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SYNOPSIS

The Environmental Impact of not Having Paved Roads in Arid Regions: An Example from Mongolia

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There is a generally held perception that roads have negative environmental impacts (Clevenger et al. 2003; Forman 2003; Roedenbeck et al. 2007). Ironically, this paradigm stems from regions where fences and regulations restrict vehicles to paved roads. The situation is different in sparsely populated rural areas in the developing world, where the scarcity of paved roads forces drivers to create their own tracks, often with considerable environmental degradation as a result. Arid and semi-arid regions, especially those with communal land ownership and easily motorable terrain, are particularly prone to this practice and the consequent degradation is widespread—plaguing regions in Central Asia, the Middle East (Batanouny 1985), South America (Pérez 1991), and Africa (Rickard et al. 1994). In such circumstances, the paradigm contradicts its own purpose—paved roads here would in fact have a positive environmental impact, as they reduce the need for "off-road driving".

The land degradation that could have been avoided by the construction of paved roads can be seen clearly in satellite imagery. We illustrate the destructive potential that this practice is having in Mongolia.

Mongolia is a sparsely populated, landlocked country which has seen an economic growth spurt since the 1990s. This growth has given rise to an increased need for transport by road, not just internally, but also internationally, to and from Russia and China. Yet, almost all vehicular mobility in this vast country relies on dirt-tracks—in 2008 only about 2,600 km of the 49,500 km of the national intercity roads were paved (National Statistical Office of Mongolia 2008).

The land degradation typically begins when repeated usage renders an original track unsuitable for driving due to the formation of washboard, ruts, potholes, and corrugations in the soil—a process facilitated by snowmelt, rainfall, and sub-soil permafrost-thawing. Consequently, a system of quasi-parallel trails is generated, denuding large swathes of land (Fig. 1a). The communal land tenure tradition in Mongolia (a predominantly nomadic pastoralist country) and usage of rugged 4-wheel drive vehicles further compounds the problem, as there is practically no restriction to either vehicular movement or vehicle speeds.

In addition to generating dust, which affects driving safety, the compulsory use of dirt-tracks considerably increases the costs of goods and public transport due to increased fuel consumption and vehicle maintenance requirements. However, for the low traffic densities found on many routes here, these costs are small in comparison to the environmental costs. The passing of vehicle-tires decimates native flora and fauna, and also degrades habitat (Brown and Schoknecht 2001). Moreover, vehicles compact the ground, damaging its ability to absorb and retain moisture and nutrients (Belnap 2002). In doing so, surface water flows are concentrated and speeded up, thus leading to soil erosion, increased sediment loads in water courses and consequently, damage to aquatic habitats and water quality as well (Misak et al. 2002). Full re-vegetation of damaged swaths takes between 10 and 15 years after the track has ceased to be in use. However, the pioneering plants are mostly invasive weed species, such as Tumbleweed (*Salsola collina*), Fringed sagebrush (*Artemisia frigida*), and Chinese wild-ryegrass (*Leymus chinensis*), and not the native grasses such as Needle-leaf sedge (*Carex duriuscula*) and Feather-grass (*Stipa krylovii*), that are socio-economically important to the indigenous pastoralists,

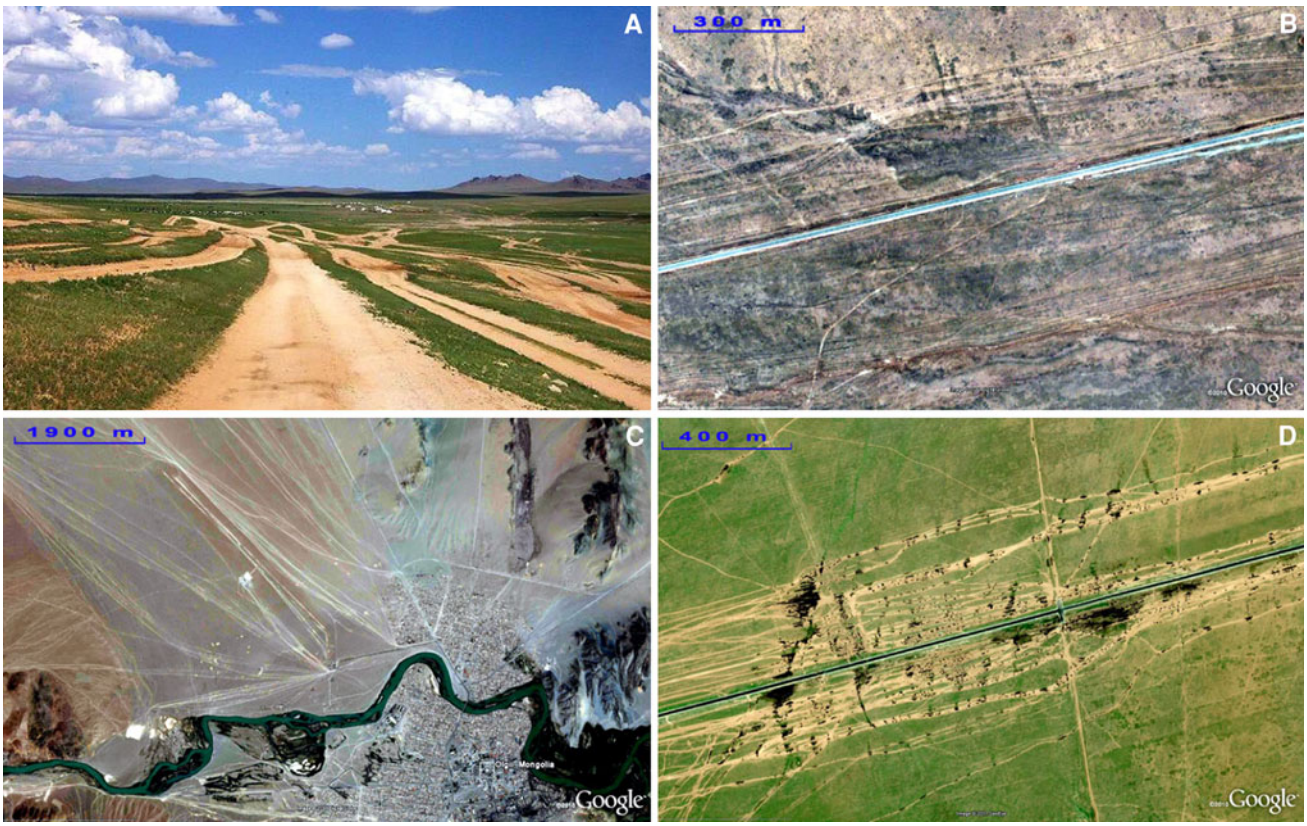

Fig. 1 **a**) A corridor of quasi-parallel dirt-tracks crisscrossing an undulating steppe landscape; **b**) A recovering dirt-track corridor three years after road construction (Google 2011a); **c**) Dirt tracks near a major town (Google 2011b); **d**) Dirt tracks near a muddy area (Google 2011c)

whose sole income is through livestock rearing (Li et al. 2006). Finally, vegetation loss, erosion, and degradation of such large swaths of land spur the ever-present threat of desertification (Damdinsuren et al. 2008).

Each track within a corridor functions as an individual road. Such multiple roads within a small location, create a larger overlapping influence-zone than a single large road (Sanderson et al. 2002). The construction of paved roads would be an effective way of restricting the environmental degradation caused by dirt-tracks (e.g. Fig. 1b). However, the planning of a cross-country paved road, such as the Trans-Mongolian Highway,[1] has been criticized. Some criticism pertained to the route-alignment itself, but most of it claimed that the highway would fragment the pristine steppe and open up the land to poaching, farming, and other disruptive anthropogenic activities (Trivedi 2003). This line of deprecation takes its lessons from examples such as Brazil's Trans-Amazonian Highway (Laurance et al. 2001), or road network expansion in Bolivia (van Gils and Ugon 2006), where increased accessibility led to degradation of an otherwise impenetrable natural forest. However, the criticism overlooks the reality of business-as-usual in Mongolia i.e. the presence of pre-existing human economic activity in the region, the easy accessibility of the steppe terrain, and the potential that paved roads could have in actually reducing land degradation by regulating vehicular movement.

An examination of the main national arterial routes including the proposed route of the Trans-Mongolian Highway, using Google Earth satellite imagery, shows that these dirt-track corridors are normally 30 to 125 m wide, but get much wider near settlements (Fig. 1c), or in muddy areas where vehicles are forced to divert from existing tracks to avoid ruts and potholes (Fig. 1d). The maximum corridor width is about 6200 m—the equivalent of a highway with 1550 contiguous lanes of 3.5 m width each.

The Mongolian road network has about 45 000 km of dirt roads and about 2000 km of gravel roads in its approximately 49 500 km network (Onon 2010). On the main national routes, about 11 000 km of the total road network, about 3260 km^2 area is being lost to degradation caused by dirt-track corridors, corresponding to an average width of 164 m. The remaining, less intensively used 34 000 km, will predictably contribute at least as much. This estimate corresponds well with the estimated

[1] Locally also known as the Millennium Road and internationally also as Asian Highway 32.

degradation of over 7000 km^2 by Batjargal et al. (2006). Along only the proposed two-lane Trans-Mongolian Highway, an average corridor width of 788 m (equivalent to 225 lanes) is affected. This translates to 2367 km^2 of land, whereas the construction of the paved 20 m wide Trans-Mongolian Highway will take about 60 km^2.

Car ownership in Mongolia is doubling almost every 5 years (National Statistical Office of Mongolia 2008) at the expense of ecosystems incapable of coping with this mounting pressure. Thus, the degradation is likely to further worsen unless roads between main populated centers are paved.

POLICY CONSEQUENCES

Arid and semi-arid regions in countries such as Mongolia contain some of the world's most fragile and vulnerable ecosystems. The depredation wrought by dirt-track corridors could endanger rare species further and reduce genetic diversity, which is a matter of serious concern. Widespread land degradation also leads to a decline of the ecosystem services' structure and to environmental problems, such as loss of productive pasture land, increased water- and wind-erosion, and dust storms.

The construction of paved roads is known to cause a variety of direct and indirect negative environmental impacts by opening up the land, thereby easing vehicular mobility, natural resource exploitation, and economic activity (N.R.C. Committee on Ecological Impacts of Road Density 2005). However, in regions without major obstacles to off-road driving, the lack of paved roads results in considerable environmental damage and economic loss also. A balance, therefore, needs to be struck.

Recent Environmental Impact Assessment (EIA) reports for road construction projects in Mongolia mention the degradation from dirt-track propagation that can be avoided by the proposed project. However, the direct and indirect environmental and socio-economic costs of the land degradation due to the lack of paved roads have not been systematically audited yet at a larger scale. Application of such project-based EIAs to approve or reject the development of a road might well conclude that the proposed road introduces landscape fragmentation, if dirt-track corridors are not taken into account. Hence, wherever dirt-track propagations are observed, there is a need for a Strategic Environmental Assessment (SEA) of transportation plans and policies—one which will account for the costs of not having a paved road, while also considering the priorities for biodiversity conservation at the national and supra-national level.

Satellite imagery confirms that dirt-track propagation is not only a pressing issue for Mongolia, but also in other countries with arid and semi-arid regions as well (for example: Google 2011d, e, f, g). Like in Mongolia, as per capita incomes in developing countries rise, vehicle ownership and road transport increase steeply. If road infrastructure development in such regions does not keep pace with growing economic activity, the negative effects of dirt-track propagation will increase. Regulatory instruments such as EIA and SEA are used to control and mitigate the impacts of new road construction, but no such instrument exists to control dirt-track propagation. Widespread awareness of this phenomenon and its implications is necessary to change the attitude toward road construction through vulnerable environments in the developing world, where inadequate transport infrastructure remains the rule, rather than the exception.

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