

IN THE LINE OF FLOODS: RANGERS AS FIRST RESPONDERS TO AN EXTREME WEATHER EVENT IN PAKISTAN

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ABSTRACT

Rangers play a vital role in biodiversity conservation, but their critical contribution as first responders in natural disasters has been overlooked. We assess the essential role played by rangers as first responders during the 2022 extreme flooding events in Pakistan, and evaluate their vulnerabilities in responding. Our study involved structured interviews and focus group discussions with 194 rangers in seven flood-affected districts along the Indus River in Pakistan. All surveyed rangers reported increased intensities of extreme weather events and that they were negatively affected by floods. Flooding disrupted their regular duties and caused personal losses, including damage to homes, agricultural lands and other possessions. Despite this, rangers participated in emergency relief efforts, supporting affected communities, rescuing livestock, aiding in evacuations, and distributing food to local communities. Our study highlights the role played by rangers in Pakistan as first responders, and underscores how rangers around the world, particularly in resource-constrained environments, should be acknowledged and supported as planetary health workers. Future research should evaluate ranger roles and vulnerabilities to other climate change-induced extreme weather events across ecosystems, providing insights to inform policy development, support mechanisms, and global recognition of the ranger profession.

Keywords: protected and conserved areas, working conditions, planetary health workers, disaster risk reduction, emergency response

INTRODUCTION

Rangers, referred to by various titles across contexts, are defined by the International Ranger Federation (IRF) as frontline professionals who play a critical role in biodiversity conservation, safeguarding nature, cultural and historical heritage, and protecting the rights and well-being of present and future generations (Galliers et al., 2022; International Ranger Federation, 2018, 2019a, 2019b, 2021).

They comprise a highly diverse group, including government staff, volunteers, members of local communities, and Indigenous peoples (International Ranger Federation, 2019c). Rangers assume a wide range of responsibilities, including visitor management, environmental education, community engagement,

managing environmental risks, and providing aid during natural disasters (Violanti et al., 2017).

A frequently overlooked role of rangers is their work as first responders during extreme weather events such as floods and cyclones, and in preventing and responding to pandemics (Gunn et al., 2021; Singh, Galliers, Moreto, et al., 2021; Stolton et al., 2023). While the roles of emergency medical personnel, firefighters and law enforcement officers in disaster response have been relatively well-documented (Perry, 2004; Violanti et al., 2017), the contributions and vulnerabilities of rangers remain largely overlooked despite their frontline presence in climate-induced crises.

Rangers often lead preparedness efforts, guide evacuations, and play key roles in post-disaster damage



Ranger working with communities in flood-affected districts of South Punjab © Janan Sindhu/WWF-Pakistan

assessment, recovery, and environmental mitigation. During Cyclone Idai in Mozambique in 2019, rangers from Gorongosa National Park worked tirelessly to support affected communities, offering critical medical aid, food and shelter to those in need (African Parks, 2019). During the 2020 California wildfires, park rangers assisted with evacuations, providing vital guidance to residents and visitors, while closely collaborating with firefighting agencies (Wong et al., 2021).

In their role as first responders, rangers often work under challenging conditions with limited resources. The Ranger Line of Duty Death (RLODD) database, compiled by the International Ranger Federation (IRF), shows an alarming upward trend, with 1,535 ranger casualties recorded from 2006 to 2021 (Galliers et al., 2022; International Ranger Federation, 2018, 2019a, 2019b, 2021). While many of these deaths are linked to homicides and fatal wildlife encounters, a significant proportion, such as those resulting from drowning and firefighting (10.2 per cent) and work-related illnesses (12 per cent), reflects the growing exposure of rangers to extreme weather events and associated hazardous working conditions (Galliers et al., 2022).

This increasing exposure to climate-related hazards was clearly demonstrated during the 2022 floods in Pakistan which disproportionately impacted southern provinces (Nanditha et al., 2023; Wang et al., 2024) affecting 33 million individuals and leading to nearly 8 million displacements. The floods claimed over 1,700

lives and led to 94 districts being declared ‘calamity-hit’ (Nanditha et al., 2023; Waseem and Rana, 2023). Rangers operating in these regions played a key role in supporting both conservation management and humanitarian response. We refer to vulnerabilities as conditions such as limited institutional support, hazardous environments, risk of disease and injury, equipment damage and loss, and lack of access to insurance and management plans, while challenges refer to the operational and situational difficulties.

Our study aimed to provide baseline data on the contributions by rangers in managing a humanitarian catastrophe of the magnitude experienced in Pakistan, and vulnerabilities and challenges faced by rangers working in regions severely affected by these floods. The term ‘ranger’ is not consistently defined across wildlife, forest and fisheries departments involved in biodiversity protection in Pakistan. It is often used to refer only to specific job titles, which creates ambiguity about who qualifies under this category. Therefore, for the purpose of this study, we adopted a broad definition aligned with the IRF’s definition, encompassing all frontline personnel engaged in biodiversity conservation. Our research employs a holistic approach to evaluate the extent of exposure, and the current adaptive capacity of rangers and their employers in mitigating natural disasters in Pakistan and globally. Additionally, the study examines how the role of rangers has expanded to include first response responsibilities, despite these duties often falling outside their official mandates.

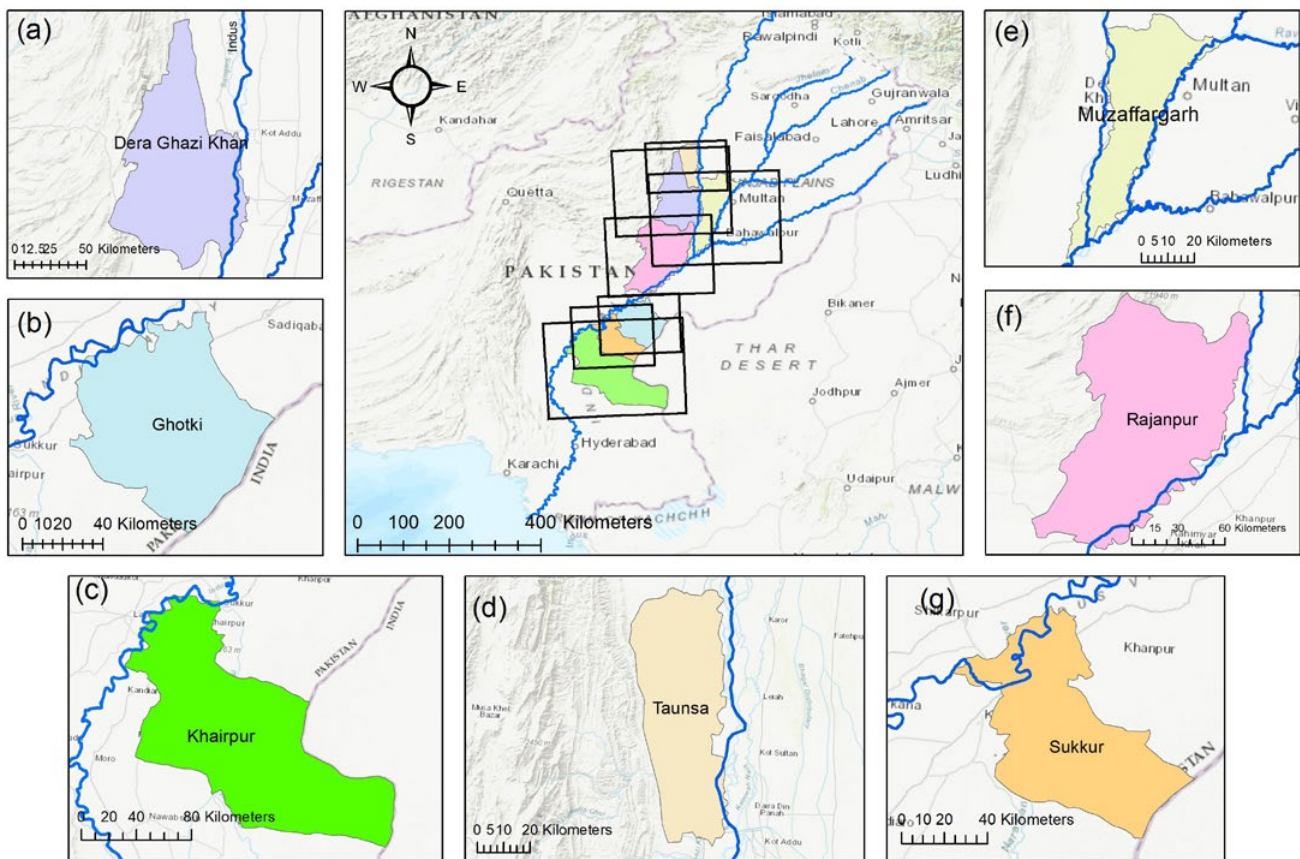


Figure 1. Study area map (centre) showing location of the study sites along the Indus River in Pakistan; and individual maps of each site (a) Dera Ghazi Khan; (b) Ghotki; (c) Khairpur; (d) Taunsa; (e) Muzaffargarh; (f) Rajanpur; (g) Sukkur in Sindh and Punjab; Central map highlights the proximity.

METHODS

Study area

The study area included seven adversely flood-affected districts in southern Pakistan along the Indus River: Khairpur, Taunsa, Sukkur, Rajanpur, Ghotki, Dera Ghazi Khan, and Muzaffargarh (Figure 1) (UN-OCHA, 2023).

Data collection

We used questionnaire-based interviews and focus group discussions (FGDs) with both closed- and open-ended questions. The questionnaire addressed specific aspects such as ranger roles, vulnerabilities, job-related and personal challenges, and current adaptive capacity that rangers possess in response to natural disasters like floods (Figure 2). The questions were developed by WWF in collaboration with subject experts and rangers. The questionnaire was endorsed by the Bio-Ethical Committee of the College of Earth and Environmental Sciences, University of the Punjab, Pakistan. The questionnaires and informed consent forms were translated into Urdu and Sindhi languages.

Data collection approach

We used a mixed-method approach involving FGDs and interviews with rangers from the wildlife, forest and fisheries departments in flood-affected districts. The data were compiled in Microsoft Excel and analysed using SPSS-Software and ARCGIS. Satellite information was derived from Landsat time series datasets (July–September 2022) with a spatial resolution of 30 m to determine the extent and severity of flooding across districts. The satellite images were downloaded from the United States Geological Survey (USGS) (<https://earthexplorer.usgs.gov/>).

A GIS-based vulnerability assessment was conducted integrating selected variables from FGDs/interviews together with flood data. The Analytical Hierarchical Process method (Fernandez et al., 2022) was applied to normalise the assigned weights of thematic layers by taking the cumulative sum of highest percentile values with corresponding assigned weights. Vulnerability-index (VI) values were divided into classes from high vulnerability to low vulnerability. The values were assigned based on published data and expert input informed by ranger responses. Table 1 presents the weight values for parameters selected for their relevance to flood impacts.

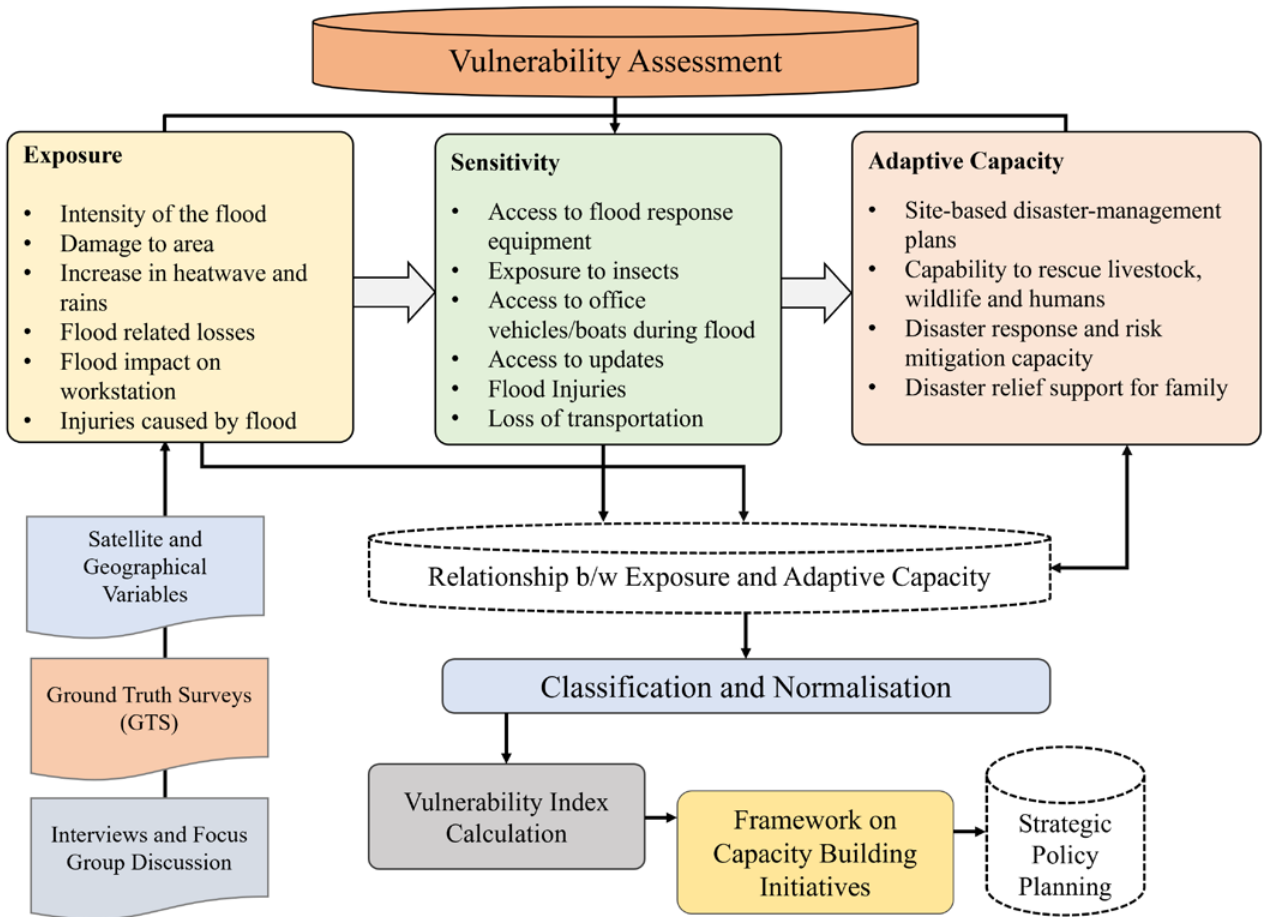


Figure 2. A schematic diagram indicating the flow of various research components for flood impacts and vulnerability assessment in rangers across the seven flood-affected districts of Pakistan.



Children from families displaced by floods in Sukkur, Pakistan © WWF-Pakistan

Table 1. Weighted averages of the scores assigned to each different variables/response

Score	Importance
1	Equally important
2	Moderately important
3	Strongly important

For the vulnerability assessment, cumulative scores were calculated using the highest percentile values and their corresponding weights. The resulting Vulnerability Index (VI) values were then categorised as follows: very low to low ($0 \leq VI < 0.3$), medium ($0.3 \leq VI < 0.6$) and high to very high ($0.6 \leq VI < 1$).

$$VI = I_1 W_1 + I_2 W_2 + I_3 W_3 + I_4 W_4 + I_5 W_5 + I_6 W_6 + I_7 W_7 + \dots + I_n W_n \quad \text{Eq.1}$$

As shown in Equation 1, the Vulnerability Index (VI) is calculated as a weighted sum of indicator values ($I_1, I_2, I_3, \dots, I_n$) and their corresponding weights ($W_1, W_2, W_3, \dots, W_n$), with Table 2 presenting the categorized indicators, their relationship to sensitivity and adaptive capacity, and their directional influence on vulnerability (\uparrow/\downarrow).



Ranger working with communities in flood-affected districts of South Punjab © Janan Sindhu/WWF-Pakistan

Table 2. Spatial temporal exposure indicators used for vulnerability assessment

Index	Indicators	Relationship
Exposure	Increased floods-intensity	Vulnerability \uparrow Indicator \uparrow
	frequency of extreme-weather events	Vulnerability \uparrow Indicator \uparrow
	Flood-extent	Vulnerability \uparrow Indicator \uparrow
	Flood-impacting ranger-workstation	Vulnerability \uparrow Indicator \uparrow
	Ranger-injuries	Vulnerability \uparrow Indicator \uparrow
	% rangers residing within flood-affected-zone	Vulnerability \uparrow Indicator \uparrow
Sensitivity	% rangers low accessibility to flood-response-equipment	Vulnerability \uparrow Indicator \uparrow
	% increase in poisonous-insect-bites	Vulnerability \uparrow Indicator \uparrow
	% rangers with access to vehicles/boats during flood	Vulnerability \uparrow % contribution in decision \downarrow
	% of rangers with access flood early-warning information	Vulnerability Indicator
	% of rangers facing (Water, Sanitation, and Hygiene) WASH-borne diseases	Vulnerability \uparrow Indicator \uparrow
	Vulnerability to job loss due to budget cuts	Vulnerability \uparrow Indicator \uparrow
	% of rangers experiencing a loss of transportation modes and access to the main road	Vulnerability \uparrow Indicator \uparrow
Adaptive Capacity	Rescue capacity during floods	Vulnerability \downarrow % rangers adaptive-capacity \uparrow
	Site-based disaster-management plans	Vulnerability \downarrow % adaptive-capacity additional responsibilities \uparrow
	Capability to rescue (livestock, wildlife and humans)	Vulnerability \downarrow % rescue livestock capability \uparrow
	Access to food, water, and blankets for disaster-displaced individuals	Vulnerability \downarrow % of additional responsibilities \uparrow
	Access to disaster relief support for family	Vulnerability \downarrow % of additional responsibilities \uparrow

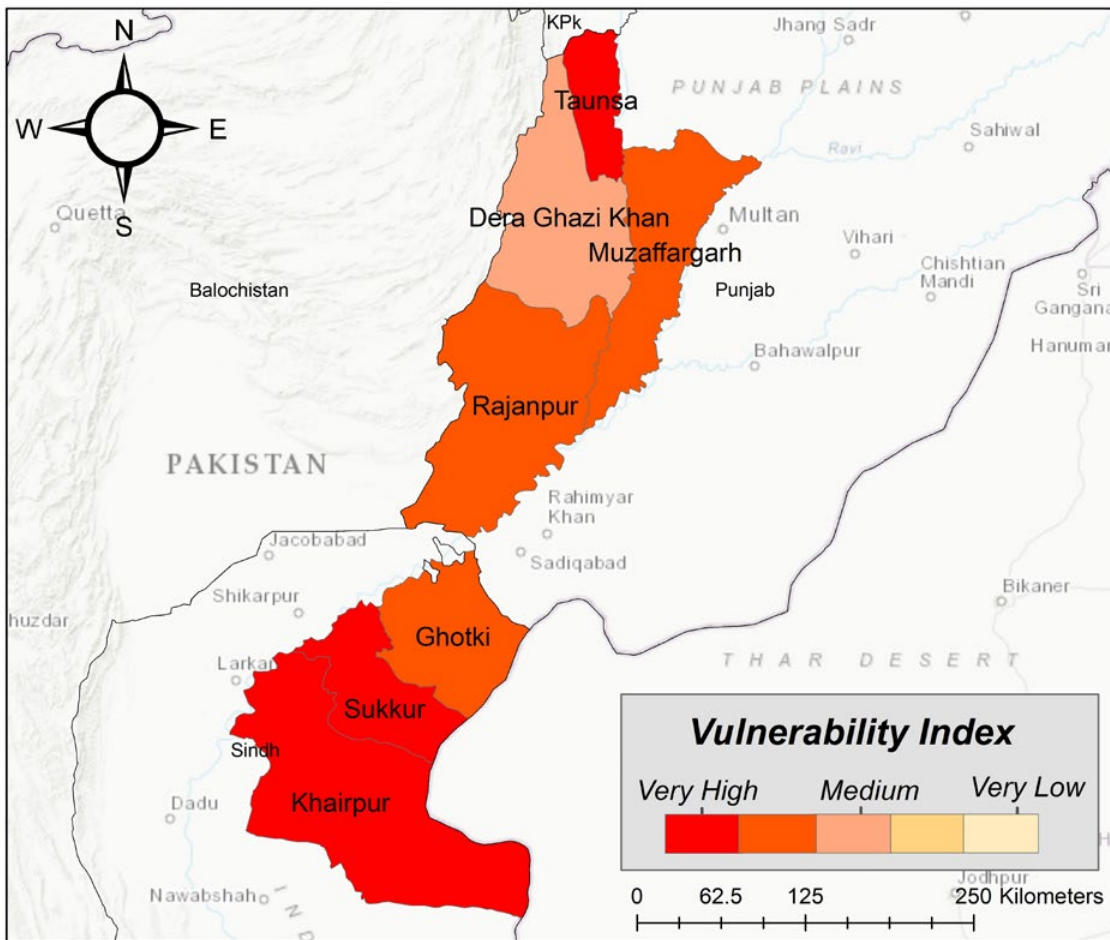


Figure 3. Vulnerability Index of the district indicates that six out of seven districts fall within the 'Very High' to 'High' Vulnerability range for rangers.

RESULTS

Geographic context and site-level Exposure

We interviewed 194 rangers across seven flood-affected districts of southern Pakistan, spanning Punjab and Sindh provinces along the Indus River. These included Khairpur, Taunsa, Sukkur, Rajanpur, Ghotki, Dera Ghazi Khan and Muzaffargarh, most of which experienced very high levels of flooding. The vulnerability assessment, based on sensitivity, exposure to floods and extreme weather events, and adaptive capacity, showed that six of the seven assessed districts were classified as having high to very high vulnerability, while only one site, Dera Ghazi Khan, was rated as moderately vulnerable (Figure 3).

The responses of rangers indicated that all sites across the seven districts were affected by the floods (100 per cent). According to the respondents, 65.5 per cent of sites were heavily impacted by the floods, 24.7 per cent experienced a medium level of flooding, and 9.8 per cent experienced partial flooding. Rangers were in agreement across all sites that the intensity of extreme weather events has increased manyfold in the past two to three years.

Demographic characteristics and experience of rangers

Respondent ages ranged from 22 to 58 years; all were men, as no women field rangers were working in the target sites. The rangers had a range of experience, spanning from 8 months to 39 years. All the respondents were based in the field and held various roles including wildlife watchers, field assistants, forest guards, game inspectors and wildlife inspectors, among others. On average, rangers spent four days per week in the field. The majority of rangers (99.6 per cent) included in the study were from the same areas where they were working, living with their families in nearby villages; 88.7 per cent had children.

Impact of floods on rangers: Work stations and operations

Ranger workstations were impacted by floods, with the level of damage varying from intense to none. A total of 32 per cent of rangers experienced complete damage to their workstations, 46.4 per cent faced partial damage, and the remaining 21.6 per cent did not face any damage. In addition to infrastructure loss, 56.3 per cent of rangers lost either one or multiple essential items of equipment

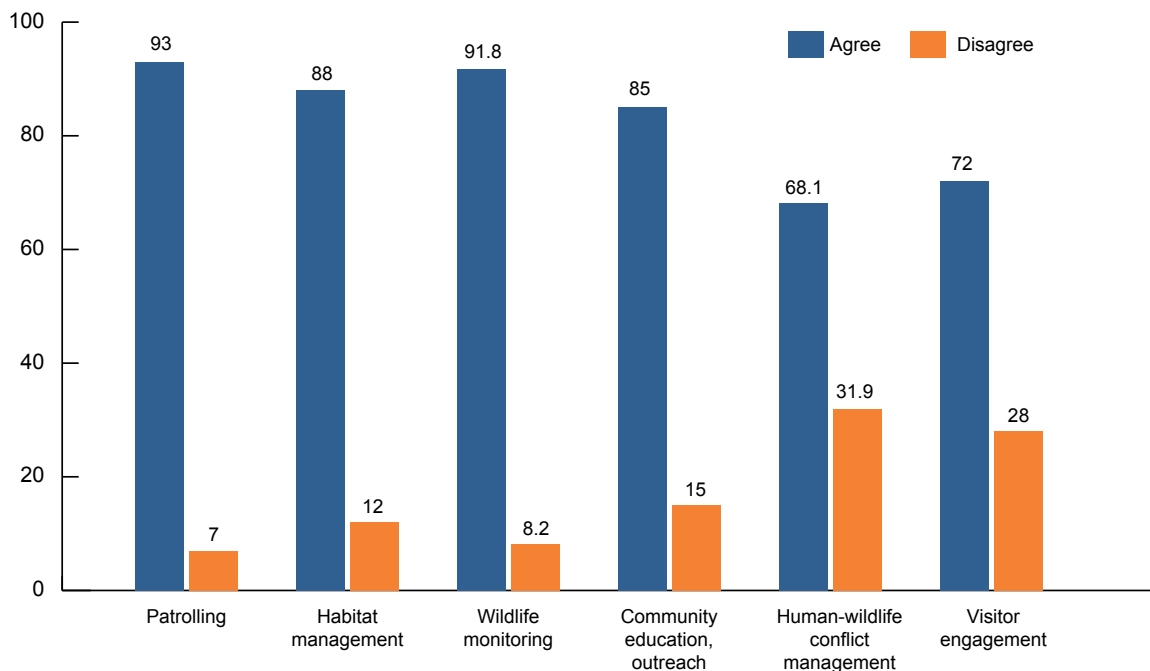


Figure 4. Percentage of rangers who agreed or disagreed that the flood has impacted various aspects of their work including patrolling, habitat management, wildlife monitoring, human–wildlife conflict management, and visitor engagement.

including motorbikes, bicycles, GPS devices, mobile phones, cameras, office furniture and generators. The floods caused physical injuries; 21.6 per cent rangers reported that either they or their colleagues were injured during the floods.

The rangers unanimously agreed that the floods significantly impacted their regular activities, including patrolling (93 per cent), habitat management (88 per cent), wildlife monitoring (91.8 per cent), human–wildlife conflict management (68.1 per cent) and visitor engagement (72 per cent). Limited engagement with visitors was attributed to the decline in visitor numbers post-flood, as access to the sites was very limited due to the floods. Despite this, the rangers highlighted that they made their best efforts to perform their duties (Figure 4).

Impact of floods on rangers: Personal losses and family challenges

At a personal level, the floods inflicted a distinct set of challenges upon the rangers, leaving them vulnerable to the impacts of natural disasters. The responses indicated that 76.8 per cent of rangers reported that floods directly affected their homes, towns and villages. The extent of the floods' impact on various aspects of the rangers' lives was substantial: 65 per cent reported the loss of personal property, 57.7 per cent experienced the loss of agricultural land, and 62.4 per cent endured damage to their homes. Additionally, 42 per cent of rangers experienced damage to their personally owned motorbikes and bicycles, which were essential for daily

transportation and mobility within their communities. These personal losses were particularly severe because the vast majority of rangers (99.6 per cent) lived with their families in the same flood-affected areas where they worked, making them directly vulnerable to the disaster's impacts at both the personal and professional level.

Approximately 64.9 per cent of rangers reported that their children were unable to attend school after the flood due to damage to educational facilities. Moreover, 47 per cent had limited or no access to healthcare facilities, while 45.4 per cent of rangers and their families suffered from outbreaks of diseases in the aftermath of the flood event. Although the rangers were government employees, there was no system to compensate them for personal or work-related losses, such as injuries or damaged equipment.

Rangers as first responders

Rangers across all sites were actively working during the floods. A majority, comprising 72.7 per cent of the rangers interviewed, were involved in additional tasks assigned to them by their management. These additional responsibilities included providing emergency relief support, such as food and water, to the flood-affected communities (68 per cent), rescuing livestock and other animals displaced by the floods (25 per cent), and assisting in community evacuation efforts (32.5 per cent). A small proportion of rangers were involved in the distribution of financial support to the flood affected communities (12.4 per cent). Although this kind

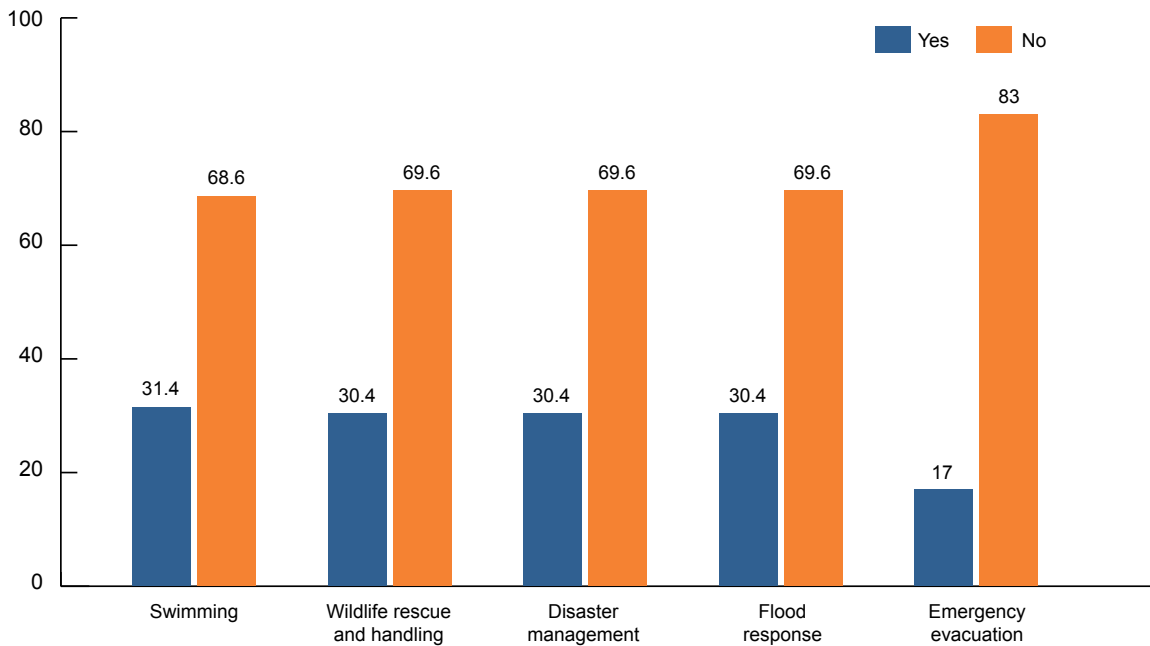


Figure 5. Percentage of rangers who received formal training in key disaster response and management aspects.

of support is not part of their official job descriptions, rangers across all sites were assigned flood response duties and played a vital role in assisting affected communities during the crisis.

Existing adaptive capacity of rangers to respond to floods and natural disasters

A high proportion of rangers, 66.5 per cent, expressed a sense of insecurity while carrying out their duties during floods. When questioned about the existence of disaster management plans within their sites, 68.7 per cent acknowledged the absence of a disaster management and response plan, 18 per cent believed that their site was equipped with such a plan, and 13 per cent were either uncertain or unaware of the concept of a disaster management plan. Additionally, even amidst the challenging flood conditions and restricted mobility due to submerged roads, 68.6 per cent of rangers were not provided with supplementary vehicles or boats to facilitate their operations.

A majority of rangers (73.2 per cent) were without official communication devices like mobile phones or walkie-talkies, which hindered their access to crucial updates on flooding conditions. A substantial 68.6 per cent of surveyed rangers lacked official insurance schemes to cover personal losses and damages incurred during their duties. Moreover, a striking 73.2 per cent of rangers did not have access to essential equipment needed for their duties, such as life-saving kits, appropriate footwear and life jackets.



In terms of capacity, a significant majority did not receive any formal training in disaster management and response. Specifically, 68.6 per cent reported not having received formal swimming training, while 69.6 per cent did not receive training in wildlife rescue, handling, and disaster management for responding to events like floods. Alarming, 83 per cent reported a lack of training in emergency evacuation.

DISCUSSION

This study sheds light on less frequently discussed aspects of the lives of rangers serving as first responders in seven flood-affected districts of Pakistan, highlighting their vulnerability to floods and other climate-induced disasters. Limited access to equipment, resources and training, critical for effective response was a key challenge, especially for rangers operating in flood-affected areas. While we did not include the responses of rangers from sites in non-flood-affected regions, participants described how these challenges were particularly acute during flood response operations. These responses are consistent with the findings of the Global Ranger Perception Survey which reported similar concerns about inadequate training, safety, and resourcing across 25 countries, including Pakistan (Belecky et al., 2019).

The literature on ranger job satisfaction levels and challenges they encounter in the course of their duties has been increasing (e.g. Warchol and Kapla, 2012; Belecky et al., 2019, 2021; Moreto et al., 2019, 2021; Singh et al., 2020). It shows that rangers are consistently exposed to dangers including wildlife, zoonotic diseases and challenging weather conditions (Belecky et al., 2019; Singh et al., 2020; Singh, Galliers, Appleton, et al., 2021; Singh, Galliers, Moreto, et al., 2021), and affirms that insufficient capacity, inadequate equipment and resources significantly affect ranger responsibilities. Rangers face additional responsibilities in responding to changing environmental conditions and natural disasters. These extra duties exacerbate their already challenging working conditions and which highlights a notable gap in existing research.

Rangers in flood-affected areas of Pakistan lacked access to clean drinking water, antivenom and insect bite treatment kits. One respondent from the Punjab Wildlife and Parks Department, who was part of a rescue operation team in flood-affected communities, contracted malaria, while the rest of his team experienced weakness, frequent nausea, persistent diarrhoea, and severe skin-related diseases.

Achieving a balance between addressing immediate flood-related concerns and maintaining sufficient funding for nature protection and first responders' roles is essential in safeguarding the overall safety and security of communities (Stolton et al., 2023; Werner et al., 2024). However, when a substantial portion of resources is directed towards flood relief, it can lead to a potential shift of funds away from other sectors, including conservation law enforcement. For example, during Hurricane Katrina in 2005, flood emergency support

affected government law-enforcement budgets including law enforcement (Tompkins and Neil Adger, 2005; Prakash et al., 2021). While our research focused on the most flood-impacted sites in southern Pakistan, the economic losses and salary cuts experienced by rangers extended beyond those located in the target affected areas. Daily-wage rangers working in Margalla Hills National Park, Islamabad, Pakistan were laid off because the funds were diverted to provide flood relief support.

Deaths resulting from occupational and work-related accidents are globally recognised as the second leading cause of ranger casualties, accounting for 254 lives lost between 2006 and 2021 (Galliers et al., 2022). In our research, we did not find any documented cases of ranger fatalities attributed to the floods of 2022 in the study areas. However, the escalating frequency and intensity of such extreme weather events may contribute to an increase in ranger casualties and injuries. One ranger from northern Pakistan was severely injured due to rain-induced landslides (Dunya News, 2023) and in 2017, one ranger died and five others injured while attempting to extinguish a forest fire in Gorani area in Khyber Pakhtunkhwa, Pakistan (The Express Tribune, 2017).

Rangers support climate adaptation and biodiversity by managing protected and conservation areas for flood prevention, coastal protection, wildfire response, and carbon sequestration and validating carbon stocks (Stolton et al., 2023). During natural disasters, they are the first responders, leveraging their deep knowledge of local ecosystems and animal behaviour to assess and address impacts on wildlife and their habitats (Carter, 2004). Coming from local communities, rangers carry a strong sense of responsibility, not only towards biodiversity protection but also in serving their communities (Parker et al., 2022). A majority of those surveyed hailed from within a 20 km radius of the site where they were stationed. At Taunsa Barrage Wildlife Sanctuary in Punjab, for instance, rangers were working with police to assist in evacuating communities from villages affected by floods, even though they had limited swimming skills. Despite facing challenges such as inadequate training and resources, they engage in these tasks due to their inherent sense of responsibility to support their fellow community members.

A substantial portion of rangers engaged in this research, expressed concerns about their safety while performing their duties during floods and stressed the pressing need for comprehensive disaster management strategies and strengthened support systems. Initiatives focused on enhancing the capacity of rangers can significantly improve their effectiveness in responding to such crises.

Advocacy is needed to ensure that ranger employers offer sufficient health and life insurance coverage to all rangers. However, this implementation may take some time. In the interim, conservation NGOs have the potential to provide support to rangers (Galliers et al., 2022).

We anticipate that this research will contribute to assessing the vulnerability of rangers to extreme weather events and disasters, such as the catastrophic floods in Pakistan, by establishing a baseline. Future research endeavours should also prioritise evaluating the regional-scale impacts of climate change and the specific vulnerabilities of rangers to extreme weather events. In addition, future studies should document the diverse roles rangers play as first responders to climate-related disasters, in order to strengthen their strategic role within disaster risk reduction and mitigation efforts.

CONCLUSIONS

Our study sheds light on the role and vulnerabilities of rangers as first responders, extending beyond the scope of traditional biodiversity conservation and law enforcement duties. During the 2022 Pakistani floods, rangers engaged in flood response and relief activities, ranging from safely evacuating communities to providing them with clean water and distributing cash grants, all while helping to protect communities' homes, livestock and essential belongings. These efforts were in addition to their core responsibilities of protecting biodiversity and managing protected areas. This multifaceted contribution received limited recognition, not only locally but also on a broader global scale. The lack of recognition can be demoralising for rangers as their roles expand and demands on the workforce increase without corresponding institutional or public support. The study serves as evidence to garner better recognition for the profession and highlight their broader contributions not only to biodiversity conservation and sustainable development, but also in their often-overlooked role as first responders.

ACKNOWLEDGMENTS

We would like to express our gratitude to the rangers who participated in the study. We acknowledge the support of the Sindh and Punjab Forest, Wildlife and Fisheries Departments. Funding for this research was provided by WWF-International as part of the project titled 'Building Back Together – Supporting Rangers and Protected Areas Affected by Floods in Pakistan'.

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RESUMEN

Los guardabosques desempeñan un papel vital en la conservación de la biodiversidad, pero se ha pasado por alto su contribución fundamental como primeros intervinientes en catástrofes naturales. En este trabajo se evalúa el papel esencial desempeñado por los guardabosques como primeros intervinientes durante las inundaciones extremas de 2022 en Pakistán, así como su vulnerabilidad. Nuestro estudio incluyó entrevistas estructuradas y grupos de discusión con 194 guardabosques de siete distritos afectados por las inundaciones a lo largo del río Indo en Pakistán. Todos los guardabosques encuestados informaron del aumento de la intensidad de los fenómenos meteorológicos extremos y de que las inundaciones les afectaban negativamente. Las inundaciones interrumpieron sus tareas habituales y les causaron pérdidas personales, como daños en viviendas, tierras agrícolas y otras posesiones. A pesar de ello, los guardabosques participaron en las labores de ayuda de emergencia, apoyando a las comunidades afectadas, rescatando ganado, ayudando en las evacuaciones y distribuyendo alimentos a las comunidades locales. Nuestro estudio pone de relieve el papel desempeñado por los guardabosques en Pakistán como primeros intervinientes y subraya cómo los guardabosques de todo el mundo, especialmente en entornos con recursos limitados, deben ser reconocidos y apoyados como trabajadores sanitarios planetarios. La investigación futura debe evaluar las funciones de los guardabosques y las vulnerabilidades a otros fenómenos meteorológicos extremos inducidos por el cambio climático en todos los ecosistemas, proporcionando información para informar el desarrollo de políticas, mecanismos de apoyo, y el reconocimiento mundial de la profesión de guardabosques.

RÉSUMÉ

Les gardes forestiers jouent un rôle essentiel dans la conservation de la biodiversité, mais leur contribution critique en tant que premiers intervenants lors de catastrophes naturelles a été négligée. Nous évaluons le rôle essentiel joué par les gardes forestiers en tant que premiers intervenants lors des inondations extrêmes de 2022 au Pakistan, ainsi que leurs vulnérabilités en la matière. Notre étude a consisté en des entretiens structurés et des discussions de groupe avec 194 gardes forestiers dans sept districts touchés par les inondations le long de l'Indus au Pakistan. Tous les gardes interrogés ont fait état d'une augmentation de l'intensité des phénomènes météorologiques extrêmes et ont indiqué qu'ils étaient affectés par les inondations. Les inondations ont perturbé leurs tâches régulières et causé des pertes personnelles, notamment des dommages aux maisons, aux terres agricoles et à d'autres biens, des terres agricoles et d'autres biens. Malgré cela, les gardes forestiers ont participé aux efforts de secours d'urgence, en soutenant les communautés touchées, en sauvant le bétail, en aidant aux évacuations et en distribuant de la nourriture aux communautés locales. Notre étude met en lumière le rôle joué par les gardes forestier au Pakistan en tant que premiers intervenants, et souligne comment les rangers du monde entier, en particulier dans les environnements à ressources limitées, devraient être reconnus et soutenus en tant qu'agents de santé planétaires. Les recherches futures devraient évaluer les rôles et les vulnérabilités des gardes forestiers face à d'autres événements météorologiques extrêmes induits par le changement climatique dans l'ensemble des écosystèmes, afin d'éclairer l'élaboration des politiques, les mécanismes de soutien et la reconnaissance mondiale de la profession de garde forestier.