kendall's Tau = 0.2471, Table 3) as the rankings varied in almost all of the characteristics (Table 2).

Discussion

Nepal is among the most vulnerable countries to climate change impacts. NARC (2010) predicted that because of climate change, events of natural disasters, including forest fires are likely to be increased in the coming years. This will cause a problem in the demand and supply of different climate services to the policymakers (Clar & Steurer, 2018). To effectively implement and involve local forest users in forest fire management, concerned official or decision–makers need to incorporate the existing knowledge of the local people, their perception

and risk in terms of forest fire and their opinions and interest in the best forest fire management measures should be incorporated. Shindler *et al.,* (2009) also stated that public acceptance of forest fire management activities can play a key role in the successful implementation of forest fire management strategies. Therefore, to reduce the knowledge gap in understanding the perception, needs and priorities of forest users' communities and increasing the social acceptability and local response to forest fire management activities, we studied different measures that have high social acceptability across two landscapes. Three major areas for discussion come from the result that is related to forest fuel management and infrastructure, forest fire management strategies and actions and public education and coordination on forest fire management.

Firstly, under the forest fuel management and infrastructure section, adoptive measures such as the increase in fire fighting force, firefighting tools and fire fighting training were ranked higher than the measures such as control burning, reduction of fuels and fire line development. The overall result indicates that local forest users focus on capacity development or infrastructure over forest fuel management. Ensuring simple yet effective forest fire suppressing equipment can prove to be less costly and more realistic if local people have some experience in managing forest fires (Appiah *et al.,* 2010). Moreno *et al.,* (2005) also argued that technological advancement improves the monitoring and warning systems in firefighting and reduces the fire detection and response time.

Under the same section, almost all of the measures were ranked as significantly important by both high–prone districts of the study areas, i.e., Chitwan and Bardiya. For example, both infrastructures and reduction of forest fuels were rated higher by both districts because they have been frequently experiencing the negative aspects of forest fires and other remaining districts have fewer forest fires. Low or medium–risk districts focused on fire fighting training and tools than forest fuel reduction. These findings are similar to those of Bright & Newman (2006) and Gordon *et al.,* (2018) who stated in their study that control or prescribed burning was strongly supported by the local people who experienced frequent or recent forest fires than that of low or no fire history. In line with this, Raftoyannis *et al.,* (2014) argued that the stakeholders of the high fire risk region are more aware of the importance of suppression measures, especially with the reduction of surface fuels and prescribed burning in the areas where large and frequent fires occurred.

The second measure that the respondents were asked to rank was the forest fire management strategies and section. Interestingly, we found a wide range of rankings where the respondents ranked the highest priority measure as the provision of insurance mechanism to the firefighters and the least preferred measure as restriction of human activities in forests among all the measures. The insurance mechanism got the highest ranking, having a mean of 4.5, making it the foremost priority of all the groups, including the other 16 activities. Both high and medium–risk districts showed primary concern about insurance mechanisms because of the direct threat to their life or physical loss while suppressing fire. Many researchers claim that the health and life insurance mechanism is vital for firefighters (Rubaca & Majid Khan, 2020; Varney *et al.,* 2020). In addition, Lee *et al.,* (2020) argue that there are chances to have around five cancer types where firefighting is involved. Most of the respondents across the landscape believed that if the insurance mechanism were provisioned, then the participation in the firefighting would be increased.

Restriction of human activities in forests under the same group received the least ranking (1.6 out of 5). Improvement in law enforcement was also ranked second least preferred measure by all most all of the respondents across the region suggesting that strong law and enforcement in this region will decrease the participation of local people in managing the forest fire. A similar result was obtained by Chhetri *et al.,* (2012) and the author explains the negative consequences of forest management when the law is enforced against local people's will. Raftoyannis *et al.,* (2014), likewise, also stated that although the human restrictions in the forest might be helpful to decrease the rate of forest fire incidents, there

would be other adverse effects on forest–related crimes, deforestation, and degradation. On the contrary, Yuliana *et al.,* (2021) in their study found that the majority of the respondents who had a high level of perception of forest fire were mostly supportive to introduce strict laws and regulation that prohibits forest fire.

Public education and coordination are also the major components of forest fire management. Encouraging stakeholders' involvement in fire management will help reduce the risk and forest fire suppression cause (Kalabokidis *et al.,* 2008). In this study, forest users also uniformly agree that awareness and collaboration are required for the efficient performance of the strategy. Under this group, community involvement in fire suppression and knowledge of fire fighting was both supported and considered effectively by the community forest managers. They believed fighting with fire needs knowledge because there have been numerous incidents in the past that took many lives for not having adequate knowledge, equipment and coordination (Bhujel *et al.,* 2017). Therefore, they ranked forest fire awareness measure as the third most important measure. If the awareness is increased in the landscape, it will have a higher level of agreement among the stakeholders (Karki, 2002) and implementation of different other measures will be easier. For example, awareness of social networks and institutions and wise decision–making can be effective for the implementation of a long–term forest fire management plan (Gordon *et al.,* 2018).

Conclusion

To increase effective participation of local people in the forest fire management sector, it is essential to understand the opinion of those forest users on the risk management. Therefore, this study highlighted the perception of community forest managers on the preferences of different forest fire management measures in order to gain wider social acceptability. The respondents were asked to rank on three main themes i.e., forest fuel management and infrastructure, forest fire management strategies and actions, and public education and coordination on forest fire management. The study found an increased concern in implementing forest fire risk management measures such as insurance mechanisms, increase of the fire fighting force, and fire fighting tools. This study could be helpful to local and regional planners for increasing public participation and social acceptability for effective implementation of forest fire management plan.

References

Appiah, M., Damnyag, L., Blay, D., & Pappinen, A. (2010). Forest and agroecosystem fire management in Ghana. *Mitigation and Adaptation Strategies for Global Change*, *15*(6), 551–570. https://doi.org/10.1007/s11027–010–9236–z

Bhujel, K. B., Maskey–Byanju, R., & Gautam, A. P. (2017). Wildfire Dynamics in Nepal from 2000–2016. *Nepal Journal of Environmental Science*, *5*, 1–8. https://doi.org/10.3126/njes.v5i0.22709

Bright, A. D., & Newman, P. (2006). How forest context influences the acceptability of prescribed burning and mechanical thinning. *The Public and Wildland Fire Management: Social Science Findings for Managers. GTR NRS–1. United States Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN*, 47–52.

Chhetri, B. B. K., Larsen, H. O., & Smith–Hall, C. (2012). Law Enforcement in Community Forestry: Consequences for the Poor. *Small–Scale Forestry*, *11*(4), 435–452. https://doi.org/10.1007/s11842–011–9194–7

Clar, C., & Steurer, R. (2018). Why popular support tools on climate change adaptation have difficulties in reaching local policy–makers: Qualitative insights from the UK and Germany. *Environmental Policy and Governance*, *28*(3), 172–182. https://doi.org/10.1002/eet.1802

Dlamini, W. M. (2009). Characterization of the July 2007 Swaziland fire disaster using

satellite remote sensing and GIS. *Applied Geography*, *29*(3), 299–307. https://doi.org/10.1016/j.apgeog.2008.10.007

Doerr, S. H., & Santín, C. (2016). Global trends in wildfire and its impacts: perceptions versus realities in a changing world. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150345. https://doi.org/10.1098/rstb.2015.0345

Donovan, G. H., & Brown, T. C. (2007). Be careful what you wish for: the legacy of Smokey Bear. *Frontiers in Ecology and the Environment*, *5*(2), 73–79.

Eriksson, M., Xu, J., Shrestha, A., Vaidya, R., Nepal, S., & Sandström, K. (2009). *The Changing Himalayas: Impact of Climate Change on Water Resources and Livelihoods in the Greater Himalayas*. ICIMOD.

Ghasemi, B., Kyle, G. T., & Absher, J. D. (2020). An examination of the social–psychological drivers of homeowner wildfire mitigation. *Journal of Environmental Psychology*, *70*, 101442. https://doi.org/10.1016/j.jenvp.2020.101442

Giglio, L., Justice, C., Boschetti, L., & Roy, D. (2015). MCD64A1 MODIS/Terra+ aqua burned area monthly L3 global 500m SIN grid V006 [data set]. *NASA EOSDIS Land Processes DAAC: Sioux Falls, SD, USA*.

Gordon, J., Willcox, A., Luloff, A. E., Finley, J. C., & Hodges, D. G. (2018). *Public perceptions of values associated with wildfire protection at the wildland–urban interface: A synthesis of national findings*. Intech Open Publishing, London, UK.

Israel, D. (2009). *Data analysis in business research: A step–by–step nonparametric approach*. Sage Publications.

Kalabokidis, K., Iosifides, T., Henderson, M., & Morehouse, B. (2008). Wildfire policy and use of science in the context of a socio–ecological system on the Aegean Archipelago. *Environmental Science & Policy*, *11*(5), 408–421. https://doi.org/10.1016/j.envsci.2008.01.006

Karki, S. (2002). *Community involvement in and management of forest fires in South East Asia*. Citeseer.

Kouassi, J.–L., Wandan, N., & Mbow, C. (2020). Exploring Wildfire Occurrence: Local Farmers' Perceptions and Adaptation Strategies in Central Côte d'Ivoire, West Africa. *Journal of Sustainable Forestry*, 1–20. https://doi.org/10.1080/10549811.2020.1845744

Kumagai, Y., Bliss, J. C., Daniels, S. E., & Carroll, M. S. (2004). Research on Causal Attribution of Wildfire: An Exploratory Multiple–Methods Approach. *Society & Natural Resources*, *17*(2), 113–127. https://doi.org/10.1080/08941920490261249

Kunwar, R. M., & Khaling, S. (2006). Forest fire in the Terai, Nepal: causes and community management interventions. *International Forest Fire News*, *34*, 46–54. https://gfmc.online/wp–content/uploads/06–IFFN–34–Nepal–2–3.pdf

Lee, D. J., Koru Sengul, T., Hernandez, M. N., Caban Martinez, A. J., McClure, L. A., Mackinnon, J. A., & Kobetz, E. N. (2020). Cancer risk among career male and female Florida firefighters: Evidence from the Florida Firefighter Cancer Registry (1981-2014). *American Journal of Industrial Medicine*, *63*(4), 285–299. https://doi.org/10.1002/ajim.23086

Matin, M. A., Chitale, V. S., Murthy, M. S. R., Uddin, K., Bajracharya, B., & Pradhan, S. (2017). Understanding forest fire patterns and risk in Nepal using remote sensing, geographic information system and historical fire data. *International Journal of Wildland Fire*, *26*(4), 276. https://doi.org/10.1071/WF16056

MFSC (2016). *Conservation Landscapes of Nepal*, Ministry of Forests and Soil Conservation,Kathmandu,Nepal.

Moreno, J. M., Aguiló, E., Alonso, S., Cobelas, M. Á., Anadón, R., & Ballester, F. (2005). A preliminary assessment of the impacts in Spain due to the effects of climate change. In *Madrid, SP: Ministerio del Medio Ambiente*.

NARC. (2010). Meeting Nepal's Food and Nutrition Security Goals through Agricultural Science and Technology: NARC's Strategic Vision for Agricultural Research, Kathamndu: Nepal Agricultural Research Council.

Palaiologou, P., Kalabokidis, K., Troumbis, A., Day, M. A., Nielsen–Pincus, M., & Ager, A. A. (2021). Socio–Ecological Perceptions of Wildfire Management and Effects in Greece. *Fire*, *4*(2), 18. https://doi.org/10.3390/fire4020018

Parajuli, A., Chand, D. B., Rayamajhi, B., Khanal, R., Baral, S., Malla, Y., & Poudel, S. (2015). Spatial and temporal distribution of forest fires in Nepal. *XIV World Forestry Congress, Durban, South Africa*, 7–11.

Parajuli, A., Gautam, A. P., Sharma, S. P., Bhujel, K. B., Sharma, G., Thapa, P. B., Bist, B. S., & Poudel, S. (2020). Forest fire risk mapping using GIS and remote sensing in two major landscapes of Nepal. *Geomatics, Natural Hazards and Risk*, *11*(1), 2569–2586.

Qadir, A., Talukdar, N. R., Uddin, M. M., Ahmad, F., & Goparaju, L. (2021). Predicting forest fire using multispectral satellite measurements in Nepal. *Remote Sensing Applications: Society and Environment*, *23*(March), 100539. https://doi.org/10.1016/j.rsase.2021.100539

Raftoyannis, Y., Nocentini, S., Marchi, E., Calama Sainz, R., Garcia Guemes, C., Pilas, I., Peric, S., Amaral Paulo, J., Moreira–Marcelino Ana, C., Costa–Ferreira, M., Kakouris, E., & Lindner, M. (2014). Perceptions of forest experts on climate change and fire management in European Mediterranean forests. *IForest – Biogeosciences and Forestry*, *7*(1), 33–41. https://doi.org/10.3832/ifor0817–006

Rubaca, U., & Majid Khan, M. (2020). The impact of perceived organizational support and job resourcefulness on supervisor rated contextual performance of firefighters: Mediating role of job satisfaction. *Journal of Contingencies and Crisis Management*, 1468–5973.12340. https://doi.org/10.1111/1468–5973.12340

Santín, C., & Doerr, S. H. (2016). Fire effects on soils: the human dimension. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150171. https://doi.org/10.1098/rstb.2015.0171

Schultz, C. A., Thompson, M. P., & McCaffrey, S. M. (2019). Forest Service fire management and the elusiveness of change. *Fire Ecology*, *15*(1), 13. https://doi.org/10.1186/s42408–019–0028–x

Shindler, B. A., Toman, E., & McCaffrey, S. M. (2009). Public perspectives of fire, fuels and the Forest Service in the Great Lakes Region: a survey of citizen – agency communication and trust. *International Journal of Wildland Fire*, *18*(2), 157. https://doi.org/10.1071/WF07135

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk–assessment battlefield. *Risk Analysis*, *19*(4), 689–701. https://chicagounbound.uchicago.edu/uclf/vol1997/iss1/4

Solomon, S., Manning, M., Marquis, M., & Qin, D. (2007). *Climate change 2007–the physical science basis: Working group I contribution to the fourth assessment report of the IPCC* (Vol. 4). Cambridge university press.

Spano, G., Elia, M., Cappelluti, O., Colangelo, G., Giannico, V., D'Este, M., Lafortezza, R., & Sanesi, G. (2021). Is Experience the Best Teacher? Knowledge, Perceptions, and Awareness of Wildfire Risk. *International Journal of Environmental Research and Public Health*, *18*(16), 8385. https://doi.org/10.3390/ijerph18168385

Thapa, G. J., Wikramanayake, E., & Forrest, J. (2015). Climate–change impacts on the biodiversity of the Terai Arc Landscape and the Chitwan–Annapurna Landscape. *Hariyo Ban, WWF Nepal, Kathmandu, Nepal*.

Tshering, K. (2006). *Development of an effective forest fire management strategy for Bhutan*. https://scholarworks.umt.edu/etd/2049?utm_source=scholarworks.umt.edu%2Fetd%2F2049&utm_medium=PDF&utm_campaign=PDFCoverPages

Vadrevu, K. P., Lasko, K., Giglio, L., Schroeder, W., Biswas, S., & Justice, C. (2019). Trends in Vegetation fires in South and Southeast Asian Countries. *Scientific Reports*, *9*(1), 7422. https://doi.org/10.1038/s41598–019–43940–x

Varney, J., Murry, K., & Humphrey, N. (2020). Putting Our First Responders First: A Call for Health Insurance in Retirement for Palm Beach Gardens Fire Rescue. *International Journal of Medical Students*. https://doi.org/10.5195/ijms.2020.710

Wikramanayake, E., Manandhar, A., Bajimaya, S., Nepal, S., Thapa, G., & Thapa, K. (2010). The Terai Arc Landscape. In *Tigers of the World* (pp. 163–173). Elsevier. https://doi.org/10.1016/B978–0–8155–1570–8.00010–4

Williamson, T. B., Parkins, J. R., & McFarlane, B. L. (2005). Perceptions of climate change risk to forest ecosystems and forest–based communities. *Forestry Chronicle*, *81*(5), 710–716. https://doi.org/10.5558/tfc81710–5

WWF Nepal (2017). Biodiversity, People and Climate Change: Final Technical Report of the Hariyo Ban Program, First Phase. *WWF Nepal, Hariyo Ban Program, Kathmandu, Nepal*.

Yuliana, N., Supriatna, J., & Winarni, N. L. (2021). Community perceptions and conceptions of the impact of forest and land fires in Bengkalis Regency, Riau Province. *IOP Conference Series: Earth and Environmental Science*, *886*(1), 012102. https://doi.org/10.1088/1755–1315/886/1/012102

Zong, X., Tian, X., & Yin, Y. (2020). Impacts of Climate Change on Wildfires in Central Asia. In *Forests* (Vol. 11, Issue 8). https://doi.org/10.3390/f11080802