Reviewers' comments v2

November 5, 2018

This revision is a significant improvement on the previously submitted draft. However, in several places the central argument as well as the data analyzed can and should be presented more explicitly. My comments below have three main parts:

Sudmeier : Authors thank the anonymous reviewer for these points. We have done our best to incorporate them in the final version of the article

1. This central point made here should come at the start of the article so that the reader knows exactly what is being argued. The data analyzed can then be presented in more direct relation to substantiate this claim: "This commentary suggests that the issue of poor roads in Nepal is a political, not a technical issue and one where better service and less environmental damage could both be significantly addressed through improved governance."

Sudmeier: Good suggestion. We have corrected accordingly.

2. While statements like this are partially true – "In general, connectivity is thus positively correlated with lower poverty rates" – other research shows that roads in fact increase levels of social stratification, marginalization, and uneven development. In addition to these references (Hettige, 2006; Iimi et al., 2016) which are cited numerous times at the start of the article, this reviewer strongly advises the authors to engage more extensively (one paragraph at least) with the highly influential work conducted by the University of East Anglia research team in the 1970s and 1980s (Blaikie et al. 1976). Please also double-check the citation year for this reference in the text. Please note that Rankin et al. 2017 closely review the findings of these studies as well.

Sudmeier: The reviewer rightly points out the important work that was undertaken by this group in the 1970s and 80s. Although our focus is more on environmental impacts of roads, rather than on socio-economic impacts, we have drafted some text to demonstrate that our ideas build on previous work in this domain.

3. The BRI issue is highly important but in the current version the text touches on the topic very lightly. I would suggest taking one of two alternative approaches: 1. discuss the BRI and its significance in more depth (not only what it means for Nepal, but why it has been taken up with such enthusiasm by elites in KTM, as well as the ambiguous and discursive nature of the BRI – a reified 'thing' that thus far has no real 'thingness'); or 2. pay less attention to the BRI and instead focus on the connection between road construction, landslides, and increasing risks and hazards due to climate change. I think the latter (#2) is actually a far more important intervention that this article can make to the current literature and broader knowledge of road construction and landscape change and hazards in the current political and climatic environments. BRI gets lots of attention these days, but this paper is not saying all that much new or contributing a great deal to such conversations. Conversely, by building on Petley, etc., it has much to offer to debates around the connections between road construction and landslide frequency.

Sudmeier: The previous draft was more heavily focused on the BRI and its potential influence. However as rightly pointed out by the reviewer, for now the BRI is a 'thing' with no concrete plans for Nepal yet, according to our understanding. We will therefore go with option 2 and have hopefully modified the manuscript accordingly.

We hope these comments are helpful with the next round of revisions and I look forward to reading the final version.

Sudmeier: Once again, we thank the anonymous reviewer for helpful and detailed comments which have significantly improved the quality of this manuscript. We also thank the guest editor for useful suggestions and guidance throughout the process.

N.B. Figure 1 : we need to remove the top line of the legend. The colleague who made this map is out of reach until after 15 November. Thank you for your understanding. Karen Sudmeier

NHESS Brief Communication

Mountain roads in Nepal at a new crossroads

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Introduction – roads as vehicles of development?

For the past two decades, development of the road network in Nepal has topped community and government priorities, a trend likely to continue as the country transitions to a decentralized Federal government (Rankin, 2017). In parallel, China's new Belt and Road Initiative (BRI) offers the promise of investments in key infrastructure: expanding trunk roads, hydro-electricity, trade and development (The Wire, 2017; The Economist, 2017). Yet as Nepal devolves significant power to ~~Local~~ local and Provincial administrations, it is uncertain whether the newly formed local administrations will rise to the challenge of establishing safeguards to ensure that promised benefits outweigh potential losses. We suggest that the issue of poor roads in Nepal is a political, not a technical issue and one where better service and less environmental damage could both be significantly addressed through improved governance. This commentary points to the need for improved road governance based on research, consultations and observations of road construction and associated landslides in Nepal. It also highlights the need for more scientific studies on the topic as most relevant publications emanated from the grey literature, government publications or media articles.

Roads are globally accepted livelihoods links for communities in rural areas. By reducing travel time on foot, opportunities are opened for quicker transportation of goods, better access to employment, education and health (Bryceson et al., 2008; Hettige, 2006; ~~Iimi et al., 2016~~). Roads generally create direct and indirect benefits to rural populations, directly through employment in constructing and maintaining roads, and in providing rural transportation services. Indirectly they provide opportunities for marketing goods and services, flexibility for employment and roadside businesses, and for transporting agricultural products to markets (~~Hettige, 2006;~~ Bryceson et al., 2008; Iimi et al., 2016). ~~Roads~~ They can provide a safety net of sorts in generating alternative livelihood opportunities, especially in circumstances where conditions for agriculture are difficult.~~,~~ In general, connectivity is thus positively correlated with lower poverty rates (Hettige, 2006; Iimi et al., 2016). Additionally, there are many non-monetary benefits of roads, especially greater access for the poor to health and other public services, such as education, which can significantly reduce vulnerability and even gender inequality (Starkey et al., 2013). In Nepal, roads are also linked to the current boom in migration, facilitating easier mobility to both near and distant migration destinations (Jaquet et al., 2015; Upreti and Shrestha, 2015). Finally, a robust road infrastructure can provide vital corridors for evacuation and rescue in the aftermath of disaster.

However, benefits of roads need to be weighed alongside evidence that roads may benefit non-poor households more, perhaps making development less even (Hettige, 2006). Furthermore, other impacts, such as increased environmental hazards, pollution, crime and unwanted cultural influences are often overlooked (Blaikie et al., ~~2002~~1976; Hettige, 2006; Murton, 2016; Jaboyedoff et al., 2016). This manuscript builds on research and publications questioning the aspirations of the Government of

Nepal as early as ~~in~~ the 1970s and 1980s. The Overseas Development Group at the University of East Anglia pioneered studies to understand short-, medium- and long-term effects of road construction on spatial and socio-economic inequality (Blaikie et al., 1976; Rankin et al., 2017). Blaikie, Cameron and Seddon (1980) revealed the inequalities created by road construction, with loss of livelihoods for those without possibility~~y~~ies to invest, and enhanced opportunities for those who could (Rankin et al., 2017).

This work was conducted during the same period as the Laban (1979) benchmark inventory of landslides in Nepal to document the number of landslides and their origin as either natural or human-induced. Although roads represented a small proportion of total land area at the time, Laban warned that as the road network continued to expand, the number of landslides will, "increase drastically in the near future, especially if more careful construction methods are not undertaken" (Laban, 1979: iv). Both research projects were widely influential and according to Rankin et al (2017), the Blaikie et al (1976) study may have redirected domestic budgets and foreign aid toward other rural development investments. However, this reprieve was soon to end with a greater focus on connectivity in the 10th 5-year plan (2002-2007) and the boom in foreign investments in road construction projects after 2008 and the end of the Maoist insurgency (Pokharel and Acharya, 2015). The 11th plan (2007-2010) established the ambitious goal of constructing a road network throughout the country whereby residents in the Hills should have a road available within ~~4~~four hours walking distance and ~~2 hours for~~ Terai residents within two hours (Pokharel and Acharya, 2015.

Nepal's mountain roads – vehicles of disaster?

Roads in Nepal are generally classified as national roads, (i.e. Strategic Road Network, SRN) under the jurisdiction of the Department of Roads (DOR), or local roads (i.e. Local Road Network, LRN). The LRN is comprised of District Road Core Network (DRCN) and Village Roads (VR) under the jurisdiction of the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) (Figure 1). Road building started to gain momentum in Nepal with the advent of multi-party democracy in the early 1990s, intensified further after the Maoist insurgency ended in 2006 and continues to be one of the country's main priorities (Upreti and Shrestha, 2016; DOLIDAR, 2016a).

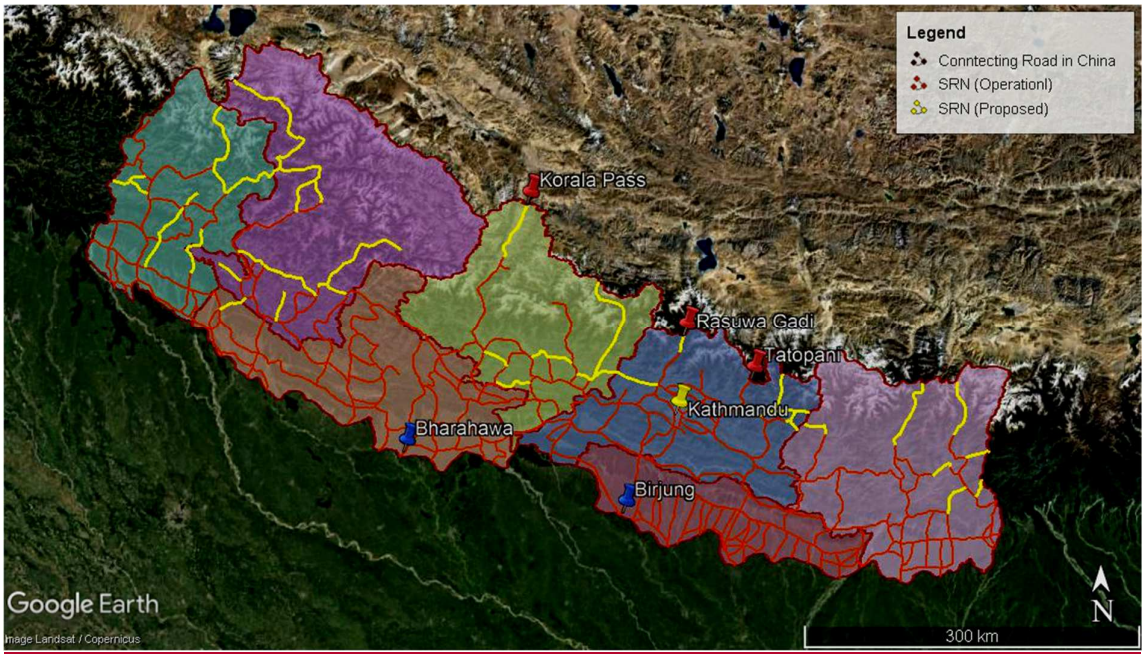


Figure 1. Nepal Provincial boundaries and national (SRN) road network highlighting existing and proposed roads, according to DOLIDAR (2016) and main current border crossings with China and India. As Provincial administrations are in the process of revising Master Plans to represent new administrative boundaries, there is opportunity to put in place governance mechanisms for improved road construction and maintenance. (Source: Modified from DOLIDAR, 2016, based on Google Earth imagery).

Twenty years ago, Nepal's road network was one of the lowest in the world with a road density for both SRN and LRN estimated at 13.7 kilometers (km) per 100 km^2 in 1998 (DOR, 2002; DOR, 2017). By 2016, it had increased to 49.6 km per 100km^2 and continues to increase at a very rapid pace (DOLIDAR, 2016a). The SRN expanded rapidly from 4,740 ~~kilometers (~~km~~)~~ (blacktop, gravel and earthen) in 1998 to 15,404 km in 2016 (DOLIDAR, 2016). The LRN experienced a 1200~~%~~ percent increase during this period, from 4,780 km in 1998 to 57,632 km in 2016 and are the most common roads in rural areas (DOLIDAR, 2016a).

In 2007, the country spent 5.2~~%~~ percent of its national budget on roads, but ~~and~~ by 2011/12~~,~~ this figure had increased to 6.7~~%~~ percent or an estimated 491.2 million USD (WB-GON, 2014). The estimated investment in the LRN was about 245.6 million USD (2011/12), of which 54~~%~~ percent of the rural road budget originated from donors and 20~~%~~ percent were soft loans to communities. Community contributions amounted to an estimated 12~~%~~ percent of the total budget through their own savings and~~,~~ remittances, and earnings from community forestry (WB-GON, 2014; DOLIDAR, 2016b). This demonstrates the significance and priority given to roads and connectivity as a vector for economic development and population mobility.

Despite the budget and priority allocated to the road network, Nepal's mountain roads are in a treacherous state, subject to frequent rockfall, landslides and accidents (Singh, 2018; DoR, 2013a) (Figure ~~1~~2). According to DoR (2013a), one of the main causes of road accidents is road design, including very steep gradients, lack of safety features and poor road conditions. Local road construction or so-called '~~"~~dozer roads'~~"~~ are most often initiated and constructed by bulldozer owners in collaboration with politicians at the request of communities, without basic grading or drainage

(ITAD, 2017; Singh, 2018). The dozer roads are usually constructed or upgraded during the dry season. During the monsoon, road segments are frequently washed out ~~as~~ because a majority of these roads lack proper engineering (WB-GON, 2013). Road failures are cleared up at high cost after the monsoon and the failure-and-clearance process is repeated for years until there is no loose soil to block roads (Leibundgut et al., 2016). Environmental impacts include destroyed irrigation schemes, springs and contaminated water supplies (Singh, 2018). Initial Environmental Examinations (IEE) to reduce environmental impacts are usually required for local road construction but are rarely enforced (ITAD, 2017).

Figure ~~2~~1. Local road, Lower Mustang District, Province 4, Nepal.

Such rapid and ineffective road construction throughout the country, but particularly in the middle hill and mountain areas, is placing increasing pressure on fragile ecosystems, wasting government resources and ~~increase~~ increasing risk to road passengers and roadside dwellers (DoR, 2013a; Singh, 2018). Studies have demonstrated that roads are one of the greatest anthropogenic drivers of environmental degradation, erosion and landslides in Nepal (Leibundgut et al. 2016; Froude and Petley, 2018; McAdoo et al, ~~under review~~accepted ; Petley et al., 2007; Vuilliez et al. 2018). This situation is worsening due to the intensifying rainfall during the monsoon, largely attributed to climate change (Bharti et al., 2016; Devkota et al. 2018; Froude and Petley, 2018; Petley et al., 2007~~; Devkota et al. 2018~~), which has led to a greater occurrence of landslides, especially in the middle hills (McAdoo, ~~under review~~accepted). The possibility of an earthquake of even greater magnitude than the 2015 Gorkha earthquake (M 7.8) raises concerns about poorly designed roads increasing the likelihood of catastrophic landslides (Singh, 2018).

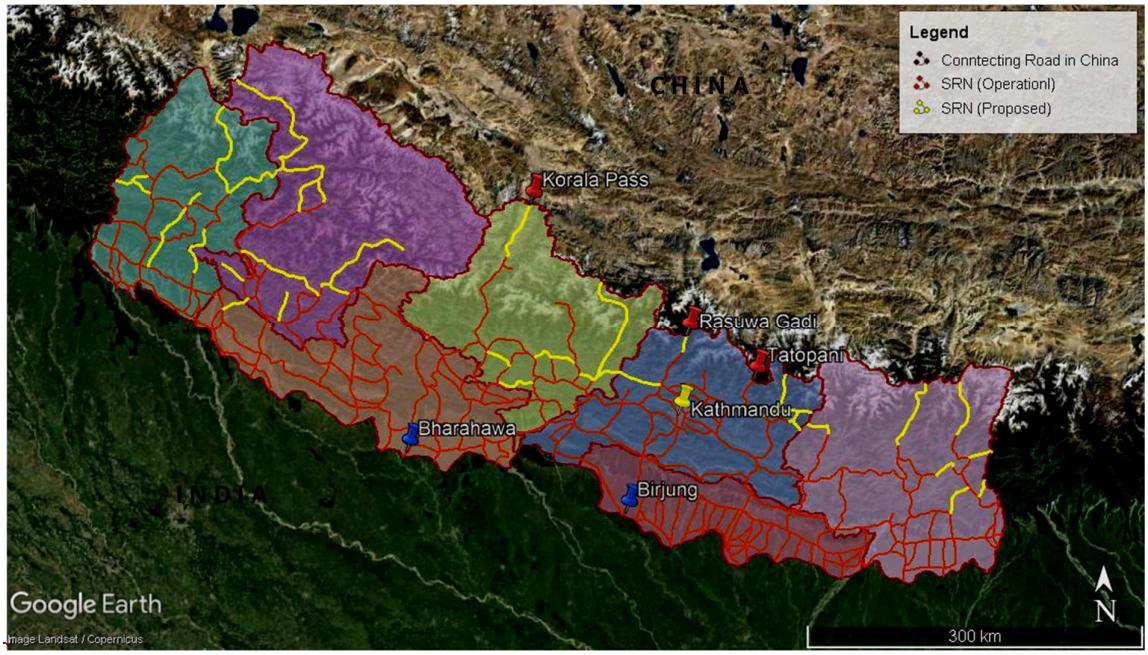
Nepal at a governance crossroads

~~This commentary suggests that the issue of poor roads in Nepal is a political, not a technical issue and one where better service and less environmental damage could both be significantly addressed~~

~~through improved governance.~~ Nepal has a range of acts, regulations, guidelines and directives that require proper road engineering practices, various levels of environmental assessments and approval. However, while funded by government budgets, a majority of local roads do not follow established government practices (ITAD, 2017). Hence, although the legal framework for ensuring proper governance of infrastructure development is well developed with public bodies to monitor and enforce governance, the lack of political will and consensus among political leaders has undermined the impact of these bodies (WB-GoN, 2013).

As the country shifts decision-making to the Provinces, it is unclear how management of roads will be affected among the main actors such as DOR, DoLIDAR, and rural and urban Municipalities. Institutional roles are shifting under on-going reforms, with executive authority over local infrastructure development being transferred from district level authorities (District Technical Officer) to Provincial Public Works Departments, which are supposed to coordinate with central level ministries and departments (ITAD, 2017). At the time of printing, it is not yet clear which administrative body will have oversight ~~over~~ of road policies and alignment of policies between Provinces. The risk is that the few gains that had been achieved over the past decade, including a greater emphasis on regular maintenance of roads, become completely diluted (ITAD, 2017).

Another development which may affect the type and pace of road construction in Nepal is ~~In parallel, in May 2017, Nepal became a signatory to~~ China's Belt and Road Initiative (BRI)~~,~~. In May 2017, Nepal became a signatory to the BRI with the promise of expanding several trunk roads in order to foster new trade and economic benefits (The Economist, 2017). This new "Silk Road" will develop a trade and infrastructure network from China towards the west and south including countries in Central and South Asia and Eastern Europe. ~~As part of this expanded network, there are plans to construct a number of highways from Tibet, over the Himalaya into Nepal, and eventually India (Figure 2). While these trunk roads offer the promise of goods and services from China, there will be undoubtedly be other impacts on communities and environments adjacent to these highways.~~



~~**Figure 2. Nepal Provincial boundaries and national (SRN) road network highlighting existing and proposed roads, according to DOLIDAR (2016) and three main border crossings with China. As Provincial administrations are in the process of revising**~~

~~Master Plans to represent new administrative boundaries, there is opportunity to put in place governance mechanisms for improved road construction and maintenance. The Belt and Road Initiative, with planned transportation corridors through Nepal, is an additional opportunity to strengthen sustainable road construction if properly managed by Provincial governments. (Source: Modified from DOLIDAR, 2016) , based on Google Earth imagery).~~

The BRI has for now elicited more questions than answers, including: which roads will be expanded, ~~The question is whether the BRI~~ will it link rural mountain communities to greater economic development opportunities, better health care and education options, and increased social networks; or will the BRI trunk roads ~~will~~ spawn more of the poorly engineered local roads with their demonstrated low cost effectiveness and high environmental impacts? Without adequate controls and support, rural villages can be expected to tie into these trunk roads by expanding the network of poorly-constructed local roads, with ensuing environmental, economic and human risks associated with roadside erosion and slope failures that damage both the roads and the neighboring productive land.

Despite this bleak picture, Nepal has the governance systems in place to resolve the problem if it chooses to do so. Numerous technical manuals and departmental guidelines provide the basis for good alignment determination, careful engineering, the stabilization of incipient landslides in slopes and the prevention of erosion through the use of bio-engineering (Deoja, 1994; DOR, 2013b). Nepal has been a world leader in the past and government agencies such as DOR and DOLIDAR all have cadres of highly trained engineers and bio-engineers who could fulfill the required technical functions satisfactorily if ~~managed~~ directed properly (ITAD, 2017; WB-GON, 2013).

However, these abilities are currently ignored in the interest of political expediency and a misplaced public perception that quickly opened roads are a panacea for socio-economic development. Institutions were established to regulate road construction. The Environmental Protection Council was formerly established under the Chairmanship of the Prime Minister to monitor environmental impacts and to regulate the environmental and social impact assessment~~s~~ legal instruments (GON, 1997), but became ineffective facades. The Department of Roads' Geo-environmental and Social Unit is also not serving its function. Finally, political influence has overrun any efforts to instill checks and balances (ITAD, 2017), notably by the Commission for Investigation of Abuse and Authority, which was created to highlight cases of poor governance.

Yet with the revision of ministerial portfolios in 2018, the re-organized Ministry of Forests and Environment has an opportunity to ensure that statutory environmental safeguards are met by those government units that will be responsible for administering road development. Newly formed Provincial administrations are now tasked with revising their Master Plans and have the opportunity to develop action plans to strengthen governance bodies, increase transparency and enforce regulations.

Conclusions

On the surface, roads are vital livelihood links for rural populations for improved access to markets, health care, education, employment and migration. Mobility is increased, rural populations can develop greater resilience to harsh environmental conditions, and there are possibilities of new economic opportunities, ultimately reducing economic vulnerability. However, mountain roads, especially when poorly constructed, present particular challenges of sustainability, risk and governance (Sidle and Ziegler, 2012). Hence, the full benefits of such roads in mountainous areas should be questioned.

Finally, the issue of poorly designed and risk-filled roads in Nepal, is a political, rather than technical issue. As Nepal moves towards greater decentralization of power, there is considerable opportunity

for its local and national administrations to turn the tide toward safer and more sustainable road development. The two new major drivers of road development in Nepal – decentralization of power and the BRI – could be harnessed to change road construction from the current trajectory of environmental disaster to vectors for development. The high environmental and maintenance costs of haphazard "'dozer roads"—' could be significantly reduced if government policies were enforced to achieve well-established road engineering designs, including basic standards of road grading, alignment, drainage and bio-engineering. Nepal is at a new crossroads with fresh opportunities to rein in the "dozer road" constructors, but this will require concerted effort and considerably more political will power than has been demonstrated over the last decade.

Acknowledgements

The authors would like to thank Prof. Michel Jaboyedoff, Faculty of Geosciences and Environment, Institute of Earth Sciences at the University of Lausanne, the Ecosystems Protecting Infrastructure and Communities (EPIC) project, managed by the International Union for Conservation of Nature, funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) 2012-2017, for contributing toward this research along with funding from Yale-NUS College's Centre for International and Professional Experience. We also thank anonymous reviewers and the guest editor for suggestions which significantly improved this manuscript.

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