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Bush fires of central highlands of Sri Lanka: What is the triple bottom line?

D.A.M. De Silva[1, *], M.A.E.K. Jayasinghe [2], A.M.S.M.R.S.G. Bandara [3], M.M.S.C. Senevirathne [3], E. Asimakopoulou [4], C.L. Liyanage [5], M. Esham [1] and B. Walley [6]

[1]Professor in Agribusiness Management, Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
[2]Temporary Lecturer, Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
[3]Lecturer in Food Business Management, Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
[4]Lecturer in Fire Engineering, School of Engineering and Computing, University of Central Lancashire, Preston, United Kingdom
[5]Professor in Facilities Management, School of Engineering and Computing, University of Central Lancashire, Preston, United Kingdom
[6]Lecturer in Community Leadership, School of Health, Social Work and Sport, University of Central Lancashire, Preston, United Kingdom
*E-mail: desilva.achini@yahoo.co.uk

Abstract

Bushfires, a type of wildfire, are becoming frequent events worldwide making their effective management a priority. The past years it has been observed that bushfires in the central highlands of Sri Lanka occur in higher frequencies and their impact is detrimental to communities. Bushfires in these areas are inevitable due to consequences of climate and weather patterns and flammable vegetation (Pine and Eucalyptus) introduced during re-forestation programs. Increased bushfires hazards are due to natural causes, such as lightings, or people either intentionally or unintentionally for example villagers setting fires to Savannas expecting fresh grass for cattle herds and clearing forests for slash and burning agriculture. Other reasons include hunters setting fires, usually in forest reserves, or campers and holidays makers ignoring windy season, along with dry weather when setting campfires and lighting cigarettes. The research locations, Haldummulla Divisional Secretariat Division (DS Division) of Badulla district and Imbulpe DS division of Rathnapura district were purposively selected based on the highest recorded bushfire incidents in recent years while these locations serve as important catchment areas and forest reserves. The scourge of bushfires in the central highlands of Sri Lanka is less attended reality causing irreversible damage to the ecosystem. Therefore, this current study aimed to investigate the context of sustainability concerning the triple bottom line (TBL) of social, economic, and environmental performance for utilities. Special emphasis was placed on community vulnerability, preparedness, and adaptation. A mixed methods approach was instrumental in data collection from 5 Grama Niladhari Divisions (GN Divisions) from each district. Participatory approaches including a transect walk, field observations, in-depth interviews with key informants and focus group discussions were used as primary data collection tools. Communities, houses, and farmlands within the high-risk areas are highly vulnerable to bushfire incidents annually. Community level adaptation strategies are limited and resilient building mechanisms, especially early warning systems are not in place.

Keywords: Bushfire, Central highlands, Communities, Sri Lanka, triple bottom line (TBL)

1. INTRODUCTION

The bushfires/forest fires in the central highlands of Sri Lanka have posed significant challenges, not

only in terms of environmental degradation but also in socio-economic dimensions, impacting local communities profoundly (Jayasinghe et al, 2024). The forest reserves, as a crucial habitat, face persistent challenges from bushfires, adversely affecting the natural ecosystem, agriculture, tea cultivation, and tourism. Pine-dominated plantations are particularly susceptible to forest fires, causing extensive damage and environmental impacts (Heenatigala, 2021), damaging water quality by disrupting microbial activities, and widespread water contamination (Roar Media, 2019. While forest fires seldom endanger human life or property, they can result in extensive environmental harm and economic losses in various ways (Bandara et al., 2019), posing a critical threat that impacts vegetation, livelihoods, and infrastructure (Fonseka et al., 2016). The frequency and intensity of these fires cause potential permanent alterations to the ecosystem and its components (Cha et al., 2020). The impact of bushfire incidents extends to residential areas in villages, houses of estate workers, religious places, irrigation channels, tanks (Wevas) and experienced physical health symptoms such as eye or throat irritation and cough due to smoke exposure, alongside anxiety, depression, and disrupted sleep, all attributed to bushfires (Rodney et al., 2021). According to data from the Sri Lanka Forest Department, there has been a noticeable increase in the frequency and intensity of bushfires, particularly during the dry season. These fires pose a significant threat to the region's biodiversity, with several endemic species at risk of habitat loss and population decline. From an environmental perspective, Basnayake et al. (2021) highlighted the ecological consequences of bushfires, including habitat destruction, loss of biodiversity and soil degradation. However, the limited research and insufficient reporting of significant incidents might lead one to perceive forest fires as a minor concern. However, forest fires have emerged as a significant contributor to the reduction of forest coverage, (Makumbura et al., 2024).

The Triple Bottom Line (TBL), aligns with principles of sustainable development and corporate social responsibility, encompassing three key dimensions commonly known as the three Ps: people, planet, and profit (Dixon, 2014). Understanding the impacts of these fires extends beyond immediate environmental concerns to encompass broader socio-economic dimensions, highlighting the need for a comprehensive approach to management. In this context, the concept of the TBL offers a valuable framework for assessing the sustainability of interventions. The TBL evaluates outcomes based on three pillars: environmental, social, and economic. Local knowledge plays a pivotal role in the evolution of disaster management practices, continually contributing to the development of resilient communities (Kapiarsa & Sariffuddin, 2018). Community involvement is vital in disaster risk management, particularly within vulnerable informal settlements. Disaster risk management entails a methodical strategy aimed at minimising vulnerabilities, fortifying resilience, and mitigating risks. The adaptability to reduce disaster risks at the grassroots level is essential. Local initiatives constitute a fundamental aspect of awareness, empowerment and community-based disaster risk reduction. Exploring these initiatives within village communities is essential for bolstering adaptability in disaster management. Fauzie and Sariffudin (2017) highlighted the importance of community engagement and support systems in mitigating the adverse effects of bushfires on social structures. The continuous evolution of disaster management practices rooted in local knowledge serves as a foundational element in building resilient communities. The TBL framework provides a holistic approach to understanding the complex dynamics of bushfires in the central highlands of Sri Lanka, emphasizing the interconnectedness of social, economic, and environmental dimensions.

2. METHODOLOGY

Haldummulla Divisional Secretariat Division (DS Division) of Badulla district and Imbulpe DS division of Rathnapura district were purposively selected based on highest recorded bushfire incidents in recent years and these locations also serve as important catchment areas and forest reserves. A mixed method approach was instrumental in data collection from 05 Grama Niladhari Divisions (GN Divisions) from each DS division. Further, structured questionnaires, participatory approaches including transaction walks to collect spatial data of an area involves systematically observing individuals, their environment, and available resources while traversing through the community (Guijt & Woodhill, 2022), field observations, in-depth interviews with key informants and focus group discussions were used as primary data collection tools. As secondary data collection tools, the annual reports issued by each DS division

regarding natural disasters were utilized. Transaction walks and field observations were done initially to observe the locations,-identify bush fire prone areas and the extent of the damages. In-depth interviews with key informants such as DS division officers, Grama Niladhari officers, villagers and bush fire victims were conducted. Moreover, interviewers administered pre-tested structured questionnaires to 150 individuals representing both DS divisions. Likert scale questions were developed to gather the required data on TBL approach. Figure 01 denotes a summary of the methodology used in data collection.

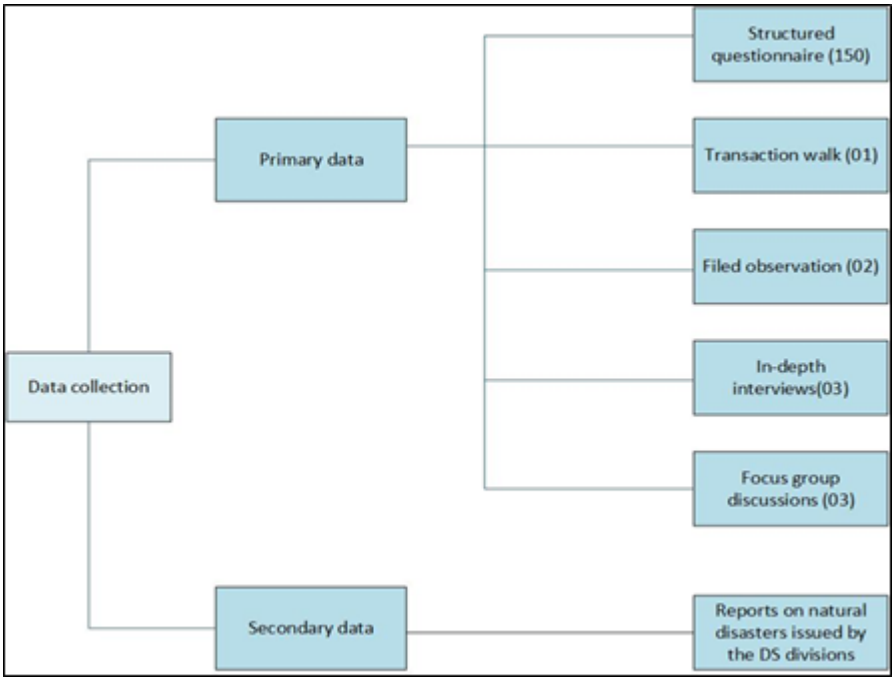

Figure 1. Data collection methodology

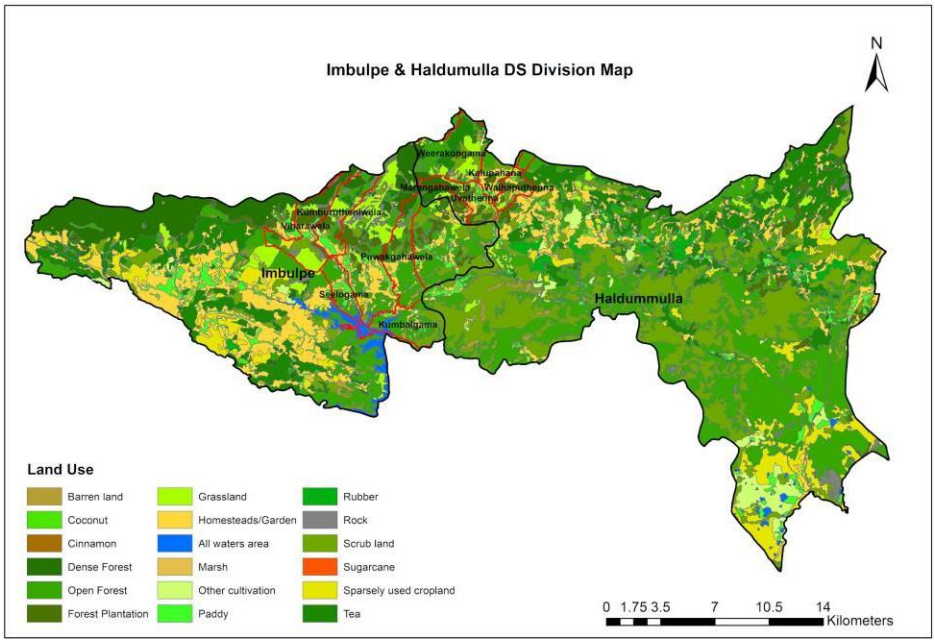

Figure 2. Study Locations: 10 GN Divisions and Land Use

3. RESULTS AND DISCUSSION

3.1. Community Vulnerability and Preparedness

This study found that communities residing within high-risk areas are particularly vulnerable to bushfire incidents. Houses, farmlands, and critical infrastructure are at risk, leading to significant socio-economic disruptions. Despite the recurring nature of bushfires, community level adaptation strategies remain limited. The lack of resilient building mechanisms and early warning systems further compounds the vulnerability of communities. Figure 3 illustrates the varying degrees of preparedness among households in the central highlands of Sri Lanka to mitigate the vulnerability of their properties and communities to bushfires/forest fires. 12% of respondents reported no preparation at all, while 49% indicated slight efforts towards reducing the vulnerability of houses and property. Preparation for evacuation in case of emergency figure shows a concerning trend, with 60% having made no arrangements. In active defence strategies, 34% are moderately prepared for active house defense and 35% highly prepared for active landscape defence. However, the study reveals that community level adaptation measures are limited, with a lack of resilient building mechanisms and early warning systems.

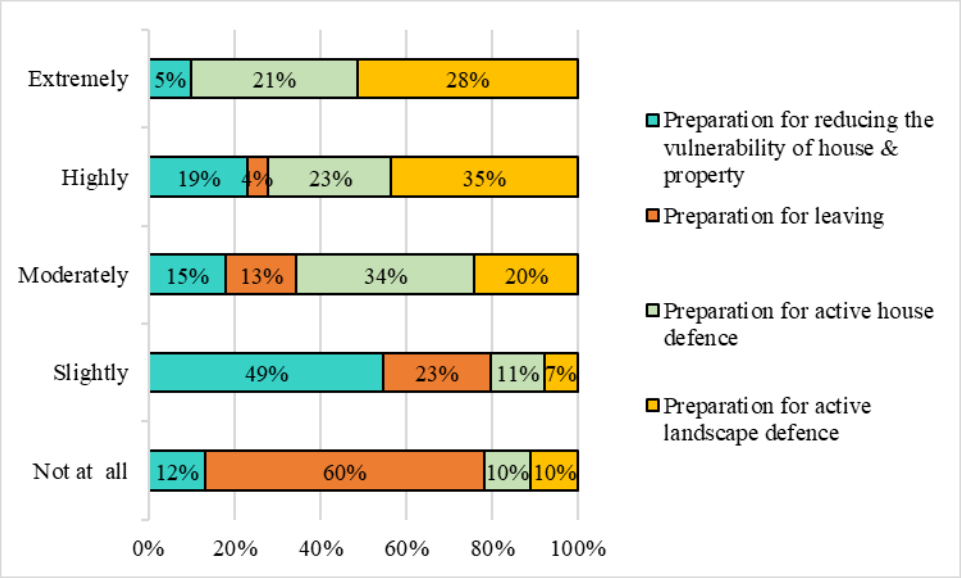

Figure 3. Preparation for Forest fire Resilience

Figure 4 shows that there are no bushfire plans in place, whether in written form or otherwise. This lack of planning is concerning as it leaves individuals unprepared to effectively respond to bushfires or bushfire emergencies. The majority (93%) of participants did not partake in community bushfire information sessions conducted by government officials in institutions such as disaster management centres, Grama Niladari, Sri Lanka police and forestry and wild life offices, highlighting a gap in disaster education initiatives. Additionally, only 51% of respondents reported owning a smartphone, while some respondents mentioned that their children possessed smartphones instead. Smartphones can be used as valuable tools for receiving alerts and facilitating effective communication during bushfire emergencies. Recent studies have demonstrated the efficacy of mobile applications in aiding individuals in escaping wildfires and reporting incidents promptly (Kamilaris et al., 2023). Advancements in technology have led to the development of mobile and web-based applications aimed at detecting and monitoring peat fires through community reporting, enabling early detection and mitigation efforts (Rony Teguh et al., 2021). Only 22% of individuals surveyed indicated having a battery-operated radio for accessing disaster-related information and updates. These findings underscore the need for enhanced bushfire

safety planning and education programs within the community to mitigate the risks associated with bushfire incidents.

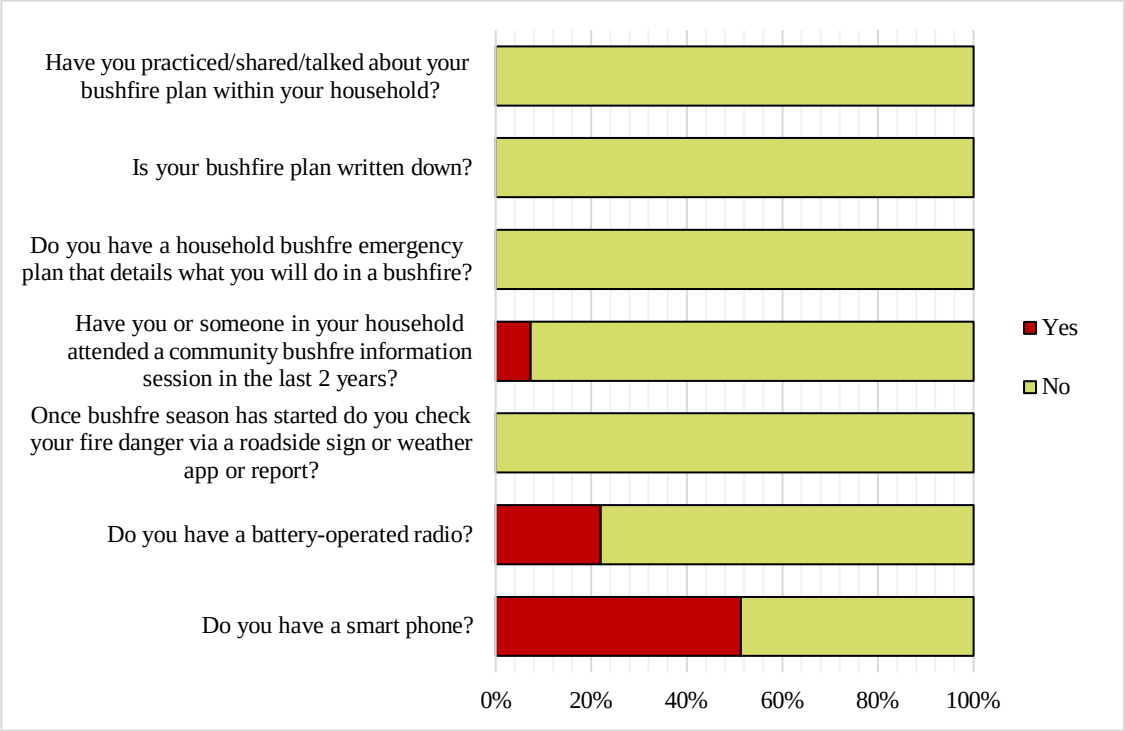

Figure 4. Safety planning – Community Preparedness

Figure 5, emphasizes the level of community preparedness for evacuating. Many households lack an evacuation strategy for bushfire emergencies, and they also lack plans for rescuing their pets or farm animals, along with alternative evacuation routes.

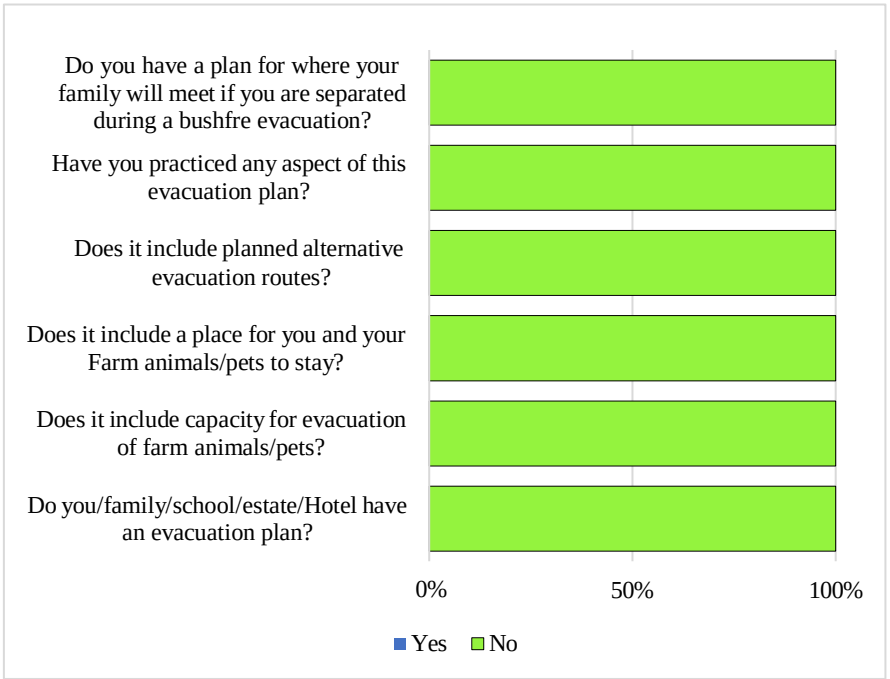

Figure 5. Preparation for evacuation

Figure 6 illustrates the various preparations undertaken by households, hotels, schools, and estate houses to mitigate vulnerability and defend their properties against bushfires. 88% of respondents reported not receiving any training in bushfire prevention methods. Instead, they resort to using tree branches to manage bushfires, occasionally seeking assistance from the Sri Lanka army and forestry department officers and other government officials. 39% strongly agreed with the idea of clearing lawns, shrubs or overhanging trees within a 20-meter fire belt around their houses. However, a concerning 80% admitted to not clearing their building gutters even once before or during the bushfire season. Furthermore, there is a lack of proactive measures among community members, as none of them have removed flammable or loose items from around their houses or verandas. These items include outdoor furniture, plants, doormats or sealing gaps in ceilings and under the house. Regarding community preparedness, 43% of individuals have not collaborated with neighbours or other community members to prepare for bushfire seasons. However, during bushfire incidents, they come together to manage the situation as best as they can. Some people opt to prepare for bushfire seasons by creating fire belts, which involves clearing pine leaves and other debris from the ground and farmland areas. 19% of individuals have not engaged and 33% have slightly engaged with the local fire brigade to mitigate fire hazards on their properties. Despite the majority of local residents being employed in government jobs, they still show a general lack of concern about bushfires and the fact that the majority of fires occur in forested areas.

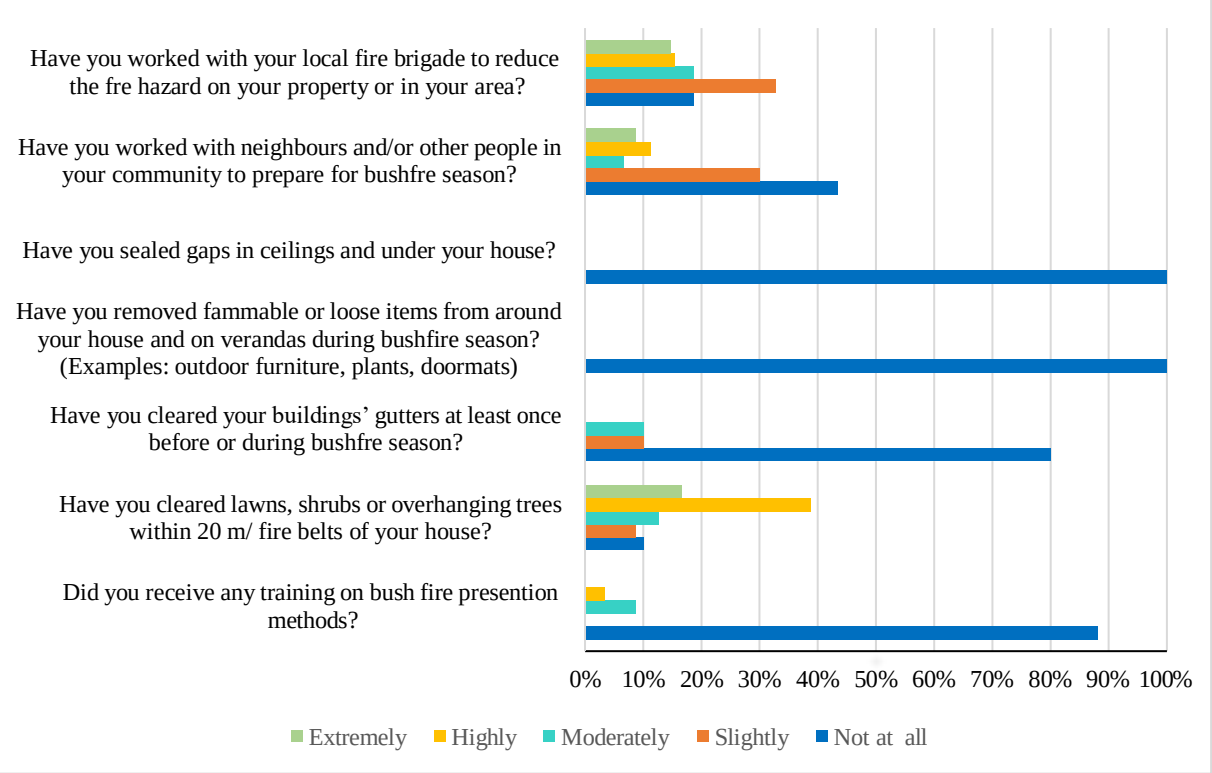

Figure 6. Preparation of house | Preparation of House to reduce vulnerability | Preparation for defense of the property

3.2. Social Impacts and Economic Consequences

Interviews and focus group discussions revealed that communities, houses, and farmlands within high-risk areas are highly vulnerable to bushfire incidents annually. Field observations highlighted the destruction of agricultural land, crops, and livestock, leading to significant economic losses for local farmers. Bushfires have severe environmental consequences in the central highlands of Sri Lanka. The economic consequences of bushfires extend beyond immediate losses to include long-term impacts on livelihoods and local economies. Damage to agricultural lands, forests, and property leads to reduced productivity and income generation opportunities for communities. The cost of firefighting efforts and post fire rehabilitation further strains government resources. Moreover, the tourism sector, which is vital

for the economy of the central highlands, suffers due to the negative perception of safety and environmental degradation caused by bushfires. The results align with those of Jayasinghe et al. (2024), indicating that villages face yearly bushfires stemming from various human activities. Despite the significant risk posed to human lives and property, the absence of recorded casualties has led to a lack of preparedness measures among the communities.

3.3. Environmental Degradation

The environmental impact of bushfires in the central highlands of Sri Lanka is multifaceted, affecting biodiversity, soil fertility, and water quality. The loss of native vegetation due to recurrent fires disrupts delicate ecosystems and reduces habitat availability for wildlife species. Moreover, the combustion of organic matter releases greenhouse gases into the atmosphere, contributing to climate change and exacerbating existing environmental challenges. In addition, the erosion of topsoil following a bushfire event led to sedimentation of waterways, compromising water quality and aquatic ecosystems. The introduction of flammable vegetation during reforestation programs, such as Pine (genus Pinus) and Eucalyptus (Eucalyptus sp.), has increased the susceptibility of these areas to fires. Moreover, the frequency and intensity of bushfires contribute to soil erosion and degradation, further compromising the ecosystem resilience.

Figure 7. Impact of Forest Fires | **a)** Forest fire incident at Marangahawela - Wewekumbura (2024), **b)** Smoke in the atmosphere during a forest fire incident, **c)** Burnt water tanks of the community water system in Haldummulla (2018).

3.4. Community Adaptation Strategies

Despite the lack of formal education and training in disaster management, the study identified innovative coping mechanisms adopted by local communities to mitigate the impacts of natural disasters on ecotourism. One such initiative is the establishment of backfire systems, informal community-supported mechanisms aimed at managing bushfires. These grassroots efforts demonstrate the resilience of rural communities in the face of environmental challenges and their commitment to safeguarding their livelihoods. Another adaptive strategy observed in the study area is the creation of fire belts as part of early preparedness measures. These fire belts act as a barrier against advancing forest fires, helping to safeguard their properties and infrastructure. Other Methods include, replantation initiatives using indigenous tree species and the removal of fire-prone introduced plantations, such as Pine and Eucalyptus, establishing natural stone walls: retaining walls, terracing, stone walls supported terraces, using non-flammable building materials, clear vegetation and rubbish away from buildings, establishing independent water tank, pumps, sprinkler system. Establishing non-inflammable landscapes like vegetable gardens, plants and trees of different heights and keeping clear areas immediately around buildings all contribute to enhancing the resilience of ecosystems to bushfires.

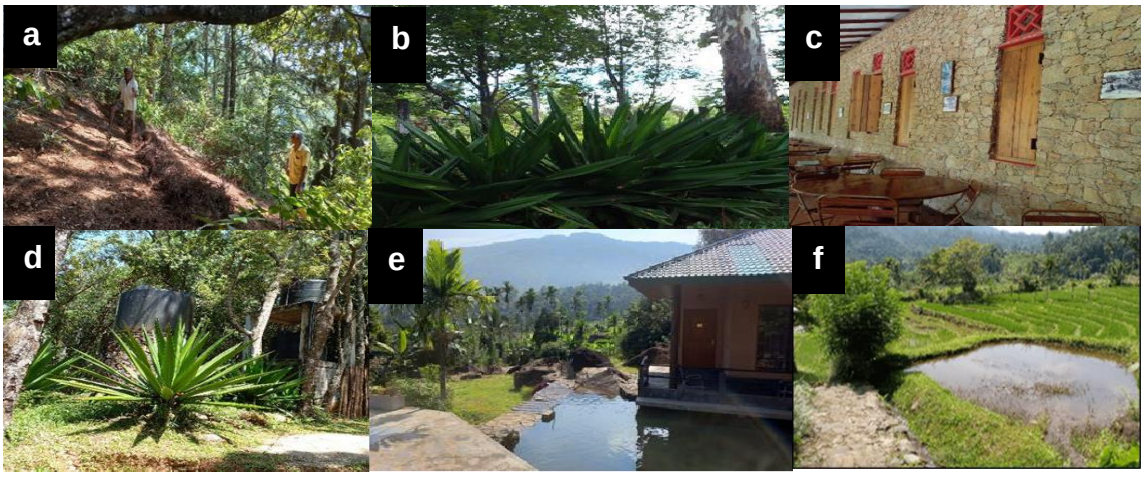

Figure 8. Adaptation Strategies | **a)** Establish fire belts, **b)** Forest belts, **c)** Use non-flammable building materials, **d)** Establish independent water tanks **e & f)** Establish non-inflammable landscape

4. CONCLUSION

This study aimed to investigate the context of sustainability TBL of social, economic, and environmental performance. Special emphasis put on community vulnerability, preparedness, and adaptation for bushfires in the central highlands especially in Haldumulla and Imbulpe DS divisions. Communities residing within high-risk areas are particularly vulnerable to bushfire incidents. Houses, farmlands, and critical infrastructure are at risk, leading to significant socio-economic disruptions. Community-level adaptation strategies are limited and resilient building mechanisms, especially early warning systems are not in place. Field observations highlight the destruction of agricultural land, crops and livestock, leading to significant economic losses for local farmers. The economic consequences of bushfires extend beyond immediate losses to include long-term impacts on livelihoods and local ecosystems. The multifaceted environmental repercussions of bushfires within the central highlands of Sri Lanka encompass the degradation of biodiversity, depletion of soil fertility, and contamination of water quality.

5. RECOMMENDATIONS

Based on the results of the study, prompt action is needed to address the significant socio-economic and environmental impacts. Being faced by communities in the central highlands of Sri Lanka, a serious attempt must be made to improve preparedness and resilience since there are few community-level adaptation options available and essential infrastructure is under risk. This involves creating and carrying out specialized strategies for preparedness, investing in resilient infrastructure like fire-resistant building materials and early warning systems, and providing impacted farmers with alternate sources of income and financial support. Moreover, to lessen the effects of bushfires on the ecosystem, environmental conservation and restoration initiatives are desperately needed. Collaboration between stakeholders and investment in research and innovation are essential to develop holistic approaches to bushfire management and build sustainable resilience in the region. This study has provided evidence that these approaches could safeguard communities, economies, and ecosystems from the destructive consequences of bushfires in Sri Lanka's central highlands.

6. ACKNOWLEDGMENTS

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