

Landscape-Based Mitigation Strategy for Addressing Human-Elephant Conflict in Horowpathana, Sri Lanka: A Comprehensive Study

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Abstract

Horowpathana has been identified as a hotspot of human-elephant conflict in Sri Lanka's north-central province, where quick intervention is required. But Sri Lanka never had a consolidated action plan to address the problem. This study deals with the question of how landscape architects can contribute to mitigating the problem in the area. It aims to create a design proposal that facilitates elephant requirements and offers functions and recreation for the residents at the same time. The design is based on the method of animal-centred design. The study demonstrates that such conflicts can be resolved through precise landscape design that considers the issue on the specific site. Effective implementation requires strong governance structures and policy support from stakeholders like governmental institutions, conservation organizations, and academics. Collaboration between infrastructure developers and conservationists can reduce the harmful effects of development projects on wildlife by employing proper design methodologies and undertaking further research to assure establishment efficacy.

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Keywords: Human-elephant conflict; Landscape-level mitigation strategies; Animal-centered design; Conservation of elephants

Introduction

Human-elephant conflict (HEC) has emerged as a pressing and extensively debated issue in Sri Lanka, causing habitat loss, crop damage, injuries, and increased mortality rates. Around 250 elephants are killed annually, with 50-70 human casualties reported (Gunawardana, S et al., 2021). These incidents cause significant hardship and trauma, especially in rural communities like Horowpathana (Gunawardhana, A. P. 2018). Sri Lanka's elephant holds significant cultural, biological, and ecological value, contributing significantly to the country's tourism industry and attracting visitors (Bandara, R et al., 2005). However, it is essential to address the negative consequences of the human-elephant conflict, as it poses challenges to conservation efforts and sustainable development. Recognizing and addressing these issues is crucial for preserving this iconic species.

Sri Lanka lacks a consolidated action plan to address the human-elephant conflict. Current prevention strategies focus on short-term solutions, transferring conflict risk (Shaffer et al.,

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2019). Long-term prevention should promote peaceful coexistence and sustainability for both parties (Köpke et al., 2021). Identifying the current threat and transforming it into opportunities to enhance lifestyles could be another mitigation strategy (Brandenburger 2017). Utilizing resources like Horowpathana National Park and elephant orphanages could promote tourism and introduce another elephant-watching destination (Wasantha Rathnayake 2021). This study proposes a conceptual model to address the human-elephant conflict in the Horowpathana area, focusing on human-elephant interactions and resource use. It suggests a long-term solution for sustainable land management and promotes peaceful coexistence between humans and elephants.

The Object of the Study

This study deals with the question of how landscape architects can contribute to preventing the human-elephant conflict in Horowpathana. The purpose is to create a design proposal for a problem-identified area that combines facilitating movements and other needs for the elephants with a proper environment that offers functions and recreation for the residents. The design is inspired by the Animal-centered design that places the animal at the center of the design process. Research questions are: How can the design of the area where the problem has been identified in Horowpathana, Sri Lanka, based on the needs of the elephant look like? And how can the needs of the residents be met at the same time?

Literature Review

In Sri Lanka, conflict mitigation strategies for elephant-human conflict include translocation, elephant drive, electric fences, bio fences, and trenches (Fernando et al., 2008; Perera B, 2009; Mallick, 2012; Prakash et al., 2020). Traditional methods like voice sounds, firecrackers, and lighting lamps have been found inefficient and only address short-term problems (Gunawardana, S et al., 2021). However, recent management uses interdisciplinary approaches, including scientific research, sociological studies, and the arts, to reduce conflicts. Effective land use practices can help mitigate conflicts between humans and wildlife.

Studies suggest that identifying elephant pathways, needs, and corridors, as well as people's needs and land requirements, can lead to coexistence between elephants and humans on a large spatial scale (Gross 2019). Elephant range states have successfully adopted various management inventions to reduce human-elephant conflict. These include habitat management activities like perennial water holes, solar-powered bore wells, fodder plantation creation, fire management, grass seed collection, weed removal, invasive species management, habitat improvement, bamboo planting, intensive soil working, and installation of barriers like elephant-proof trenches, hanging fences, rustle walls, solar-powered high-electric fences, beehive fences, bio fences, and chilly fences. The Wildlife Institute in India's Karnataka Forest Department has also strengthened elephant corridors by purchasing 25.37 acres of private land to ensure the safe movement of elephants (Panda et al., 2020).

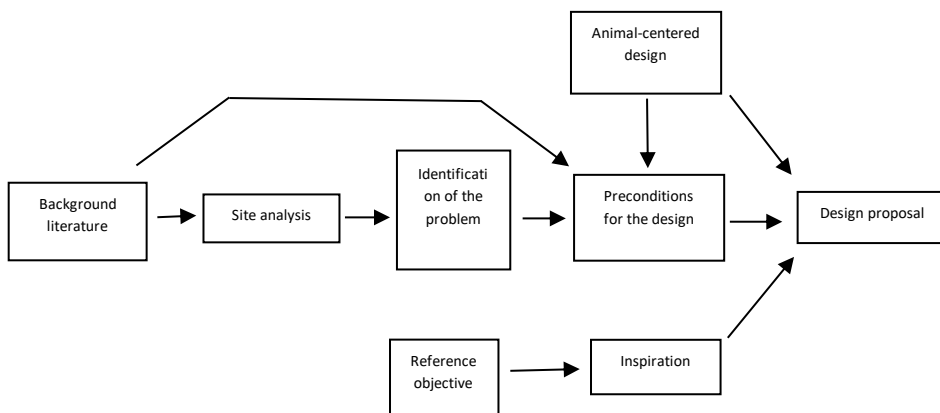
Tanzania aims to promote the sustainable use of community-supported chili fences to protect crop-raiding elephants in HEC hotspots around national parks and wildlife corridors. During the nine-year project period, no HEC reports were reported (Chang' et al., 2016). In Sri Lanka, an orange elephant project was conducted in 2006, showing the elephants' distaste for citrus varieties (Dharmarathne et al., 2020). To reduce human-elephant conflicts, better land use planning can be used to avoid settlement and cultivation near protected areas. Buffer zones can also be established around national parks and reserves to minimize human-wildlife overlap (Lamichhane et al., 2019). Palmyra Bio Fencing is a pilot project in Sri Lanka, testing the technology in three locations with support from governmental agencies and local communities affected by wild elephants. This technology benefits the elephant population and marginalized farmers (Perera, R

et al., 2013). To prevent animal movement fragmentation due to road construction, animal passes are widely applied worldwide. Structural solutions, such as overpasses, underpasses, and flyovers, are being deployed in various Asian elephant range states (Ament et al., 2021).

Methods

This study was carried out using secondary data. To answer the research question, a design proposal based on the method of animal-centered design was created.

Figure 01: Illustration showing the method and process leading to the design proposal of this study.



Background information on Human-elephant conflict in Horowpathana was collected from newspaper articles, blogs, and research papers found by searching the internet and identified the problems that cause for the Human-elephant conflict in the area also carried out a literature search on elephant behavior, conservation, and attitudes.

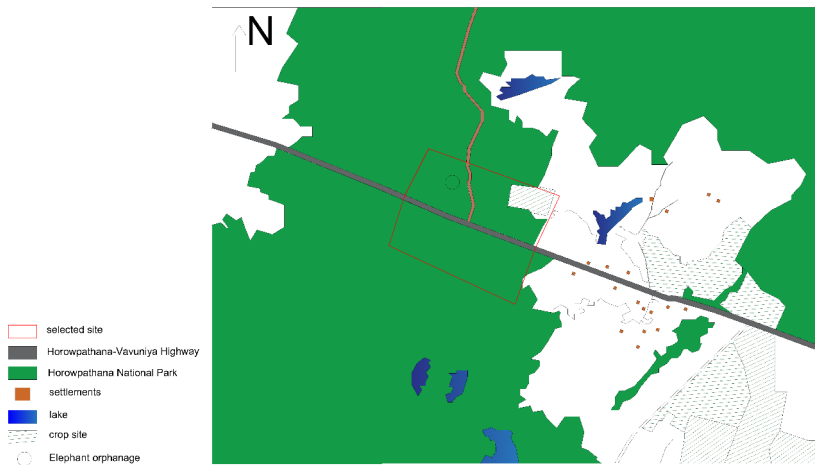
Site Analysis

The site's map was studied using satellite images, including terrain from the Horowpathana National Park.

Figure 02: Study area; Horowpathana; Anuradhapura district; North central province; Sri Lanka (from Google earth pro)



Figure 03: Detailed map of the site



Identification of the problem

Hazard map was created according to that data collected from the background information.

Figure 04 : Hazard map of the site



The biggest challenge noted for the area's human-elephant conflict is habitat fragmentation caused by the Linear infrastructure from Horowpathana to Vavuniya Highway. The disruption of elephant movement caused an invasion of elephants into settlements and agricultural plots along the forest boundaries. As a result, it is critical to allow elephants to continue moving inside the Horowpathana National Park and to separate the National Park boundary from the Village line as a barrier to elephant entry into the villages.

Preconditions for the design

Preconditions were taken into consideration for the design proposal regarding both the needs of the elephants and wildlife and the needs of the residents, as well as site-specific preconditions.

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| <p><u>Elephant and wildlife needs</u></p> <ul style="list-style-type: none"> ● Protection against hunters/humans ● The natural environment and habitats ● Opportunity to move/migrate ● Enough space for living ● Food resources and water availability ● Breeding facilities ● Health care facilities - wildlife and veterinary facilities | <p><u>Human needs</u></p> <ul style="list-style-type: none"> ● Safe movement along the Horowpathana-Vavuniya roadway ● Block the invasion of elephants into the villages and crop sites near the forest borders |
|--|---|

Site-specific preconditions

Around the selected location is Horowpathana National Park. However, a detailed examination of the site map reveals that the national park has been overrun by agricultural sites and illegal occupants. To prevent human harm to the forest and animals, the authorities in the region should be informed of this situation. To meet the water needs of the elephant and other species as well, the suggested design should handle the water shortage of the Horowpathana region, and to avoid any negative effects from this project, the other design and construction should be completed after a comprehensive investigation of the flora and fauna species along the chosen site.

Animal-centered design

Animal-centered design, also known as animal-centric design or biocentric design, is an approach to designing products, systems, and environments that prioritize the well-being and needs of animals (Webber et al., 2022). It aims to ensure that animals are considered important stakeholders in the design process and that their welfare, behaviors, and instincts are taken into account. The concept of animal-centered design is closely related to the broader concept of user-centered design, which focuses on designing products and services that meet the needs and preferences of end-users. In the case of animal-centered design, the "users" are animals, and the goal is to create environments and products that cater to their physical and psychological needs. In this study we especially focus on the elephant as the animal species and the design will be developed mainly considering the aspect of mitigating HEC in the area.

Reference object

Wildlife underpasses and culverts along the railway for elephants and other wildlife movements were the reference object situated in Tsavo National Park Kenya to inspire the design proposal of this study (Lala et al., 2022). Many times, necessary transportation-related developments have been carried out inside national parks around the world. These structures should be sustainable for both people and animals. Conservationists and infrastructure developers should collaborate

on development initiatives, and more research and studies should be conducted to guarantee the establishment's efficacy.

Choice of the structure type

The type of structure is determined by a multi-criterion analysis that considers at least three aspects: (Technical prescriptions for wildlife crossing and fence design 2016).

Criterion 1 - Importance of the section for ecological connectivity and wildlife movements

Full connectivity between habitats on both sides of the road must be ensured by maintaining the continuity of the vegetation cover.

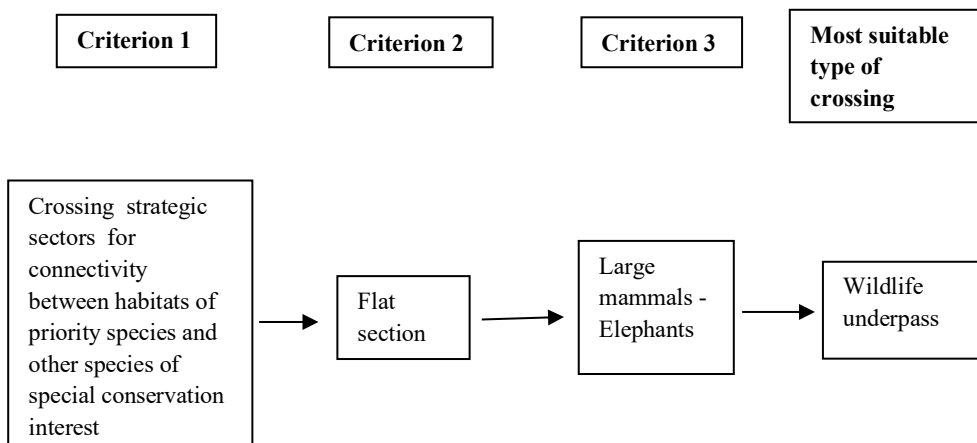
Criterion 2 - Topographic constraints

Flat section - Raising the road surface on a viaduct where the wildlife underpass can be built.

Criterion 3 - Target species or fauna groups

Large mammals – elephants

Figure 05: Criteria for the choice of a wildlife crossing type and location to new infrastructure projects. Source: Technical prescriptions for wildlife crossing and fence design 2016. Pp.26



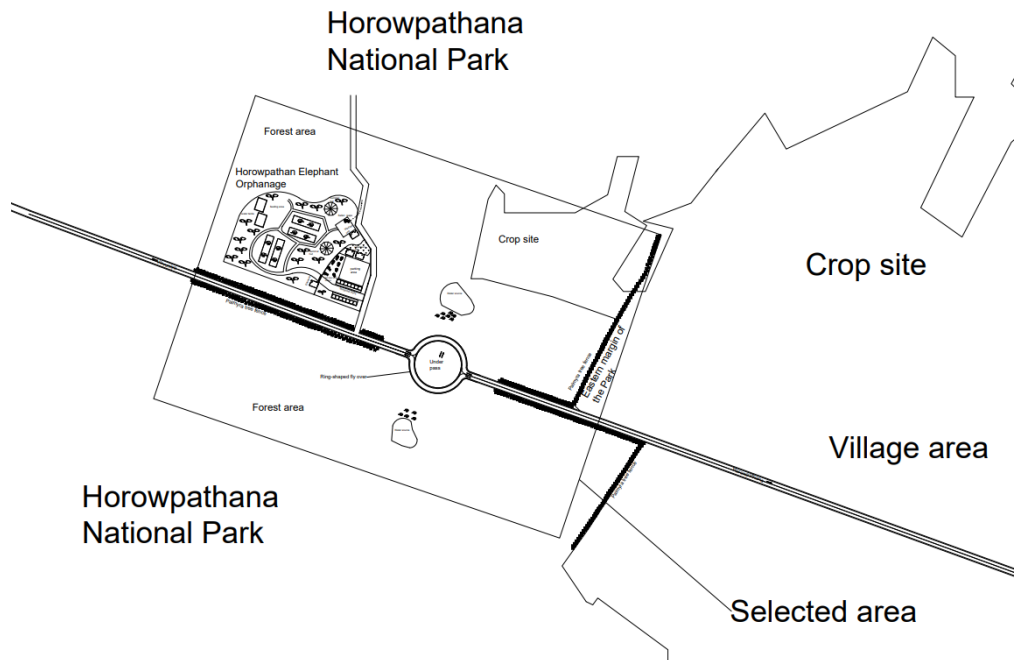
Design solutions

After reviewing and discussing this information, we discussed and sketched ideas for designed solutions. all the design solutions were under a given criterion of construction.

- Establish a flyover at the elephant pass between the Vavuniya- Horowpathana highway that facilitates the elephant's movement as an underpass.
- Design the flyover with a ring shape with sidewalks to facilitate the movement of pedestrians and motor vehicles.
- Establish two water sources on two sides of the underpass to encourage the movement of elephants between the two sides.
- Develop the design of the current elephant orphanage to facilitate the hosting of 15-20 elephants at the same time with the veterinary services and attracting tourists.
- Establish shopping stalls that allow villages to get employment.
- Establish safari jeep facilities to watch wild elephants in the National Park.
- Establish a palmyra fence along the two sides of the Vavuniya-Horowpathana highway that ensures the elephant movement only at the underpass.
- Enclose the margins of the National Park by Palmyra fences to avoid the entrance of the elephants to the villages and the crop field at the merger of the National Park.

Design proposal

Figure 06: Final design proposal

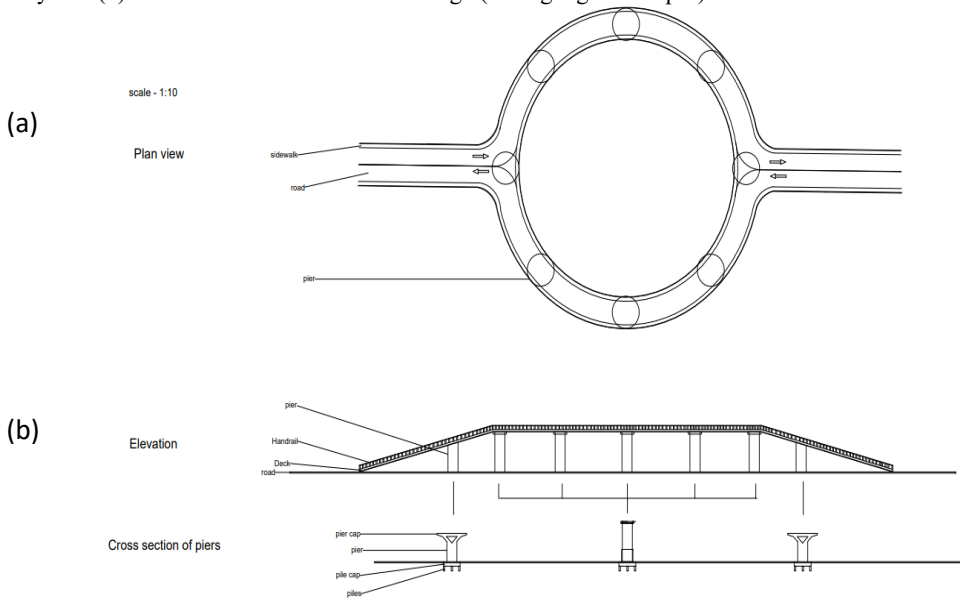


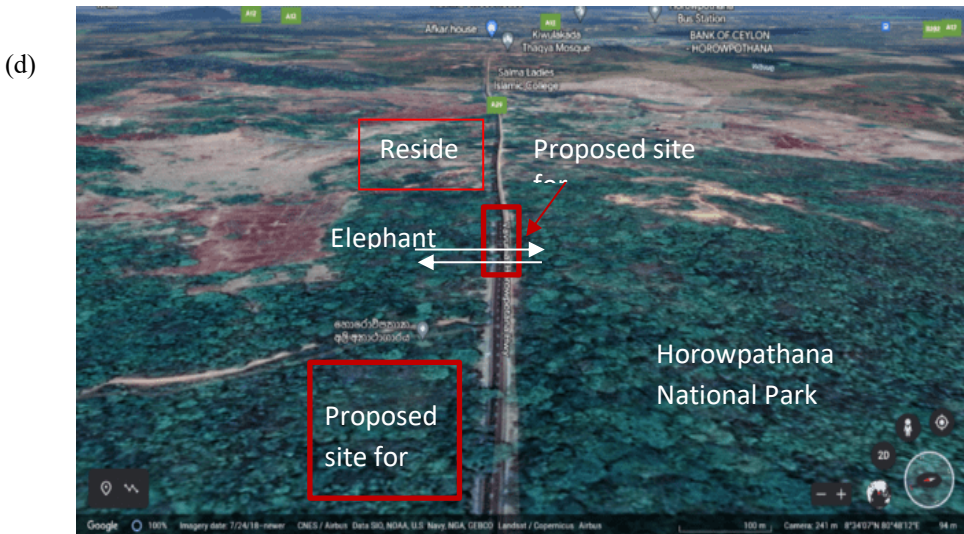
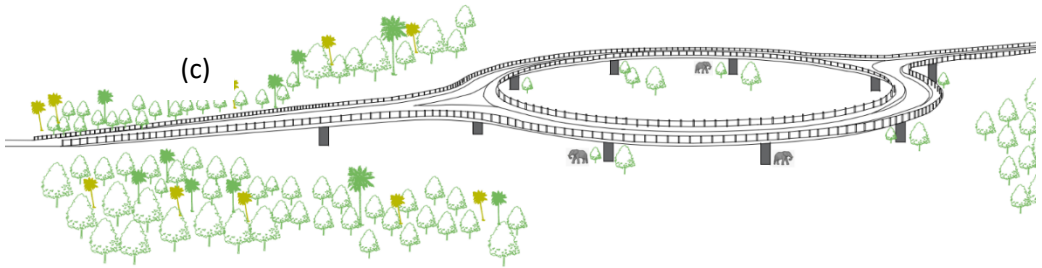
Results and Discussion

Steve Jobs famously said that creativity is "just connecting things" (Wolf 1996). The power of the combination is often said to be greatest when the ingredients brought together seem distantly related or even to be in some tension with one another. There is a surprise factor in the productive combination (Brandenburger 2017). This study integrated landscape designs that have been scientifically taken out as consolidated mitigation strategies for the human-elephant conflict under the situation of the hazard at the Horowpathana area.

Linear infrastructure is essential for economic growth and development in a country, but it can pose serious issues for wildlife. And wildlife can interrupt the vehicles and passengers' movements. This is the main cause of the Human-elephant conflict in Horowpathana and many other areas in Sri Lanka, as well as other places around the world. When considering the existing problem of the interruption of wild elephants to motor vehicles, it was identified to ensure the continuous movement of motor vehicles along the Vavuniya-Horowpathana highway and simultaneously the movement of the elephants and the other wildlife. Therefore, this study supposes a flyover that facilitates both requirements at the same time without any interruption for both parties (Ament et al., 2021). The ring-shaped flyover facilitates the continuous movement of pedestrians and motor vehicles along the Vavuniya-Horowpathana Highway (*Laguna Garzón Bridge* - 2016). Simultaneously, this tall enough flyover facilitates underpasses for elephants and other wildlife movements.

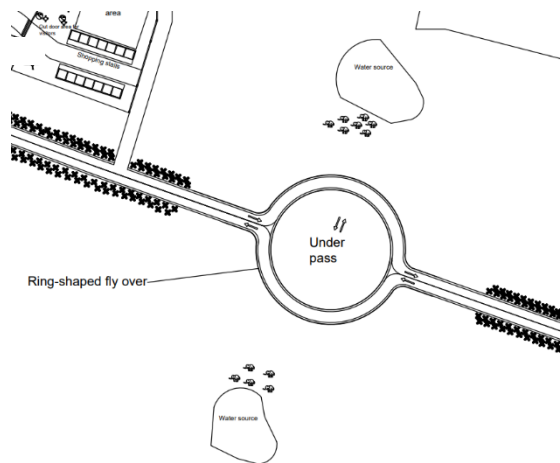
Figure 07: (a) plan view; ring-shaped flyover, (b) elevation view of elephant underpass (c) annotation of the flyover (d) location & orientation of the design (from google earth pro)





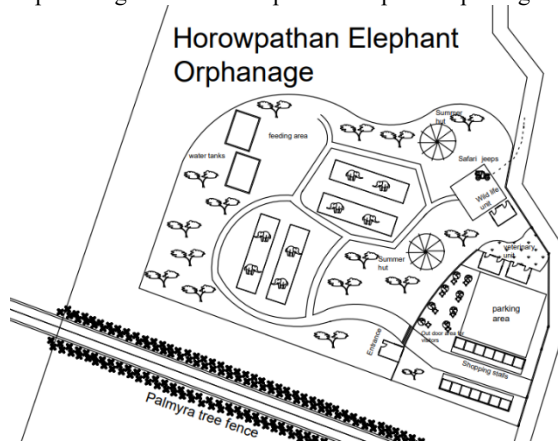
The circular shape of the bridge reduces the speed of the drivers and provides an opportunity to enjoy panoramic views of nature with wildlife. (Fig. 7.) The bridge consists of two semi-circular bridges, attached at either end to make a ring. This also allows for pedestrian access along the one-way circular route on the sidewalks of the circle. The designed shape and the features of the flyover will ensure the attraction of tourists because the sidewalks will facilitate the elephant watching and experiencing the beauty of the surroundings. The water sources that are going to be established on the two sides of the flyover will ensure the movements of elephants between the two sides, while encounters of elephant herds provide beautiful sceneries for the watchers (Fig. 8).

Figure 08: Water sources



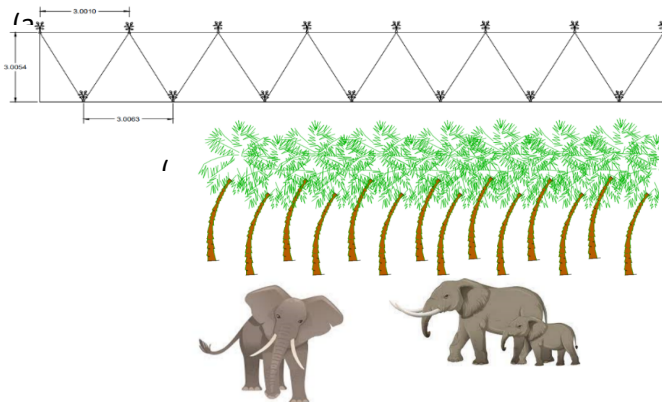
The development and the modern design of the existing elephant orphanage in the Horowpathana National Park are vital for the conservation of the current elephant herd in the area hosting 15-20 elephants at the same time (Fig.9.). And the elephant orphanage was developed with veterinary facilities and wildlife instructors to ensure the wellness of the elephants and other wildlife. Activities for the tourists at the Elephant Orphanage include milk feeding and fruit feeding to the elephant, which will give a memory for a lifetime of seeing such beautiful animals up close. The designed orphanage has shopping stalls that employ the villages while promoting tourism (Tisdell et al., 2005). Establishing safari facilities for wild elephant watching in the National Park is another approach to tourism. This will help localize the Horowpathana as another traveling destination in Sri Lanka for those who love wild elephant watching.

Figure 09: Developed design of the Horowpathana elephant orphanage



Also, all along the highway, elephant-proof Palmyra fences avoid elephant entrance to the highway and interruption to passengers by ensuring elephant underpasses only through the elephant pass. Here palmyra trees will be planted in a triangular way so that the elephants cannot pass through the fence, and they will plant at an appropriate distance (by 3m) considering the requirement of the plant (Fig. 10.). 1 km of Palmyra fence can provide a minimum of 270 metric tons of fruit and add around 2 500 trees to the vegetation (Parameswaran 2014).

Figure 10: (a), (b) triangular way



Similarly, we enclosed the merge of the national park by a palmyra fence to avoid elephant

entrance to the surrounding villages and crop sites. The eastern boundary at the elephant pass in the National Park will extend towards the adjacent crop site to facilitate enough space for elephant movement. This lost livelihood will be replaced by the designed shopping stalls at the elephant orphanage.

Furthermore, it is recommended that the margin of the Horowpathana National Park be fortified by the construction of a palmyra tree fence, aiming to effectively mitigate the incursion of elephants into the neighboring villages and agricultural areas. This proposition aligns with existing research on wildlife management and human-elephant conflict mitigation strategies (Nguyen et al., 2022). By erecting a palmyra tree fence, the natural barriers provided by the dense foliage and robust trunks of these trees can serve as an effective deterrent to discourage elephant movement beyond the boundaries of the park.

The efficacy of this proposed measure is contingent upon the regular monitoring and maintenance of the Palmyra tree fence. Close collaboration between the wildlife unit of the Horowpathana National Park and local communities is crucial in ensuring the integrity and functionality of the fence. Additionally, consultations with relevant experts and stakeholders, such as wildlife biologists and local authorities, should be undertaken to obtain comprehensive insights into the design, implementation, and management of such structures (Bernacchi et al., 2015).

In tandem with the enclosure initiative, the wildlife unit of the National Park should conduct regular assessments to ascertain the availability of sufficient food and water resources for elephants within the territorial confines of the park. This evaluation is particularly important during periods of drought when natural sources of sustenance may become scarce (Wato et al., 2016). Comprehensive studies on elephant behavior and ecological requirements can aid in identifying potential challenges related to food and water availability (Smith et al., 2007). By closely monitoring these factors, appropriate measures can be implemented to ensure the well-being and conservation of the elephant population within the National Park.

Furthermore, the veterinary unit operating within the Horowpathana National Park should assume responsibility for providing medical care and treatment to elephants suffering from preventable diseases and injuries. This includes the administration of essential medications, wound care, and the implementation of disease prevention protocols (Schmidt et al., 2019). Collaboration with expert veterinarians specializing in elephant health and conservation would be advantageous in establishing best practices for the provision of healthcare services for the elephant population (Bansiddhi et al., 2019). Regular veterinary check-ups and health monitoring should be conducted to detect and address any emerging health issues promptly. In the event of emergencies involving orphaned elephants, the establishment of an elephant orphanage within the National Park is recommended. This facility would serve as a temporary refuge, providing specialized care, nourishment, and support to the young elephants until appropriate arrangements for their long-term welfare can be made (Tisdell et al., 2011). Collaborative efforts with reputable wildlife conservation organizations, such as the International Union for Conservation of Nature (IUCN), can contribute to the development and implementation of standardized protocols for emergency elephant care and rehabilitation (IUCN, 2022).

Conclusion

In conclusion, it is crucial to shift our perspective and transform identified threats into opportunities that can lead to the advancement of both the victims and their surroundings, ultimately eradicating the existing hazard. By embracing a landscape-level mitigation strategy, we can surpass the limitations of the current localized approaches employed to address the

human-elephant conflict in Sri Lanka. To ensure a successful outcome, it is paramount to conduct an extensive and thorough study of the affected site. This comprehensive analysis should encompass various aspects, including an assessment of existing resources and an understanding of the socioeconomic dynamics, ecological factors, and cultural context. Such an in-depth investigation will provide valuable insights into the specific challenges and opportunities presented by the human-elephant conflict in the region.

Utilizing the knowledge gained from this study, the animal-centered design method should be adopted into further design and development projects where the conservation or protection of any kind of flora and fauna species within the site is involved. These strategies should aim to leverage the existing resources effectively and optimize the potential for sustainable coexistence between humans and elephants. Key considerations in formulating these strategies include the integration of habitat corridors, the creation of buffer zones, the establishment of alternative food and water sources for elephants, and the implementation of effective communication and early warning systems. Moreover, fostering community participation and collaboration is paramount to ensuring the success and acceptance of these strategies (Bandara, T. 2020; Water et al., 2022).

By adopting a landscape-level approach, mitigation efforts can address the complex and interconnected aspects of human-elephant conflict. This approach recognizes the ecological, social, and economic dimensions of the issue, facilitating a more holistic and comprehensive solution. Furthermore, the successful implementation of landscape-level strategies requires robust governance mechanisms and policy support. It is crucial to engage relevant stakeholders, including local communities, government agencies, conservation organizations, and researchers, in a collaborative and participatory manner. Such inclusive and multi-disciplinary approaches have proven effective in other regions grappling with similar human-wildlife conflicts (Mekonen 2020). In conclusion, collaboration and interaction between infrastructure developers and conservationists, and ecologists while doing the developments can address negative outcomes from the construction of wildlife by embarking on the correct design methods. More research and studies should be conducted to guarantee the establishment's efficacy.

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