Human-Elephant Conflict: A Spatial Pattern of Risk and Challenges in Koralaipattu South, Batticaloa

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Abstract

Human-Elephant Conflict (HEC) has long been a significant issue in the elephant range region of Batticaloa District, Sri Lanka. Koralaipattu South is one of the most vulnerable regions out of 14 divisional secretariat divisions of the Batticaloa district. In this context, the study focused on Koralipattu South Divisional Secretariat Division, Batticaloa. In the study area, some issues and root causes of HEC are evident, such as the expansion of temporary settlements, wild resource exploitation, and widespread elephant habitat losses due to agricultural fields across Koralipattu South, degraded forage, and reduced natural landscape connectivity. Due to the shrink of the elephant habitat, they are progressively forced into closer contact with the human population in forest precincts or cultivated areas, resulting in more frequent and severe conflict between humans and elephants. As a result, many properties, human lives, and communities in Koralaipattu South have been disrupted in various ways. In this backdrop, the study's main objective is to prepare a map to elaborate spatial patterns of HEC at Koralaipattu Divisional Secretariat Division. The study approaches mixed methods of spatial analysis through Geospatial Technology. Field observation, GPS survey, interviews, and talks with diverse people in Koralaipattu South are the primary data sources for this study. The land-use condition of the study area was determined using remotely sensed data. Data were spatially applied using grid index system analysis in the ArcGIS platform. Results reveal that HEC is a severe issue in the community, posing a threat to human lives, livelihoods, and settlements. Fourteen Grama Niladhari Divisions (GNDs) out Eighteen in the Koralipattu South were seriously affected by HEC. Domesticating, translocating, and eliminating troublesome elephants were among the innovative and co-existing strategies established and applied in Sri Lanka. But in the study area, the majority appears to be driven by short-term, site-specific factors that often transfer the HEC problems from one place to another. The risk map of HEC will supports respective officers, the public, and researchers from various sectors in preventing HEC in the future.

Keywords: *Human-Elephant Conflict, Geospatial Technology, Risk Map, Land Use/Land Cover (LULC)*

1. Introduction

Human-Elephant Conflict (HEC) is a significant conservation concern in elephant range countries worldwide. HEC has been defined as "*any and all disagreements or contentions relating to destruction, loss of life or property, and interference with rights of individuals or groups that are attributable directly or indirectly to elephants"* (Kenya Wildlife

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Service 1994; Robert 2000). It has been estimated that the Asian wild elephant population is around 48,463-52,320 in twelve countries, and above 30,000 elephants are living in India and 5879 in Sri Lanka (IUCN 2016), the Asian elephant (*Elephas maximus*) is categorized as endangered in the IUCN Red List which contributes to 10% of the world elephant population (IUCN 2007; Santiapillai 2010; Gamage & Wijesundara 2016). It has been reported that home range sizes are different in different areas, according to Sri Lanka, the range size deviates from 29 to 160 km2 for females and 53 to 345 km2 for males (Fernando et al., 2005, Ajay et al., 2015). In this context, the elephant is an identity of pride, cultural values, and religious significance to Sri Lankans and Asia. HEC has been a serious concern in Sri Lanka for decades; nevertheless, the severity of the problem has recently worsened. To avoid and minimize HEC, a range of management measures have been implemented and practiced at various scales (Shaffer 2019). The majority of available HEC management solutions only provide a short-term remedy. The management of the HEC should be a top priority for both community and elephant conservation.

There have been14,516 incidents recorded during the period 2010 -2019 in Sri Lanka; there was a total of 807 human death, 579 injuries and 10,532 property damages caused by elephants, and 2631 elephant death by humans (Prakash, Wijeratna & Fernando 2020). It demonstrates the significant problem that our Island has faced in recent decades. Those challenges have been widely spread district-wide on various scales.

In terms of human population, Sri Lanka's population density is at 300 persons per square kilometer, with about 750 people joining the population every day (Department of Census & Statistics 2014; Amilinda 2014). As a result, more land is required to accommodate the growing population, resulting in human and wild elephant deaths. In the first 10 months of 2019, as a result of the HEC, 93 humans and 293 elephants, were killed compared to 96 humans and 319 elephants in the entire year of 2018 (Ministry of wildlife 2020). The Species Conservation Centre (SCC) of Sri Lanka records that the frequency of elephant assaults increased significantly since 1998 (Senaretna 2018). One of the reasons is that under the State Land Development Ordinance, state-owned properties were granted to people for development under "JAYABOOMI" deeds (SLDO). For example, in the North Central Province, around the Padaviya Tank Sanctuary, such deeds were led to increase human habitation and HEC in the area.

In terms of HECs in the research area, it has been found that HECs ~~to~~ occur in nine of the fourteen divisional secretariat divisions in the Batticaloa District (DSDs). These events vary in intensity amongst divisional secretariat divisions; the highest is in Eravurpattu and Koralaipattu South, while the lowest are in others (Prakash, Wijeratna & Fernando 2020). People have invaded wildlife habitats to meet their land requirements for agriculture, habitation, cattle ranges, and other legal and illegal economic activities as the population grows in rural areas where people are experiencing poverty. This scenario is the primary root cause for the aggravation of HEC in Batticaloa and at large in Sri Lanka. Koralipattu South divisional secretariat division (DSD) has had enough forest areas and sufficient land resources for paddy cultivation; however, chena cultivation has resulted in extensive HEC concerns. As a result, elephant habitats are shrinking, and they are increasingly forced into closer contact with human populations in forest precincts or agricultural areas, resulting in more frequent and severe human-elephant conflict. As a result, many physical properties, human lives, and communities are affected in a variety of ways. The study uses a mixed-method approach to achieve its main objective of preparing a risk map to elaborate HEC spatial patterns in Koralaipattu DSD. The sub-objectives involve detecting LULC spatial patterns, displaying the spatial pattern of the presence of elephants using their dung, and evaluating the risk level of the study area.

2. Methods

2.1 Study Area

The study was carried out in Koraliapattu South (Kiran), Batticaloa Sri Lanka which is one of the Divisional Secretariat Divisions out of fourteen in the Batticaloa District. Koralaipattu South is located northward of Batticaloa town between $7^0$46’ 05” N – $7^0$58’ 00” N and 81^0 13’ 30” E – $81^0$35’ 10” E that covers an area of 620 km^2, land area of whole district 2610km^2, and internal reservoir 244km^2 altogether a total administrative area of Batticaloa is 2854 km^2 (District Statistical Branch, 2019). There are 18 Grama Niladhari (GN) divisions are functioning under the Koralipattu South Divisional Secretariat’s administration.

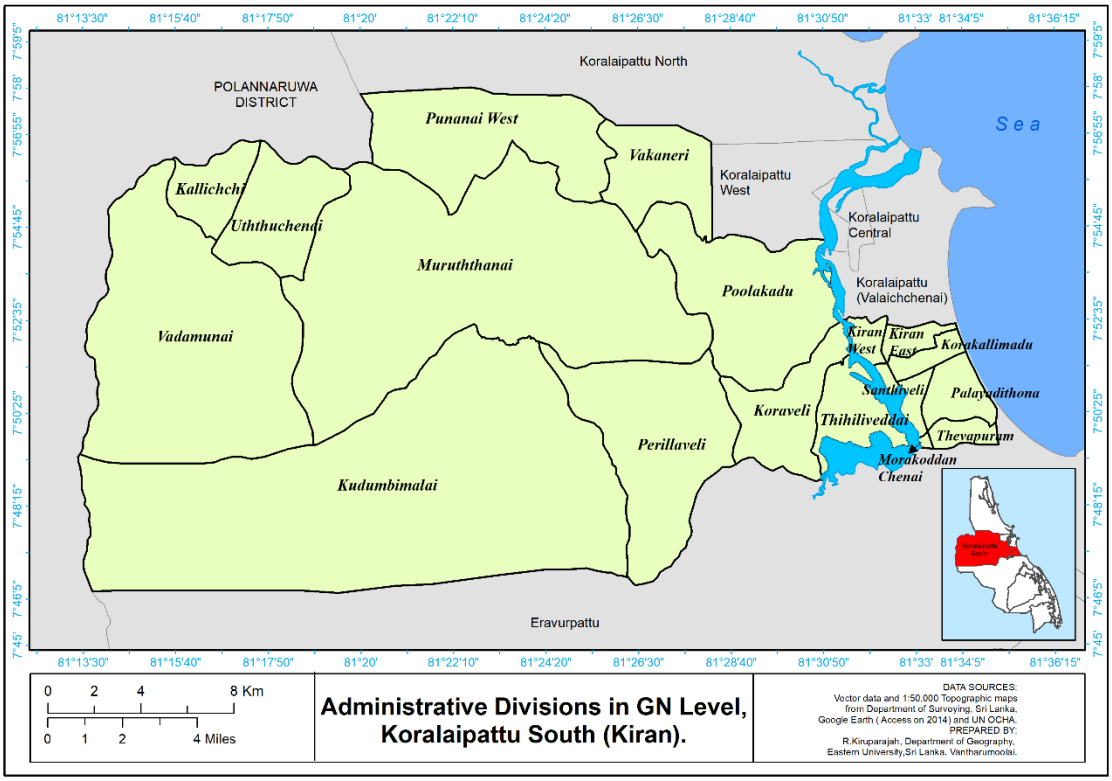

Figure 1: Location map of Study Area

The climatic region of the Koralaipattu South DSD, Batticaloa, is classified as tropical, and rainfall is significant with precipitation even during the Northeast Monsoon period (December – February) and second inter monsoon (October – November) period. Generally, the DSD experiences high rainfall in December and the least in March.

2.2 Data and Data Analysis

Data were collected from the places where HEC exists by using the following methods: interviews, observation, focus group discussion, analysed reports and documents, and GPS surveys. The relevant LULC classes were identified with the help of high-resolution Google Erath images, and the images were classified according to the classification scheme developed by the Survey Department, Sri Lanka. Interviews and the analysis of elephant dung samples with the GPS survey were used to identify the depredation pattern in paddy fields and other crops. Vector data of the district and DSDs of Sri Lanka from the Survey Department of Sri Lanka were used as the base map to extract the study area. ArcGIS 10.5, Google Earth Pro, Topographic map, and MS-365 Excel were used to perform the processing, mapping, and statistical analysis. The UTM projection in the ArcGIS platform was used to convert remotely sensed images from a geographic coordinate system (latitude/ Longitude) to a projected coordinate system (northing/

easting). The elephant presence was defined as the seasonal round within a grid cell. Elephants have been known to appear in cells with irregularities.

3. Result and Discussion

3.1 Land use/Land Cover (LULC)

In terms of land use and topographic condition of the area, Koralaipattu South Divisional Secretariat Division has significant features and various types of land use. The study found that forests, paddy lands, settlements, rivers, ponds, lakes, marshlands, and other croplands are significant land-use types in the study area. The Southern part of Koralaipattu is divided into 2529 grids, and each grid represents an area of ¼ square kilometers. Based on that, the land use pattern was identified. The lush forest is a significant feature of the area due to the water resources that prevail in the area. The Madhuru Oya river surrounds the forest while many other tributaries flow across this area, boosting the forest. The forest provides adequate food and ideal habitats for the wildlife elephants. Thus, it is acceptable for the locals to claim that there are no days without elephants. When viewing the spatial pattern of the land use based on the grids, 1239 grids represent forest cover, and it accounts for approximately ½ portion of the region's total land area.

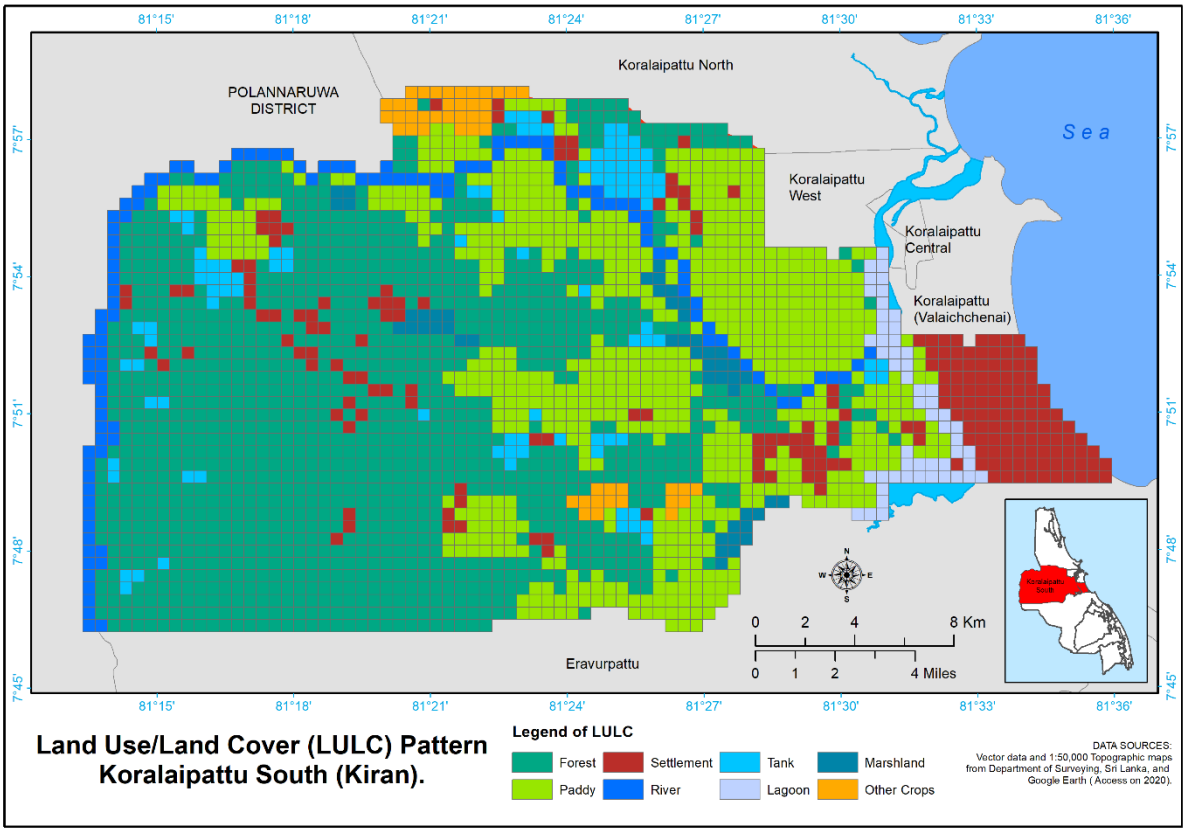

Figure 2: Land Use/Land Cover patters of Koralaipattu South Divisional Secretariat Division, Batticaloa

Paddy lands adjacent to the forest cover, being a primary source of livelihood in this area, is another important land use following the forest cover. The Madhuru Oya river, which flows through this region and joins the Valaichenai lagoon, is the prime water source for agriculture in this area. Moreover, seasonal streams and ponds are also a source of agriculture. In terms of the proportion of the paddy land out of total land, 694 grids represent the paddy lands. Due to the larger proportion of paddy land adjacent to the forests, the settlement adjacent between forest and paddy lands, elephants seek to meet their food needs, resulting in more human-elephant conflict (HEC).

The study found two settlement patterns in this area: densely spread nucleated settlement in the east and scattered settlement in the west adjacent to paddy lands and forest land. People in these scattered settlements are permanently exposed to human-elephant conflicts, and the elderly, children, and women face more difficulties than others. The eastern part of the study area is seen as a frequent path for the farmers between east to west for agricultural activities. They, too, become entangled in the human-elephant conflict while on their way to guard their agricultural fields. The extent of the settlement area represents by 222 grids. The settlement ratio from east to west is 50:50. The eastern settlement pattern represents 111 grids, while 111 grids represent the western settlement pattern. In terms of water bodies in the study area, rivers, tanks, lakes, and marshlands are important. Geographically, groundwater scarcity is one of the critical challenges in this area due to its topography, soil, and rock structures. However, the Koralaipattu division is enriched with surface water and, therefore, less prone to water scarcity.

The Madhuru Oya River has a significant impact on the region. Even though the water level in this area decreases seasonally, it is never at risk of scarcity. It irrigates paddy fields, irrigation ponds, wildlife, livestock, and other croplands in this region. The Madhuru Oya river is represented by 123 grids. Apart from these, the area consists of numerous small and large ponds. A tank called Vaganeri is the largest in this area. The 101 grid represents the distribution of tanks. There are three lagoons in the Batticaloa districts and Valaichenai lagoon approximately extends to 20kilometers in the central part of Batticaloa. The distribution of ponds in this area is represented by the 101 cells. and 14 kilometers (70%) come under the Koralaipattu South. Marshland can be found in

many areas of this region, specifically adjacent to ponds, rivers, lagoons, and canals. Forty-nine grids represent the marshlands of this area.

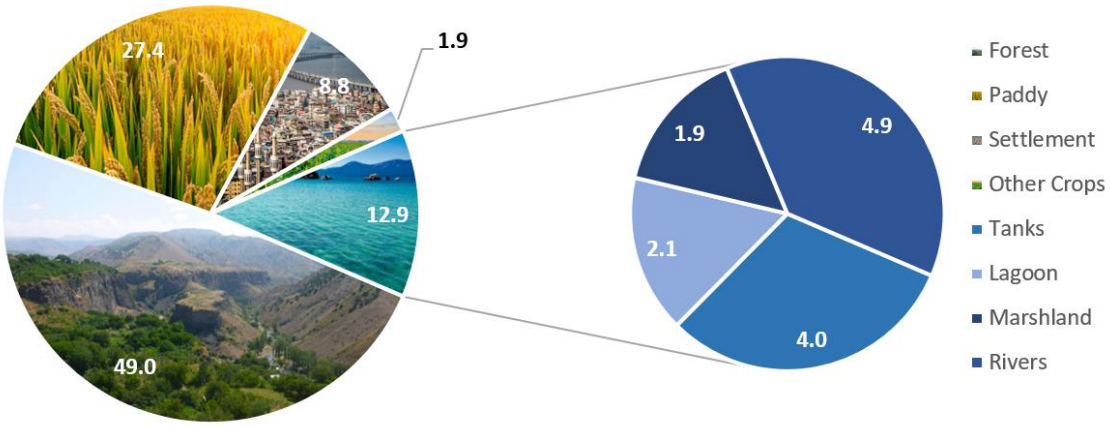

Figure 3: Land Use/Land Cover ratio of Koralaipattu South Divisional Secretariat Division, Batticaloa

The analysis shows that the land use of the study area, such as forests, paddyland, water bodies, settlement, other crops, accounts for 49%, 27.4%, 12.9%, 8.8%, and 1.9% respectively. Moreover, in terms of water bodies in the study area, rivers, lagoons, tanks, and marshlands are importantly identified, and they are found to be 4.9%, 4%, 2.1%, and 1.9%, respectively.

3.2 Presence of Elephants

The field observation confirms the rapid increase in the elephant movement in the Koralaipattu division. It was further confirmed by interviews and discussions with villagers, farmers, people who depend on forest resources for their livelihood, and development officers in charge of disaster management at the divisional secretariat. There was no disagreement found in this regard.

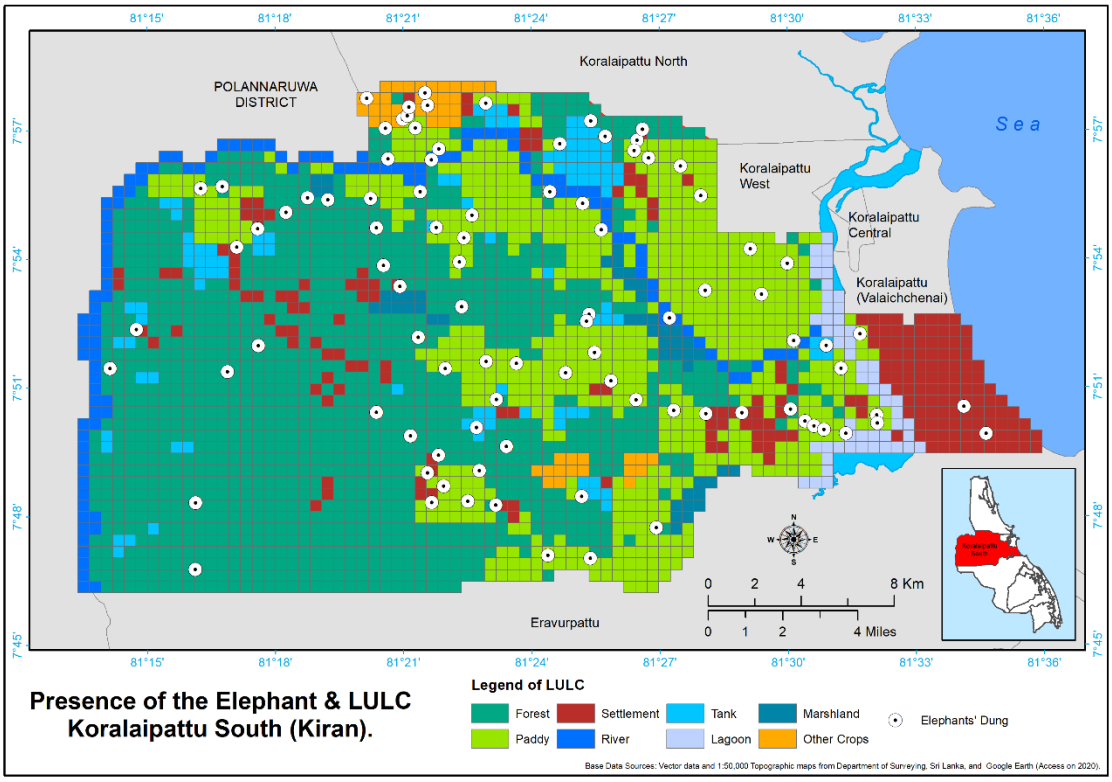

Figure 4: Overlapping the Presence of Elephants on LULC at Koralaipattu South Divisional Secretariat Division.

During the field visit, the dungs of the elephants were randomly identified, recorded by GPS technology, and mapped to detect the elephant movement and distribution and confirm the presence. Ninety-four spots were identified, which overlay with the LULC of the study area. It clearly emphasizes the pattern of the elephant movement in the Koralaipattu Division. Generally, the elephant's presence is identified along with the water bodies, paddy lands, other croplands, and settlement areas. Therefore, people who reside in this area are highly vulnerable to HEC.

It must be understood why HEC was so rarely found a decade ago. According to the peoples' observations and experiences, the past civil war has controlled the movement of the elephant population. According to them, the LTTE, who had been involved in the civil war, used the forest as their stronghold. The LTTE members' habitats and hideouts were mainly in the forest; thus, the movement of people was confined while being controlled. Moreover, they chased the elephants out and prevented them from returning for their protection. Consequently, a fewer HEC events were recorded as the movement of the elephant and people had been restricted. There were restrictions in place, such as confining the boundaries, forbidding the movement, and restricting the movement within an hour for crossing.

The discussions with people in 10 GN divisions, which recorded a higher number of elephant presence in the Koralaipattu Division, had the same consideration. They also point out that they live in fear of what will happen to them and their children at any moment. The analysis carried out on the dungs of the elephants confirms the perspective of the people. Further, people state that elephants destroy home gardens several times, it is no point to cultivate ~~the~~ coconut plants as elephants destroy them during the flowering season. The study found that elephants elicit more fear for villagers because they cause significant damage to the agricultural lands, destroy their properties and cause injuries and deaths. Elephants continue to destroy the crops such as sugarcane and cassava, fences and invade the villages.

Therefore, HEC has become a severe concern in this area. The risk of elephant attacks, both day and night, is the biggest problem that these villagers ~~face~~ who are living on the forest edges, have to face. Despite the initiatives taken by the Department of Wildlife Conservation, Forest Department, and Non-Governmental Organizations (NGOs) to reduce the HEC, the continuation of the problem indicates that existing practices are not adequate and ineffective. There are two methods in practice combative and preventive (Charles, 1996) to control the threat of elephants. The combative method includes destroying the elephant using various methods such as chasing the elephant using various methods, assaulting, poisoning, and trapping the elephant. Preventive methods refer to the initiatives that support protecting human life and elephants, such as elephant fencing, modification of cultivation practices, and educating and making aware of people.

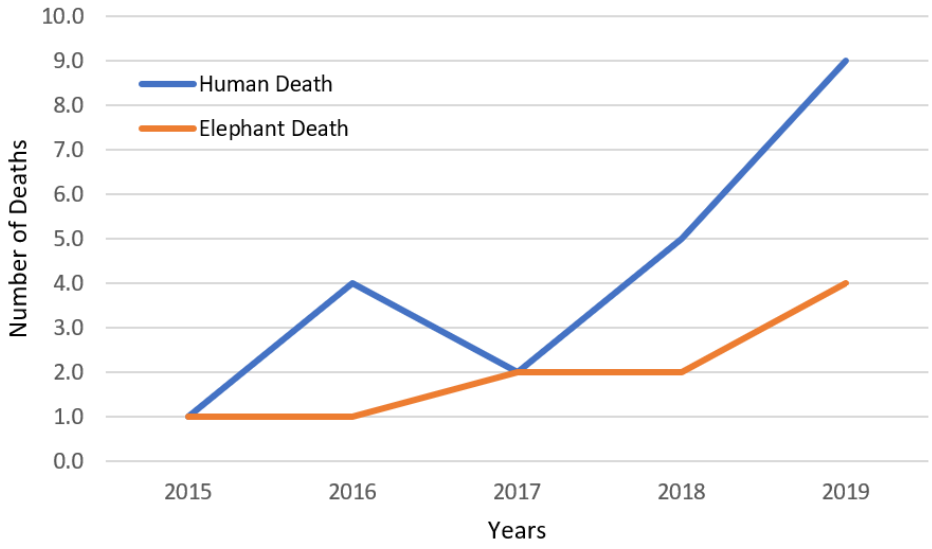

Figure 5: Trend of human and Elephant death by Human-Elephant Conflict at Koralaipattu South Divisional Secretariat Division.

According to the data, HEC is increasing, and many human and elephant casualties have increased. In the last five years (2015–2019), 21 human deaths and 12 elephant deaths have been reported in this area (Figure 5). Human casualties have occurred during the attack by elephants, invading the settlement area, crossing the forest trails, and colliding unexpectedly. Causes of elephant deaths have been identified as shooting, poisoning, and trapping. This situation indicates that the Koralaipattu division is highly vulnerable to HEC. The LULC of this area is potential habitat for permanent habitation for elephants. Since the elephant presence is found in almost all areas, severe concern is essential. Based on the field visits, observations, discussions, interviews, and statistics, deaths and property damages caused places to have been identified as high-risk areas. Property damages recorded areas were considered as moderate risk areas, while the areas that elephants roams were recorded as low-risk areas.

3.3 Spatial patterns of risk

Risk condition can be viewed in two ways based on GPS data; one is identifying the risk condition based on elephant presence once every two-week in periods of six months using the number of elephants dungs. Secondly, the total numbers of elephant dung represent every GN division throughout Koralaipattu DSDs.

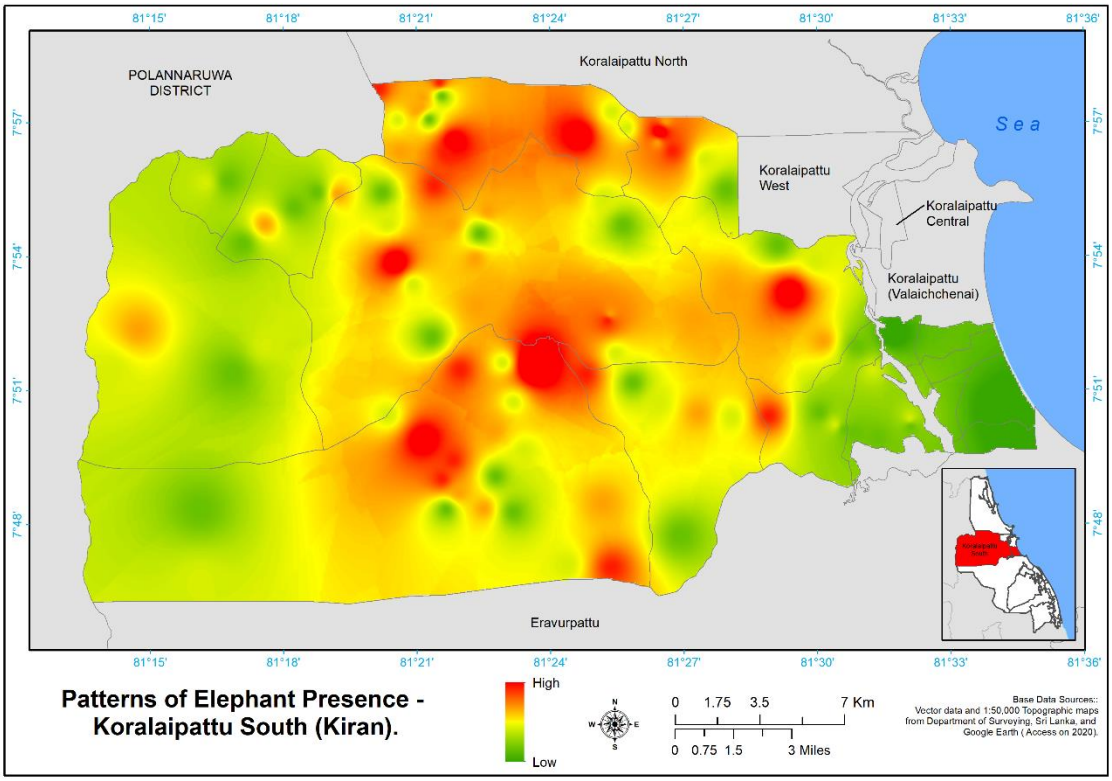

Figure 6: Spatial Pattern of dungs represent the Elephants' presence at Koralaipattu South Divisional Secretariat Division.

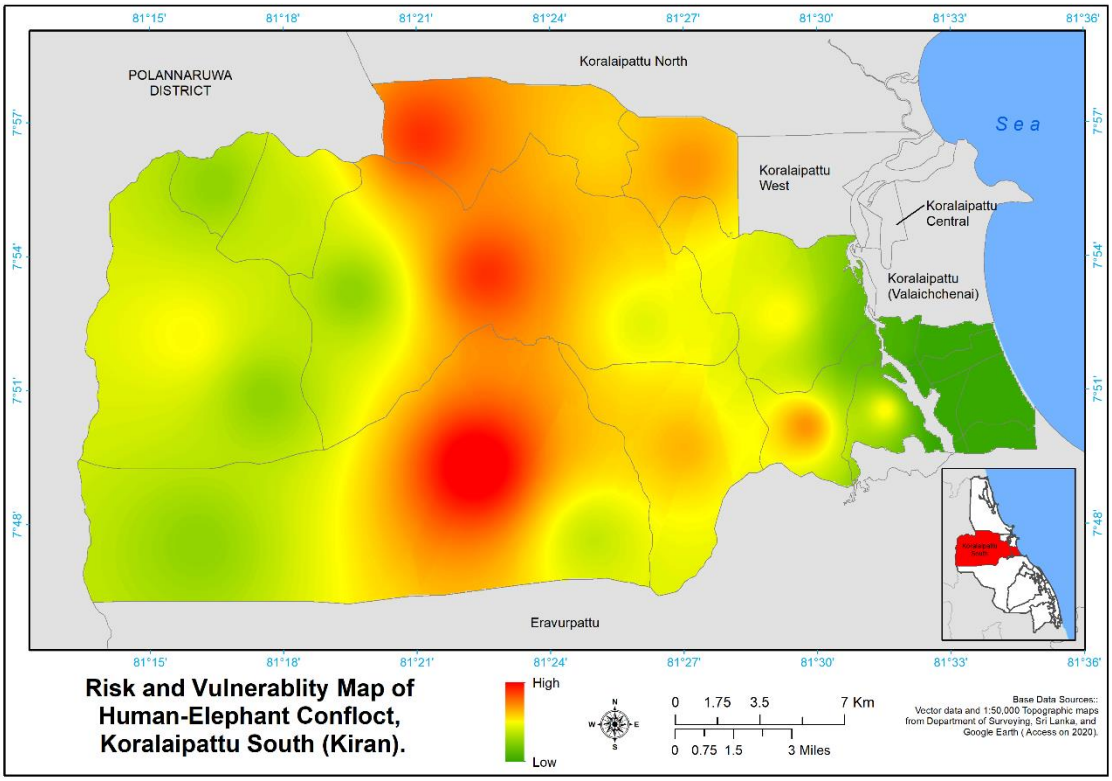

Figure 7: Spatial Pattern of the Elephants' presence shows based on the number of dungs collected throughout at Koralaipattu South Divisional Secretariat Division.

3.4 Challenges

The community in Koralaipattu South Divisional Secretariat, Batticaloa, encounters severe challenges by HEC in several ways. The study found that farmers, field workers, students, the fishing community, wild resource collectors, and dairy farmers are more vulnerable to HEC in this area.

Several crops, including coconut, sugarcane, cassava, and banana, are cultivated by the households in their surroundings. Since these crops are preferred foods of elephants, they enter the settlement area in search of food and cause havoc to them. Therefore, villagers can no longer cultivate crops that can fulfil their daily needs. Moreover, they store paddy in their homes for their future needs, knowing this the elephants cause damages to such residences. This situation has caused severe problems in stockpiling paddy for their needs. Therefore, people encounter difficulties to meet their daily rice needs and paying for them.

Apart from this, the movement of people has also been restricted in this area due to the Human-elephant conflicts. Going to the town, hospital, and other places to meet their needs, travelling by road is a challenge for these people. In particular, students must walk long distances while trekking along forest paths with fear. As the movement of the elephants has increased in the recent past, the school children's attendance is also poor due to the fear of HEC.

Moreover, since this area is a high potential area for livestock farming, dairy farmers also meet significant challenges in maintaining their livestock. If livestock farmers fail to return to their site before 5 pm, they have to face the risk of HEC. The reason is that after 5pm the elephants came on the road. Therefore, raising and maintaining livestock are seen as a significant challenge.

4. Conclusion

HEC has been a significant issue in the Koralaipattu Division for more than a decade. For various reasons, finding a permanent and immediate solution is a significant challenge, as it depends on various factors. One of the crucial factors is the complexity of delineating the accurate boundaries of the forest department and wildlife conservation department. However, some initiatives are being taken by the authorities and the communities to minimize the risk of HEC. However, the problem remains unsolved. Though the majority of the people living in this area are illiterate, they have gained experience and knowledge about their environment and the behavior of the elephants, which leads them to avoid the causalities and conserve the properties in some instances, irrespective of high presence of elephants in this area. People have taken some community-based initiatives to protect themselves, such as growing crops and trees along fences undesirable to elephants. These practices, however, are uncommon in the study area. As a result, the study concludes that appropriate strategies should be implemented to reduce HEC and ensure the safety of the people and elephant population in the Koralaipattu Division.

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