



Not Everyone Wants Roads: Assessing Indigenous People's Support for Roads in a Globally Important Tiger Conservation Landscape

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Introduction

Road development in the tropics is fraught with economic, socio-political, and environmental risks (Alamgir *et al.* 2017). Roads have helped alleviate rural poverty to some extent (Jones 2006), but have also caused tremendous collateral environmental damage (e.g., Singleton *et al.* 2004). In Southeast Asia, for example, roads have been shown to have detrimental environmental impacts on threatened biodiversity (Clements *et al.* 2014). It is therefore important that road development projects strive to balance social benefits and environmental costs (Laurance and Arrea 2017).

The social impacts of roads, particularly on indigenous people, have not been adequately quantified. In reality, indigenous people are rarely consulted in the planning phase of road projects despite the fact that they have rights to self-determination and consultation involving the development of indigenous lands and resources, including road construction, according to

the United Nations Declaration on the Rights of Indigenous Peoples (Wiessner 2008). Studies have shown that roads can provide indigenous people greater access to markets, increased social mobility, migration, and greater economic opportunities (Adam *et al.* 2011). Roads can also facilitate access to traditional hunting grounds; however, forest loss and degradation over time (e.g., Clements *et al.* 2014) may negatively affect their livelihoods and cultural traditions in the long term. Given these trade-offs, it is important to understand indigenous people's level of support for road development, and to examine motivations behind their attitudes towards road development.

In Peninsular Malaysia, we conducted a questionnaire survey of indigenous groups residing in a globally important tiger landscape, in order to identify factors (i.e., demography, livelihood activities, and perceived impacts of the road on their livelihoods) affecting their support for the presence of an existing road, and the construction of additional roads to their village. We also assessed their perceptions concerning the state of wildlife near the existing road. Our findings have important implications for conservation practitioners working in biologically important areas, with indigenous communities that are or will be affected by road construction.

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Material and Methods

Study Area

The Belum-Temengor Forest Complex (3546 km²) is a key site for tiger conservation (Rayan and Linkie 2015), and lies in a global priority Tiger Conservation Landscape (Sanderson *et al.* 2010). In 1982, the 203 km-long East-West Highway (Federal Route 4, and hereafter referred to as the 'existing road') was built through this forest complex. The complex comprises a protected area where logging is strictly prohibited, and production forest reserves where selective logging is allowed (Fig. 1). Villages

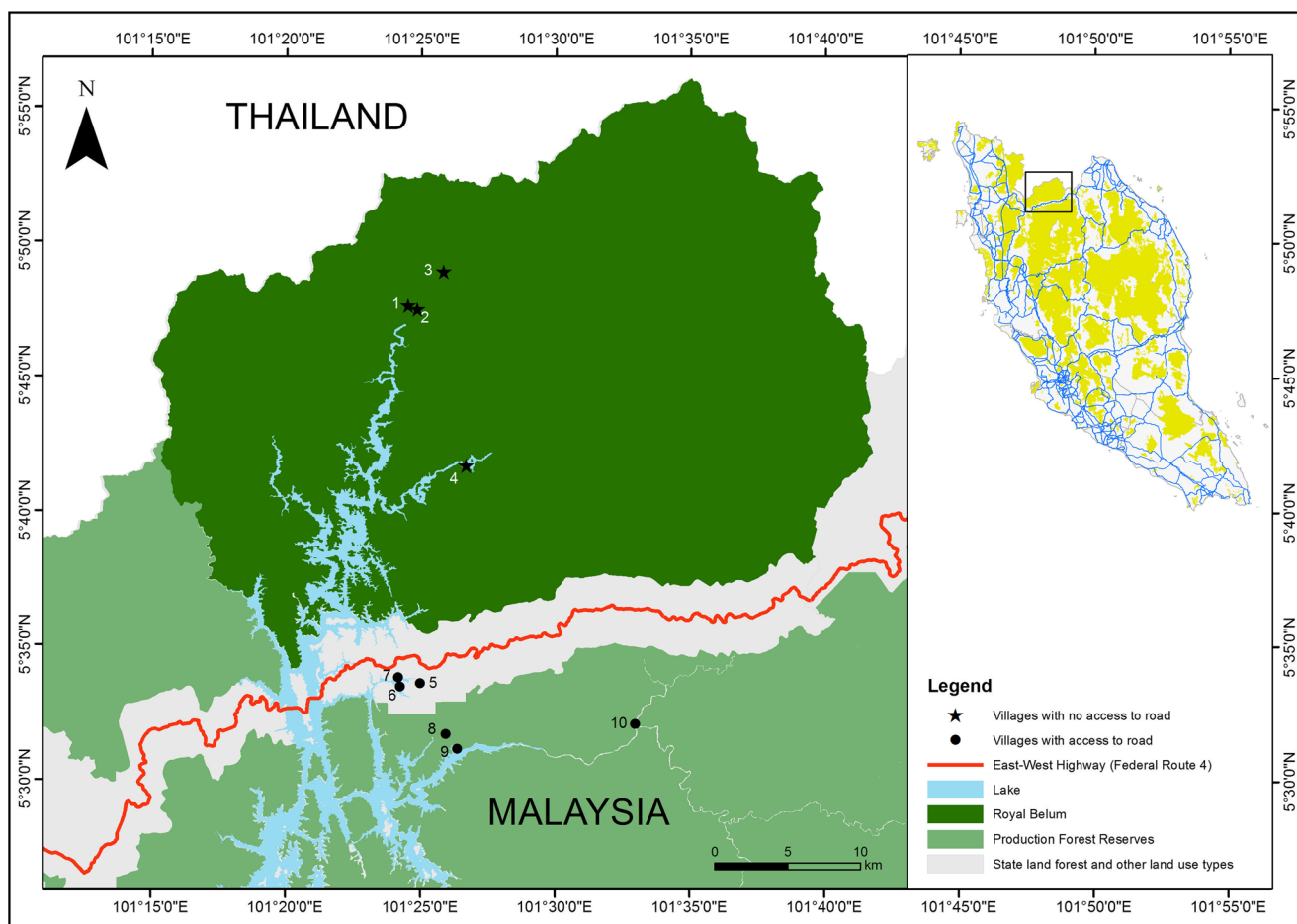


Fig. 1 Map of the Belum-Temengor Forest Complex and location of 10 Orang Asli villages in relation to the East-West Highway in the State of Perak, Peninsular Malaysia. See Appendix 1 for corresponding village names

populated by Orang Asli (the indigenous peoples of Peninsular Malaysia) can be found in both the protected area and the production forest reserves. In both areas, Orang Asli can legally hunt certain species of protected animals, fish, and extract non-timber forest products for subsistence (Aziz *et al.* 2013).

The Orang Asli

The two main sub-ethnic groups of Orang Asli living in Belum-Temengor are the Jahai and Temiar. Four Orang Asli villages located in the state park (Fig. 1; villages 1–4 in Appendix 1) do not have direct access to the existing road. During the construction of Temengor Dam in 1979, most of the Orang Asli communities in the inundated areas were resettled in villages in the forest reserve (Fig. 1; villages 5–10 in Appendix 1) that are accessible via the existing road (WWF-Malaysia 2011). The Orang Asli are known to hunt wildlife for both subsistence and commercial purposes (Andaya 2008; Azrina *et al.* 2011). While it can be legal depending on location, hunting method, and species hunted (Aziz *et al.* 2013), a small number of individuals in

Peninsular Malaysia have been caught engaging in illegal hunting. For instance, there is evidence of high poaching pressure in the forests adjacent to the existing road (Fig. 1) bisecting Belum-Temengor (Clements *et al.* 2010).

Questionnaire Survey

We visited a total of 10 Orang Asli villages (Fig. 1; Appendix 1): four that have no access to the existing road, and the six nearest villages to the existing road. We administered the questionnaire survey via face-to-face interviews. Interviews were conducted in Bahasa Malaysia, the national language spoken by the Orang Asli in addition to their own native languages. All households in each village were visited, with interviews targeting the household head, or, if unavailable, another permanent household member. Only males were interviewed, as females are less involved in natural resource extraction activities (R. Clements, pers. obs.). Consent to participate was obtained prior to commencement of the interview, after an explanation of the questionnaire survey was given.

Part one of the questionnaire survey consisted of 22 open-ended and fixed-response questions (Appendix 2) with relevant visuals (e.g., photographs of the existing road) that aimed to obtain data for five information groups (Fig. 2): (1) demography (i.e., age of respondent, origin of respondent, village access to the existing road); (2) use of the existing road for livelihood activities (i.e., to hunt, to sell hunted mammals, to get to markets, and to get to work); (3) perceived negative impacts of the existing road on livelihoods (i.e., introduces pollution, disease, or poachers); (4) perceived positive impacts of the existing road on livelihoods (i.e., brings in health workers, donations, or jobs); and (5) support for the presence of the existing road and construction of additional roads to their village. Part two of the questionnaire survey assessed villagers' perceptions concerning the state of wildlife near the existing road.

The order of “yes” and “no” answers in various questions was alternated to circumvent the natural tendency of some respondents to pick the first answer. Each interviewer scored the reliability of answers from each respondent (‘high’ — displayed an understanding of more than half the questions; ‘low’ — otherwise); those with a ‘low’ reliability score were excluded from analyses.

Statistical Analyses

We constructed generalised linear mixed-effect models (GLMMs) in an all-subsets multimodel inference framework (Burnham and Anderson 2002) to examine which combinations of four demographic variables, four livelihood activities, and six perceptions (Fig. 2) were most important in influencing support for the existing road (EXI) and construction of additional roads to the respondents' villages (ADD). This approach was based on a framework modified from Fig. 2 in Lee *et al.* (2009).

For all three analyses, we used binomial (logit-link) GLMMs to model the binary (yes vs. no) response variables (Fig. 2). To account for possible non-independence of answers within each village (VIL), we allowed model intercepts to vary across VIL. Whenever one or more pairs of explanatory variables were highly correlated ($r > |0.5|$) based on bi-serial correlation (for continuous-categorical relationships) and phi coefficients (for categorical-categorical variable relationships), we excluded the less meaningful variable from the analyses to obtain more stable and interpretable parameter estimates. We used sample-size corrected Akaike Information Criterion (AICc) to determine the best candidate

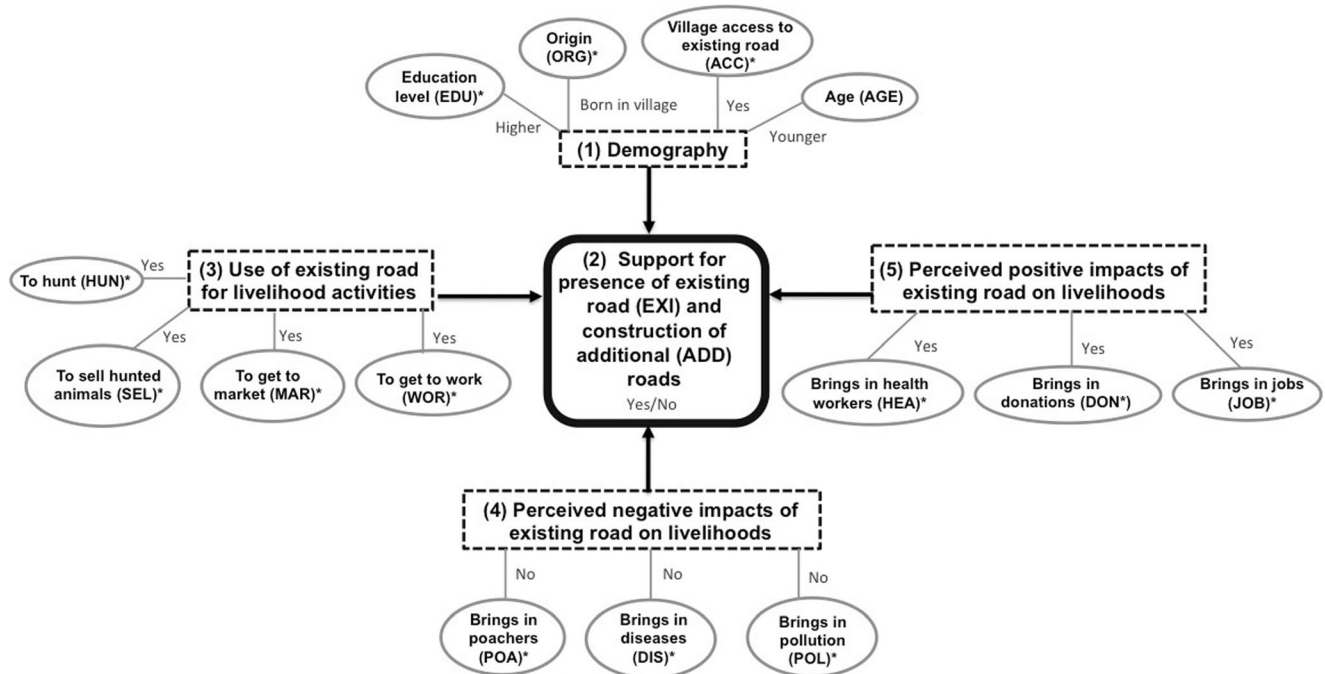


Fig. 2 Hypothetical relationships (arrows) among five information groups. (1) demography (i.e. education [EDU], origin [ORG], age [AGE] and village access to existing road [ACC]); (2) support for the presence of the existing road (EXI) and the construction of additional roads (ADD) to their village; (3) use of the existing road for livelihood activities (i.e. to hunt [HUN], to sell hunted animals [SEL], to get to market [MAR] or to reach work [WOR]); (4) perceived negative impacts of existing road on livelihoods (i.e., brings in poachers [POA], disease [DIS] or pollution [POL]); and (5) perceived positive impacts of exiting

road on livelihoods (i.e., brings in health workers [HEA], donations [DON] or jobs [JOB]). A hypothetical response is provided next to each variable; for example, we could have found that when we examined their demography, indigenous people who have: 1) a higher education level; 2) originated from the village 3) direct access to the existing road; and/or 4) are younger may hypothetically support the presence of the existing road and the construction of more roads. Asterisks connote categorical variables

model, Akaike weights ($wAIC_c$) to quantify the probability by which a given model is the best within the candidate models set, and the sum of Akaike weights (SW) to estimate relative variable importance (Burnham and Anderson 2002; Giam and Olden 2015). We calculated R_m^2 to quantify the variance in the response variable that is explained by fixed effects in each GLMM model (Nakagawa and Schielzeth 2012). All analyses were conducted in R statistical environment 3.2.2 (R Development Core Team 2015) (see [Appendices](#) for further details).

Results

Of the 264 Orang Asli households across nine villages, 169 male heads-of-household agreed to be interviewed, and data from 144 households were considered reliable. The mean \pm SD age of the respondents was 36 ± 13 years (range: 16–70), with 55% originally born in their villages. More than half (54%) of the respondents had received some form of formal education.

Eighty-four percent of the interviewed households supported the presence of the existing road, whereas 65% supported the idea of constructing additional roads to their village. Overall use of the existing road for livelihood activities among all respondents was low: respondents used the existing road to get to work (28%), to reach markets (24%), to hunt (19%), and to sell hunted animals (2%). Use of the existing road for the same purposes increased (57%, 47%, 21 and 4%, respectively) when we only considered respondents who have direct vehicular access to the existing road.

Perceptions of the existing road having some negative impacts on respondents' livelihoods were evenly divided. The existing road was perceived by 47% of respondents as causing pollution, 49% as introducing/spreading disease, and 49% as bringing in poachers. Conversely, a large proportion of respondents perceived the existing road to also have a positive impact on their livelihoods. Seventy-six percent of respondents believed that the existing road brought in health workers, while 56% thought it facilitated charitable donations, and 66% perceived an improvement in employment prospects. When we asked respondents whether they actually wanted these benefits, 92%, 94%, and 90% of them, respectively, indicated that they did.

Factors Affecting Support for Existing and Additional Roads

Among candidate GLMM models that examined the effects of demography, Orang Asli living in villages with direct access to the existing road (ACC) were more likely to express support for the existing road and the construction of additional roads to their village (top models with ACC as an explanatory variable had R_m^2 values ranging from 0.27 to 0.53; Table 1). In terms of

Table 1 Generalized linear mixed-effect models (GLMMs) examining the influence of variables related to demography, livelihood activities and perceptions on Orang Asli support for the existing road (EXI) and the construction of additional roads to their village (ADD)

	k	AIC _c	dAIC _c	wAIC _c	R_m^2
Demography					
EXI~ACC	3	110.72	0.00	0.27	0.27
EXI~ACC + AGE	4	111.38	0.67	0.19	0.27
EXI~ACC + EDU	4	112.38	1.67	0.12	0.26
ADD~ACC	3	139.24	0.00	0.34	0.53
ADD~ACC + AGE	4	140.86	1.62	0.15	0.53
ADD~ACC + ORG	4	140.93	1.69	0.15	0.53
Livelihood activities					
EXI~WOR	3	114.53	0.00	0.42	0.08
EXI~1	2	115.39	0.86	0.27	0.00
EXI~WOR + HUN	4	116.10	1.57	0.19	0.08
ADD~1	2	148.06	0.00	0.44	0.00
ADD~HUN	3	149.09	1.02	0.26	0.00
ADD~WOR	3	149.74	1.67	0.19	0.00
Perceptions*					
EXI~HEA + JOB	4	74.37	0.00	0.27	0.21
EXI~HEA + JOB + DIS	4	75.54	1.17	0.15	0.23
EXI~HEA + JOB + POA	5	76.19	1.82	0.11	0.24
ADD~1	2	127.52	0.00	0.12	0.00
ADD~DIS	3	127.93	0.40	0.10	0.00
ADD~HEA	3	128.83	1.31	0.06	0.00

GLMMs examining the influence of livelihood activities only included a combination of WOR and HUN in order for the global model to achieve convergence

Explanatory variables are: village access to existing road (ACC); age (AGE); education (EDU); origin (ORG); use of existing road to get to work (WOR) and hunt (HUN); perception that the existing road introduces health workers (HEA), jobs (JOB), diseases (DIS) and poachers (POA). The top three models in the analysis of each response variable (EXI and ADD) are presented

Term abbreviations are defined as follows: k = number of parameters, dAIC_c = difference in AIC_c for each model from the most parsimonious model, wAIC_c = AIC_c weight, and R_m^2 = according to Nakagawa and Schielzeth (2012)

*POL was excluded due to collinearity with other variables

relative variable importance assessed by the sum of $wAIC$ (SW), ACC was the most important demographic variable relative to the other variables that predicted support for the existing road (ACC: 0.87 > AGE: 0.40 > EDU: 0.29 > ORG: 0.26) and the construction of additional roads (ACC: 0.99 > AGE: 0.32 > EDU: 0.31 > ORG: 0.27).

Among candidate GLMM models that examined the effects of livelihood activities, no variable appeared to affect support for the existing road; the low R_m^2 value (0.09; Table 1) of the top model suggests that very little variance in the response variable is explained. Moreover, the intercept-only null model was the 'best' model in one analysis; none

of the livelihood activities we examined were important in influencing support for additional roads.

Among candidate GLMM models that examined the effects of perceptions, the Orang Asli perceptions of the existing road bringing in health workers (HEA) and jobs (JOB) predicted support for the existing road (top models with HEA and JOB as variables had reasonable R^2_m values ranging from 0.21 to 0.24; Table 1). In terms of relative variable importance assessed by the sum of $wAIC$ (SW), HEA and JOB were relatively more important than the other variables in influencing support for the existing road (HEA: 0.91 > JOB: 0.90 > DIS: 0.35 > POA: 0.31 > DON: 0.27). However, none of the livelihood activities were important in influencing support for the construction of additional roads to villages, as the null model was the ‘best’ model.

Perceived State of Wildlife near Existing Road

The majority of the respondents (63%) perceived that threats to wildlife along the existing road were greater than in the forest interior, with respondents believing that sources of the threats (in order of decreasing importance) were: (1) logging, (2) roadkill, (3) infrastructure development, (4) non-indigenous locals, (5) foreigners, (6) Orang Asli from other villages, and (7) Orang Asli from their own villages. Furthermore, the majority (79%) felt that wildlife was less abundant along the existing road than in the forest interior. Respondents who were willing to reveal species they hunted in forests along the existing road ($n = 9$) identified squirrels, monkeys, wild pig (*Sus scrofa*), sambar deer (*Rusa unicolor*), barking deer (*Muntiacus muntjak*), and Sunda pangolin (*Manis javanica*).

Discussion

To our knowledge, this is the first study to investigate the social impacts of roads on indigenous people in Malaysia. Our results suggest that indigenous people can have different levels of support for roads, with levels of support for existing and additional roads seemingly higher among those who already have access to an existing road from which they derive socioeconomic benefits. Interestingly, most respondents perceived that threats to wildlife are greater in forests nearer to roads than forest interiors. We acknowledge that there might be other factors influencing the Orang Asli’s support for roads, and emphasise the need for more interviews to be carried out with other Orang Asli sub-ethnic groups elsewhere in the peninsula in order to obtain more representative views.

We found that the Orang Asli most frequently cited “ease of travelling” as a reason for their support of roads — this is consistent with a study in Tanzania that found most villagers around the Serengeti National Park who have access to a

poor road supported its improvement, despite protests from environmentalists (Fyumagwa *et al.* 2013). However, we found that Orang Asli who lack direct access to roads may be less supportive of existing and additional roads, possibly because they have not experienced the real or perceived ‘benefits’ brought by existing roads. For example, comments made against having roads in Royal Belum State Park included “wanting to see the forest remain in its pristine state”, “roads destroy nature”, and “additional roads will take up too much land such that (one day) there may be nothing left to eat”. Kirby *et al.* (2006) highlight similar attitudes among indigenous groups living in the Brazilian Amazon, where isolated communities are more likely to retain traditional values and belief systems than those closer to roads, who can be influenced by cash offers from illegal loggers and miners. Our study suggests that new road projects will not always gain unanimous support from indigenous communities living in roadless protected areas such as Royal Belum, where alternative means of transport (e.g., boats via the lake) are also available.

The majority of Orang Asli, especially those living near the existing road, believe that the road has a positive impact on their livelihoods. Access to markets in towns and perceived benefits brought by the existing road such as employment and health workers appear to drive support for it among respondents. Their desire for access to healthcare is unsurprising, as Orang Asli communities suffer from diseases associated with economic under-development (Chee 1996). Given that a large proportion of the Orang Asli live below the poverty line, with 50% classified as ‘very poor’ (compared to 2.5% nationally; Nicholas 2004), it is not surprising that they desire greater access to employment in order to improve their livelihoods. In order to curb the threat of unsustainable or illegal hunting by the Orang Asli, alternative means of improving the social welfare of resident indigenous communities must be offered, especially in areas where the desire for access to markets, healthcare, and employment is greater. If basic socioeconomic needs are not met, there is a danger that forest communities may increasingly hunt animals to be traded at markets they can reach via roads (e.g., Wilkie *et al.* 2000).

We found that the level of indigenous support for roads can still be high even if actual use for livelihood activities appears relatively low. Instead of utilising forests along the existing road in our study area, the Orang Asli were heavily dependent on forest resources *around* their villages for agriculture and harvesting for subsistence, and/or commercial trade (Nicholas 2004). Of the 164 respondents who provided information on their occupation, 68% were engaged in harvesting non-timber forest products such as agarwood (*Aquilaria* spp.), and fishing in forests near their village part- or full-time. By contrast, only 1% appeared to have jobs that required regular use of the existing road, such as working as nature guides in nearby resorts or assisting conservation NGOs.

Roads may sometimes alter hunting patterns of indigenous peoples. An oil road in Ecuadorian Amazon, for example, was found to have transformed once semi-nomadic indigenous hunters into commercial poachers (Suárez *et al.* 2009). Assuming that truthful answers were provided in our questionnaire survey, the Orang Asli do not appear to be the main poaching threat in forests near to the existing road, because the majority of respondents in our study indicated their preference to hunt in forests near their village. Hunting evidence collected by researchers and NGO-led anti-poaching patrols suggests that poaching along this existing road may instead be attributed to well-organised commercial syndicates, comprising foreigners from Indochina or non-indigenous locals from nearby towns (R. Clements, unpublished data). Similar to studies that have quantified the threat of poaching to endangered animals living near roads (Clements *et al.* 2014), the Orang Asli also perceive that animals in or near roadside forests are subjected to higher poaching pressure (and hence are fewer in number) than in the forest interior, citing non-indigenous locals and foreigners as a higher poaching threat than themselves. As such, law enforcement efforts must be increased in the forests along the existing road to ensure that poachers do not decimate species that can be legally hunted by the Orang Asli for consumption.

Our study shows that people do not always want new or additional roads. Thus, it is vital to conduct Social Impact Assessments (SIAs) prior to road construction projects, especially in biologically important landscapes with indigenous communities. There is increasing recognition that habitat and biodiversity conservation requires greater involvement of indigenous peoples (e.g., Nicholas 2005; Hood and Bettinger 2008; Gill *et al.* 2009; Aziz *et al.* 2013). In Peninsular Malaysia, the Orang Asli are becoming increasingly vocal against development activities affecting their livelihoods (e.g., Kuek 2012). To avoid conflict, it is therefore imperative that the Malaysian government consult with Orang Asli in areas slated for development, prior to road construction. Scientists have already called attention to the inherent flaws in the current approach to Environmental Impact Assessments (EIAs) for road infrastructure projects in Malaysia, highlighting the urgent need to improve the process (Alamgir *et al.* 2018). It is therefore timely to also include SIAs as an additional safeguard. Not only can such measures help ameliorate potential negative social impacts of road construction on indigenous practices and livelihoods it could also ultimately help reduce environmental impacts on biodiversity.

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Compliance with Ethical Standards

Ethics Approval Ethics approval for interviews was obtained from the James Cook University Ethics Committee (Ethics Approval Application ID H3655).

Conflict of Interest The authors declare that they have no conflict of interest.

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