Elephants, Roads and Drivers: Case Study of Gerik-Jeli Highway


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At the start of 2018, the United Nations estimated that world population had reached 7.6 billion. Today, there are few untouched natural habitats left, where wildlife can live without crossing paths with humans and our activities. Linear infrastructures, such as roads, are rapidly proliferating all over the world.

Southeast Asia, in particular, is undergoing rapid economic growth and experiencing a massive, unprecedented expansion of road coverage. This is also the region with a large number of threatened megafauna, such as elephants, tigers, and tapirs. The largest terrestrial animal in Asia, the Asian Elephant (Elephas maximus), is already endangered due to the rapid decline in its population, due mostly to habitat loss and the resulting human-elephant conflict in the form of crop raiding (Fernando & Pastorini, 2011). The expected infrastructure development over the coming decades will most likely further threaten elephants and other megafauna in the region.

Roads affect animal behaviour, movement and distribution. Roads also affect wild habitat by modifying the environmental conditions in their vicinity, for example, by allowing more sunlight to penetrate to the ground and altering humidity and temperature. This is known as the "edge effect" and the result is changes to plant and wildlife populations as well as community structures in areas bordering roads and in other habitat fragments.

Roads impede wildlife movement and ability to use resources in the habitat. On a larger scale, roads can reduce landscape permeability and connectivity by acting as barriers that cause fragmentation and isolation of wildlife populations. Small populations are usually more vulnerable to local extinction due to inbreeding and stochastic events.

Elephants are particularly susceptible to landscape changes and the effect of roads as barriers. They are intelligent and sentient beings with a high attachment to traditional and very large home ranges. Adult females, especially the matriarchs, store in their memory intricate details of the landscapes, including movement routes that have paid rich dividends in the past (e.g. they remember where to find resources such as salt-licks, fruiting trees, grasslands and water). This perhaps explains why general patterns of elephant movements and habitat use have remained relatively unchanged for more than a century when one compares Sanderson's (1878) description of elephant movements with a study conducted by Sukumar (1989) in the same region of southern India.

Peninsular Malaysia is an important stronghold for wildlife, including Asian Elephants (*Salman et al., 2011*). Development has led to many land use changes in the country. The peninsula has lost its forest cover from nearly 80% in the 1940s to less than 37% in 2010 (Miettinen, Shi, & Liew 2011).

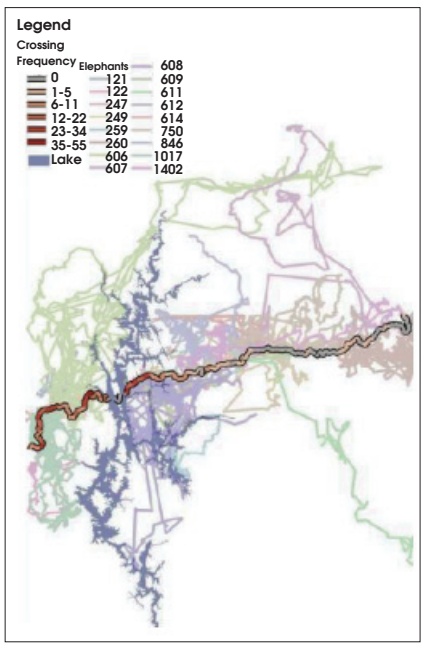

Figure 1: Map showing the frequency of road crossings by GPS collared elephants along the Gerik-Jeli Highway

Recognising the importance of the country's biodiversity and the dangers of a "business as usual" approach, the Malaysian Government has developed legislation and policies to protect its wildlife. The Central Forest Spine (CFS) is a very important national land-use master plan to maintain habitat connectivity for wildlife across major habitat patches in Peninsular Malaysia (DTCP, 2009).

The implementation of the CFS plan involved the construction of several viaducts under existing highways to facilitate wildlife crossing. The conservation of Asian Elephants in the peninsula is guided by the National Elephant Conservation Action Plan (DWNP, 2013). Scientific evidence from research will greatly help the implementation of these national plans. Here we present some of our on-going work on understanding how a major road affects the movements of elephants in Belum-Temengor, a priority landscape for elephant and tiger conservation.

COMPLEX EFFECT OF ROADS ON ELEPHANTS

Our study (*Wadey et al., 2018*) used GPS telemetry data and a mechanistic movement modelling framework to understand when and where wild elephants crossed the Gerik-Jeli Highway, a 120km long road that bisected the Belum-Temengor Landscape (BTL, Fig. 1).

The highway is fully asphalted, with a width of 2-3 lanes (~25 m), and often has additional structures such as steel and concrete barriers as well as concrete drains along its sides. Between 1970 and 1995, the forest reserves that run parallel to the road were heavily logged.

Wadey et al., (2018) monitored 17 wild elephants (10 local and 7 translocated from conflict areas) and found that local elephants crossed the road 14 times more frequently than translocated ones, indicating that familiarity with the landscape was important for elephants (Fig. 1). Elephants also crossed the road predominantly at night (81% of crossings were between 7.00 p.m. and 7.00 a.m.), when traffic density was lower. A study done in India found that Asian Elephants crossed roads in a wildlife sanctuary in order to get to a water source during the dry season, but they also showed higher levels of agitation in response to disturbance from vehicles (*Vidya & Thuppil, 2010*).

The Malaysian study also found that the Gerik-Jeli Highway acted as a strong barrier to elephant movements, with an 80% reduction in permeability.

However, the relationship between elephants and the road is very nuanced and although the road seriously disrupts elephants' availability to move from one side to the other, it also acts as an attractor as elephants spend a lot of time feeding on the abundant fodder on the roadside.

In another study in the same landscape, we found that elephants staying near the Gerik-Jeli Highway were able to consume more of their preferred food, such as grass and other early succession plants, while elephants far (> 5km) away from the road had to consume more woody plants (*Yamamoto-Ebina et al., 2016*).

Asian Elephants are known to be edge specialists (Campos-Arceiz, 2013) and so they are attracted to the roadsides. They are often labelled as mega-gardeners of the forest due to their important ecological role as agents of seed dispersal (i.e. they consume large-seeded fruits like mango and durian and disperse the seeds in new places for the next generation of trees to grow; Campos-Arceiz & Blake, 2011). Given that the road affects their diet and movements, elephants that stay near the road end up consuming a much simpler diet, with less wild fruit and they disperse seeds over shorter distances than elephants living in the primary rainforest.

The steady increase in traffic volume (~4% annually between 2005 and 2014; MoWM, 2014) along the Gerik-Jeli Highway can eventually deter elephants from crossing the road altogether, majorly impacting habitat connectivity between Belum and Temengor. In 2017, two elephants, a juvenile and a sub-adult, were killed in a collision with a vehicle on this highway (Fig. 2).

Figure 2: Juvenile elephant killed in a car accident on 16 June, 2017, along the Gerik-Jeli Highway

Figure 3: A translocated elephant killed by poachers for the tusks

In addition, two of the nine (22%) males we tracked in the Belum-Temengor landscape were poached for their ivory (Fig. 3) within 3 km from the road. The BTL is considered one of the hotspots for poachers. According to WWF-Malaysia (2011), there are at least 80 access points which facilitate poaching along the 120km highway in BTL. The road has become what is called an ecological sink (or ecological trap) because elephants are attracted by the abundant food but also suffer negative effects on their movements and safety due to collisions and poaching.

VIADUCTS, DRIVER BEHAVIOUR AND MITIGATING THE IMPACT OF ROADS

Towards the end of our study, the Malaysian Government had constructed a wildlife viaduct along the Gerik-Jeli Highway. Our elephant movement data was collected prior to the establishment of the viaduct and we cannot, therefore, judge its effectiveness, although before the viaduct construction we detected

only one road-crossing event in that area.

Follow-up studies are now necessary to monitor the movement of elephants near the viaduct to assess its effectiveness in facilitating landscape connectivity for elephants and other wildlife. In any case, a single viaduct across such a long stretch of road is not sufficient to provide landscape connectivity for elephants. The viaduct should therefore, be considered as part of a suite of mitigation tools, rather than as a silver bullet to maintain permeability in the BTL.

Although much has been discussed about green infrastructure (e.g. viaducts), the role of infrastructure user behaviour has been largely neglected so far, in spite of its high potential to mitigate the impact of roads on wildlife.

The predominant determinant of the risk of motorist-wildlife collision is vehicular speed. Reducing speed, either through speed limits or physical barriers such as speed bumps, will go a long way towards reducing collisions. The enforcement of low speed limits in wildlife habitats should therefore be a priority. But even when motorists adhere to speed limits, collisions with wildlife can still happen when motorists fail to perceive and react to the presence of wildlife. When motorists do not anticipate encountering hazards, such as in rural and forest areas, they are prone to "inattentional blindness" (i.e. failure to perceive something that exists in their field of vision). This means that while motorists "see" an animal on the roadside, their brains fail to "perceive" it, so the motorists will either not react or react only when it is too late. The risk increases if motorists are driving faster in rural and forest areas than they usually do in urban areas.

Inattentional blindness can also occur when the driver is fully engaged in focusing on stimuli relevant to driving (e.g. other vehicles on the road) and does not perceive an additional stimulus (e.g. wildlife on the roadside). Cognitive psychology has identified that it is easier for us to detect an additional stimulus that shares features and characteristics with the task at hand than it is to detect a vastly different stimulus. For example, studies have shown that drivers perceive pedestrians and animals more readily in an urban context as opposed to a rural context (Palmer & Blink, 2013), implying that drivers may associate non-urban driving with hazard-free smooth driving. This is indeed a problem when it comes to motorists driving through forested areas with wildlife crossing the road!

A MEME's satellite-collared elephant walking near the barrier along the Gerik-Jeli Highway

Elephants crossing the Gerik-Jeli Highway

To overcome inattentional blindness, one possible intervention is to provide artificial stimuli at the start of the highway (e.g. a life-size elephant statue and sound) to prime the motorist's attention towards wildlife presence in the area. After priming, the driver should be more likely to self-regulate the driving speed and spot wildlife by the road, thereby avoiding collisions. This might help to reduce vehicle accidents, save human lives and avoid wildlife roadkills. Additionally, where appropriate, traffic management during the night may help mitigate the loss of permeability of roads to wildlife.

OUR RECOMMENDATIONS

To mitigate the impact of roads on elephants and other wildlife, we recommend the following:

1. Avoid expanding the number of lanes on the Gerik-Jeli Highway and the creation of new roads in the BTL, as road expansion will further reduce permeability.
2. Encourage responsible driving behaviour on roads traversing important wildlife habitats in Malaysia. Consider the implementation of psychological techniques aimed at safer driving by priming motorists to be more vigilant about their surroundings and to self-regulate their driving speed.
3. Establish low speed limits and enforce them through awareness signs, speed bumps, speed

A family of elephants in the forest within Belum-Temengor Landscape

traps and fines to reduce road accidents and wildlife roadkills. Consider managing traffic volume at night.

4. Consider habitat management (e.g. long-term reforestation) near the road to reduce grasslands and avoid the concentration of elephants on roadsides.
5. Monitor the effectiveness of the viaduct on habitat connectivity for elephants and other wildlife.
6. Implement extensive enforcement patrolling and other anti-poaching efforts along highways and roads bisecting forested areas, especially at viaducts and areas frequently used by wildlife.
7. Recognise the Belum-Temengor Landscape as an important elephant habitat that should be treasured and promoted as part of the country's natural heritage.

CONCLUSION

Our research highlights the importance of considering the impact of infrastructure development on megafauna and other wildlife, especially in South East Asia, a region with a large number of threatened megafauna and with large-scale infrastructure development plans for the coming decades. Instead of working in silo, engineers, wildlife biologists and psychologists should work together to develop creative solutions to help conserve the rich biodiversity for our future generations. ■

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