Threats to the Conservation of Asian Elephants: A review study

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ABSTRACT

The paper aims to examine the main threats to the conservation of the Asian elephants and identify the factors associated to these threats and their implications for the Asian elephants. We compiled and reviewed journal articles published between 2004 and 2014. We carried out a search using Science Direct, Springer Link, and Gajah. The information obtained was interpreted using thematic content analysis. According to the findings, the main threats to Asian elephants were habitat loss and fragmentation, human-elephant conflict (HEC), poaching and accidents. The rapid conversion of forests into plantations and human-dominated areas, including infrastructure developments, had reduced and fragmentised elephants' habitat and home range. As a result, elephants caused conflicts in the forms of crop raidings, property damages, human or elephants' injuries or deaths. The high demand and monetary return from elephant body parts trafficking, particularly ivory, are the main reasons that threatened elephant population. The fragmentation of elephants' habitat due to conversion of forests into plantations, human-dominated areas and infrastructures developments also increased poachers' accessibility. Furthermore, the study found that poverty and corruption also contributes to elephant poaching. Besides that, literature also shows that snare injuries, HEC, abandoned mining areas and train movements were causes to accidents that threatened elephants.

Keywords: *Asian elephants, endangered species, habitat loss and fragmentation, human-elephant conflict (HEC), poaching.*

INTRODUCTION

Asian elephants are geographically distributed in thirteen Asian elephant range states namely India, Bangladesh, Nepal, Sri Lanka, Thailand, Cambodia, Vietnam, Malaysia, Indonesia, China, Myanmar, Laos, and Bhutan. According to the most recent statistics, it is estimated that the current population of Asian elephants lies between 35,791 and 49,626; India holds the largest number of wild Asian elephants with approximately 22,800 to 32,400 Asian elephants (Santiapillai & Sukumar, 2006). According to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Asian elephants are an endangered species since the 1970s ("Status of elephant populations," 2011). Indeed, the population of Asian elephants living in the wild has reduced to at least 50 percent within the last three generations (Choudhury et al., 2015; IUCN, 2012).

The main subspecies of Asian elephants include elephants from Asia mainland (*Elephas maximus indicus*), Sri Lankan elephants (*Elephas maximus maximus*), Sumatran elephants (*Elephas maximus sumatranus*), Borneo Pygmy elephants (*Elephas maximus borneensis*) and the Indian elephants (*Elephas maximus indicus*) (Choudhury et al., 2015; Santiapillai & Sukumar, 2006; World Wide Fund for Nature (WWF), n.d.). However, some have considered Borneo Pygmy elephants to be a different species because according to mitochondrial DNA (mtDNA) analysis, the Borneo Pygmy elephants samples collected from Borneo are different from the rest of the elephant samples collected from the Asian elephant range states (Fernando et al., 2003). Furthermore, although Borneo Pygmy elephants are native to Borneo Malaysia and Indonesia, the microsatellite loci analysis indicated that Borneo Pygmy elephants are unlikely to be the same species as the Asian elephants and are different from the Asian elephants living in Peninsular Malaysia (Fernando et al., 2003). Therefore, the present study focuses on Asian elephant species which inhabited on the mainland of Asia and excludes Borneo Pygmy elephants from the review.

Considering that Asian elephants consume high amount of vegetation ranging from grass, shrubs, herbs, climbers to trees; they forage about 17-19 hours in a day. Asian elephants are the largest land herbivore and keystone species and play a significant role as environment gardener which are important to a forest ecosystem (Baskaran et al., 2010; Samansiri & Weerakoon, 2007; Vancuylenberg, 1977). Elephants are excellent seeds disperser too (Vancuylenberg, 1977). The gut passing time of the eaten

seeds also influenced the viability and germination of seeds (Sukumar, 2003; Campos-arceiz & Blake, 2011). For example, experiments conducted by Diana Lieberman showed that the process of ingestion has increased the rate of seeds germination of two types among 11 types of seeds in Ghana's moist forests (Sukumar, 2003). Thus, various types of fruit and plant seeds are being dispersed. Examples of commonly dispersed general plant families by elephants are Fabaceae, Malvaceae, Saporaceas, Poaceae, Moraceae and Euphorbiaseae with over 20 species being dispersed from each family (Campos-arceiz & Blake, 2011). Since elephants only digest slightly over 50 percent of vegetation they consume, their defecation often resulted in incomplete digested dung samples and the partially digested organic matters contained in elephant dung provide alternative habitat resources to organisms with similar function as leaf litter (Campos-Arceiz, 2009; Samansiri & Weerakoon, 2007). That is, elephant dung is an ideal microhabitat for insects, vertebrates and amphibians. Therefore, elephants also contribute to the spatial diversity, population dynamics, and seedling germination of various plant taxa in the forests. Yet, research on the causes and implications of the threats to Asian elephant remained scarce as compared to African elephants. Hence, this review paper aims to examine main threats to the conservation of the Asian elephants and identify the factors associated to these threats and their implications to the Asian elephants.

METHODS

The reviewed published academic journal articles were obtained from Science Direct, Springer Link, and *Gajah* that were published between 2004 and 2014. Science Direct and Springer Link were selected because Universiti Putra Malaysia (UPM) subscribes to two of these high quality publications. Furthermore, *Gajah* was selected because it is a bi-annual journal of the Asian Elephant Specialist Group (AsESG) from Species Survival Commission (SSC) in The World Conservation Union (IUCN); it focuses on the conservation related issues of Asian elephant from all Asian elephant range states. Although the time criteria was between 2004 and 2014, other related academic journal articles published not within the time criteria and a book on *The Fate of The Elephant*, as well as web pages were included as supplementary to discussion section based on their relevance to this paper.

Primarily, the keyword use for the title search was "Elephant" and the period of publication was 2004 to 2014. Then, the search results were filtered with

keywords "Asian Elephant" and "*Elephas maximus*". After obtaining the search results, the articles that focus on biological aspects of Asian elephants; elephant's epistemology; social organization; mahout and veterinary related workshop or training; historical geography; African elephant; and other wildlife such as Elephant seals, Elephant fish, and Elephant grass were excluded. Book reviews, short communications, editorials, epilogues, and correspondences throughout the search were also excluded from this study. Within the first search results and initial selection of publications, a second search was carried out to limit the results to articles carried out within Asia only. A total of 76 out of 576 journal articles were selected. The selected journal articles were analyzed using thematic content analysis assisted by the qualitative analysis software NVivo 10.

MAIN THREATS AND ITS CAUSES AND IMPLICATIONS TO ASIAN ELEPHANTS

The results from the thematic content analysis indicated that the most common threats to Asian elephants cited in the literature are habitat loss and fragmentation; human-elephant conflict (HEC); poaching; and accident. The large conversion of land use from forests into plantations and human-dominated areas, including infrastructure developments, has significantly reduced and fragmentised elephant habitats and caused HEC. The loss and fragmentation of habitats can cause inbreeding depression which, in turn, may affect the reproduction of Asian elephants. Elephant poaching was associated with the high demand and monetary return from ivory trades. Societal problems were also associated with poaching in the literature. The accidental killing of elephant was described in the literature as caused by snare injuries, abandoned mine pits and train collision. Accidental electrocution and translocation related accidents resulted from poor management and maintenance of HEC mitigations can threaten the species likewise. These 4 main threats are described in detail in this section.

Habitat loss and fragmentation

Habitat loss and fragmentation is defined as the disappearance and segmentation of forests into patches due to the rapid conversion of forested areas into plantations and human-dominated areas resulted from human developments (Blake & Hedges, 2004; Hedges et al., 2005). As a direct result of such large conversion of forests into plantations for food and cash crops

(eg. rubber, oil palm etc), the most rapidly expanding agricultural sectors have swept the forested areas in the last 4 decades, particularly in Southeast Asia countries (Azmi & Gunaryadi, 2011; Mukherjee & Sovacool, 2014; Santiapillai & Wijeyamohan, 2003). The constructions of infrastructure have also lead to loss of elephants' habitat in elephant range states to support the perpetual growth of human population. Furthermore, the rise of rubber price in the market resulted from the increasing demand of rubber latex products (e.g. tires, gloves, etc.) and rubber wood furniture, has much increased the forests conversion into rubber plantations in Southeast Asia. For example, the rubber wood export of Malaysia constituted as much as 26 percent in 1998 and rise up to 35 percent in 2007, stemmed from the increased of rubber wood furniture demand (Shigematsu et al., 2011). Therefore, Southeast Asia's rubber plantations shared an average of 83 percent out of the total planted area of rubber in the world between 1985 to 2005 (Shigematsu et al., 2011). Worse still, the introduction of Latex Timber Clone (LTC) rubber tree also further diminishes the elephant habitat, because LTC rubber trees have increased the production of latex in addition to a shorter production period as compared to the ordinary rubber tree species. Subsequently, large forested areas in Malaysia were replaced with LTC rubber tree plantations (Clements et al., 2010). Similarly, less than 0.02 hectare (ha) per capita of forest has remained in Bangladesh due to massive conversion into plantations (Islam et al., 2011). Thus, the increased of rubber price due to increasing demand to rubber latex products and rubber wood furniture, as well as the introduction of LTC rubber trees has caused the massive conversion of forests into rubber plantations.

Palm oil plantations have also contributed towards the deterioration of elephants' habitat. The high demand of crude palm oil (CPO), palm kernel oil, and biofuel have encouraged forest clearance for oil palm plantations. This is because CPO and palm kernel oil is widely used as one of the sources of edibles oils and fats for human consumption while biofuel is highly needed to achieve sustainable feedstock for biodiesel production as an alternative renewable fuel for future (Mba et al., 2015). With the perpetual growth of human population, the production of CPO in Malaysia has increased from 2.6 million tonnes in 1980 to 15.8 million tonnes in 2007 (Lam et al., 2009). Besides the production of CPO and others from oil palm seeds, oil palm trees are also being burned to produce biofuel such as biodiesel and bio-jet fuel. In Indonesia, for instance, the biodiesel export has accelerated to 1.2 billion liters, which eventually caused the loss of 20 million ha of forest to oil palm plantations (Leimgruber et al., 2011). As a result, more forests are being converted into oil palm plantations.

In addition, utilities and infrastructure developments such as roads, highways, railways, human settlements have reduced and fragmentised the elephants' habitat. Consequently, the loss and fragmentation of forests or elephants' habitat are reducing the available food sources and home ranges to the elephants. Moreover, the migratory routes of elephant located within forests might also be disrupted, because the infrastructures are being built on the routes. With the limited home range to forage and move, elephant herds might be trapped within already limited forest patches and formed into several isolated populations or pocketed herds (Chadwick, 1992; Matsubayashi et al., 2006). Such herds can also suffer from inbreeding depression which refers to a genetic disturbance on the genetic traits of Asian elephants caused by close breeding with members in the same herd. This is because the formation of pocket herd or isolated population of elephants due to herds displacements into remaining patches of forest has reduced the social communication and interaction between elephants and subsequently increased the possibility of inbreeding depression (Ahlering et al., 2011; Debata et al., 2013; Santiapillai & Sukumar, 2006; Sitompul et al., 2008; Sukumar & Santiapillai, 2006). As a result, the good genes might be depleted if the situation became adverse.

Asia elephant range states have implemented the system of protected areas (PAs) to tackle the impacts from habitat loss and fragmentation. For example, 3 national parks have been established solely for the protection of elephants in Sri Lanka, namely Lunugamvehera, Minneriya and Kaudulla (Santiapillai et al., 2006). It can be argued that the establishment of PAs is able to protect the remaining elephants' habitat, yet, the existing ranges in PAs might not be adequate to host the entire huge population of Asian elephant, such as in Sri Lanka (Santiapillai et al., 2006). Likewise, inadequate funding and incapacity to manage and maintain PAs can be the possible hindrance to the better management of PAs (Islam et al., 2011). Nevertheless, the conservation of areas outside PAs is also important for better conservation of Asian elephants (Fernando et al., 2008). This is because elephants tend to forage in secondary forests, given that secondary forests allows more varieties of vegetation to grow, especially on the forest floor, and creates water reservoirs (Baskaran et al., 2010; Perera, 2009; Santiapillai et al., 2006). Although PAs have been established to conserve elephants' habitat, more researches on the foraging behavior of elephants shall be funded to assist and improve the existing system of PAs considering the importance of secondary forests.

HUMAN-ELEPHANT CONFLICT (HEC)

In the study, human-elephant conflict (HEC) is defined as the negative interactions of humans and elephants when they coexist in a same landscape. These negative interactions often result in destruction of crops and properties as well as in human or elephants' injuries and deaths. For example, between June 2000 and September 2002 HEC has caused a total of 771 crop losses; 21 house damages; 3 human deaths; and 1 human injury in Bukit Barisan Selatan National Park (BBSNP) and Way Kambas National Park (WKNP) in Indonesia (Hedges et al., 2005; Perera, 2009). The habitat loss and fragmentation resulted from massive conversion of forests have reduced the available food sources to elephants. Subsequently, elephants are being pushed to forage at plantations or human settlements for food, water and minerals and face retaliation from farmers.

Cultivation practices such as slash and burn has also increased HEC. When the farmers burn the forested areas to clear the land for cultivation, they indirectly destroy the elephant habitat. That is because slashing and burning clear out the soil completely and faster than other deforestation methods. For example, it was reported that between 1995 and 2004, 250 hectares (ha) of forested areas located between the boundaries of Deramakot Forest Reserve was burnt for agricultural cultivations, contributing towards the devastating habitat loss and it resulted in a closer contact between elephant and humans (Bal et al., 2011). The disruption of elephants' migratory routes by human developments have also blocked elephants path to their seasonal forage areas, forcing the elephant herds to intrude into nearby plantations or human settlements to search for food, water and mineral sources or cross to another area. As a result, the disruption of elephants' migratory routes increases crop raiding and therefore exacerbate the HEC (Haturusinghe & Weerakoon, 2012; Joshi & Singh, 2007; Saaban et al., 2011). On the other hand, the concentration of elephants' favorite crops such as banana, oil palm and sugarcane attracts more crop raiding and increases HEC (Campos-arceiz et al., 2009; Debata et al., 2013; Sahu & Das, 2012). Consequently, banana and oil palm plantations located near Mekong and Yunnan, are frequently intruded by elephant herds, especially during harvesting period (Luo, 2007).

Crop raiding and HEC incidences can result in monetary losses and in human and elephant injuries and fatalities, as well as financial and emotional stress to farmers and villagers. Although wildlife officers take all the necessarily measures to protect the elephants, elephants are legally killed when they

caused immediate danger to people around. Farmers will go to any extent to protect their crops and properties from damages caused by elephant raiding. As humans attempt to stop or push away the 'trespassing' elephants, they drive the elephants into rampage which at the end will result in crop and property damages and human and elephant injuries and fatalities. Worse still, since rampant elephants will not back away easily from plantations or houses, they often end up being punished through intentional shooting, poisoning and electrocution, for instance, at least 200 raiding elephants were condemned in India within 2006 to 2011 (Baskaran et al., 2011; Doyle et al., 2010). That is why villagers are not supportive of any conservation initiatives.

Legal culling, being one of the HEC mitigations also can decrease elephant population (Azmi & Gunaryadi, 2011; Saaban et al., 2011). With the rapid occurrence of HEC caused by habitat loss and fragementation, elephant deaths might increase due to growth of legal culling of conflicted elephants. After all, the main purpose of legal culling is to protect human lives and properties at any cost, rather than protecting the elephant population. It can be argued that other HEC mitigations have been implemented to tackle HEC instead of legal culling, however, HEC cases seem to remain stable. For example, approximately 828 HEC complaints were reported on average to the Department of Wildlife and National Parks (DWNP) Peninsular Malaysia between 1998 and 2010 (Saaban et al., 2011). Although fire crackers burning, drums beating, engine oil burning have been substituted by translocation and electric fencing, as the main HEC mitigations, inadequate funding reimbursement and maintenance can be one of the possible reasons that deterred effective HEC mitigations (Jigme & Williams, 2011; Leimgruber et al., 2011; Maltby & Bourchier, 2011; Santra et al., 2007; Sukumar & Easa, 2006).

Apart from that, literature shows that electric fencing is a non-lethal alternative that is able to prevent elephants from entering into plantations and into human settlements, but electric fences are expensive to install and maintain (Perera, 2009; Sukumar & Santiapillai, 2006). In addition, the lack of monitoring of these electric fences has contribute to frequent 'fence breakers' and the lack of maintenance from authorities or private owners has deterred the efficiency of electric fences (Joshi & Singh, 2007; Perera, 2009). Worse still, fence equipment is being stolen and causes the electric fences to malfunction (Pradhan et al., 2011). For instance, villagers often steal wooded posts of electric fencing for firewood burning (Santra et al., 2007). Additionally, it is also very difficult to maintain and monitor the effectiveness

of electric fencing consistently without the cooperation from the plantations owners or workers in the plantations, thus, geographical factors and strong knowledge on Asian elephant's social behaviour shall be considered when erecting the electric fences (Gunaratne & Premarathne, 2006; He et al., 2011; Joshi & Singh, 2007; Santra et al., 2007). Hence, poor governance in terms of management and maintenance of erected electric fences can deter HEC mitigations. It can be argued that electrocution incidents of elephants due to such installation can be simply caused by the strong wind and fallen trees which exposed elephants to the power lines (Choudhury & Vivek, 2006; Santiapillai et al., 2006). Literature also shows that some electrocution cases were caused by illegal tampering of high tension wires by farmers to curb crop raiding (Doyle et al., 2010; Gubbi et al., 2014; Haturusinghe & Weerakoon, 2012; Joshi & Singh, 2007; Perera, 2009; Pradhan et al., 2011). Notwithstanding that, the installation of electric fences is still needed to protect elephants from intrusion into plantations or human-dominated areas considering issues related to poor management and maintenance of electric fences and electrocution.

Besides that, translocation is another main HEC mitigation to alleviate HEC in elephant range states; it refers to the relocation of elephant from the conflicted areas to another area. In Peninsular Malaysia, over 600 elephants were translocated to Taman Negara National Parks, Royal Belum State Park, Endau Rompin National Park since 1970's (Saaban et al., 2011). However, it can be argued that translocation only moves the problems to a new location instead of solving the problem (Perera, 2009; Roy et al., 2010; Sukumar & Santiapillai, 2006). Some elephants may also go back to the initial location, as elephant believed to have high fidelity towards their habitats and spatial temporal memory to guide them back to their initial habitat (Fernando et al., 2012). Although other HEC mitigations have been implemented across Asian elephant range states to curb HEC, yet, the installation of electric fences and translocation remained crucial regardless of their weaknesses in poor maintenance and management. This is because the combination of several HEC mitigations might be the key to better mitigation given that the nature of HEC cases can be very different within or between range states (Khounboline, 2007; Perera, 2009; Zimmermann et al., 2009). Thus, research tackling the effectiveness of HEC mitigations shall be encouraged.

Poaching

Poaching is defined as hunting of elephants or its derivatives to be traded for profit. Elephants are being poached for ivory, meat, tail hair, hide, trunk

and foot trafficking (Choudhury & Vivek, 2006; Sukumar & Santiapillai, 2006). Poaching elephant for body parts trafficking is banned by the 1973 CITES ivory trade ban in Africa and Asia. However because ivory has a high commodity value and persist illegal ivory trade to support the ivory demand, the ivory price remained stable or decreased (Lavigne, 2010; Stiles, 2004). Subsequently, trade ban has not effectively reduced ivory trade and it might have increased the poaching of Asian elephants, such as in Myanmar, Thailand and China (Stiles, 2004). In addition, massive conversion of forested lands into plantations and infrastructure developments had forced elephants into living in a smaller area and increased poachers' accessibility (Naylor, 2005). As a result, elephants become more visible and easy targets for poachers (Lavigne, 2010; Mohd Azlan, 2006). Therefore, high demand and monetary return from ivory trade and habitat loss are much likely the reasons to the increment of illegal poaching and decrement of elephant population. People can argue that poverty in the rural areas of the Asian elephant range states and corruption among local state authorities have also contributed towards the increment of elephant poaching (Hedges et al., 2005). Even though they are aware of the risk to be killed during elephant poaching, they have no choice due to poverty. Thus, poor governance in societal problems can become another major threat for the remaining elephant populations if proper solutions were not taken to curb societal problems.

Accidents

The accidents induced by the poaching of other animals and HEC are also a threat to the elephants, for example, accidental killing of elephants from snare injuries, collision with train, abandoned mine pits and electrocution (Perera, 2009; Santiapillai et al., 2006). Snares to poach other smaller mammals might injure elephant trunk and foot when they accidentally touch and step on it. Worse still, the snare gets entangled around elephant's trunk or foot which will further restrict elephants' movement to forage and socialise (Alfred et al., 2011). As a result, elephants may die from malnutrition. Some elephants were killed because of falling into abandoned gem pits or mining areas (Maltby & Bourchier, 2011). Consequently, injured elephant will die, because they might not able to walk to search for food or water and to eat or drink (Becker et al., 2013; Saaban et al., 2011). Arguably, the occurrences of such accidents might not be significant enough to decrease the existing population of elephants given that the size of elephant is huge. Nevertheless, the increased train movements can possibly hit the elephants and caused deaths during crossing (Roy et al., 2009). Worse still, the high speed moving

trains can cause immediate death of crossing elephants (Roy et al., 2010). For example, in Odisha, India, 16 elephants were killed due to collision with trains between 2000 to 2013 (Palei et al., 2013). Hence, cases of elephants being killed in accidents can be possibly increased since massive conversion of forests to plantations, human-dominated areas and utilities is rapid.

CONCLUSION

The major conversion of forested lands into plantations and human-dominated areas including infrastructure developments such as construction of roads, highways, railways, human settlements and others, have led to the massive reduction and fragmentation of elephant habitats in recent decades. The plantations are often planted with crops of rice, wheat, banana, sugarcane, and oil palm for extraction of palm oil and rubber which dominate forests conversion in Southeast Asia. In addition, the continuous reductions and fragmentations of habitats and available food sources have driven elephants to intrude into plantations; raid crops; damage properties; and injured and killed people. The grouping of all high quality and elephants' favorite crops in a particular area rather than naturally scattered around as in the forests has also lead elephants to forage in the plantations instead of the forests. Furthermore, cultivation practices have also resulted in severe habitat loss and fragmentation as forest is being burned by the farmers to clear for cultivation. The loss and fragmentation of habitats also disrupts the migratory routes of elephants; force the formation of pocket herds or isolated populations, which may indirectly bring into inbreeding depression. Moreover, poaching and accidents also threatens the elephant population. Thus, the results of this study indicate that habitat loss and fragmentation; HEC; poaching; and accident are the current main threats to Asian elephants in elephant range states.

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