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Burying water and biodiversity through road constructions in Brazil

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Water resources affect ecological and social processes, and riparian vegetation protects these resources, conserves biodiversity, controls soil erosion, and filters pollutants (Riis et al., 2020). Human pollution, poor governance, leading to inadequate agricultural activities, the destruction of recharging aquifers, the suppression of riparian vegetation, and the burying of watercourses for road construction all degrade water resources quickly. Road construction has impacts on natural environments, especially in sensitive areas, such as water bodies, interrupting water flow and leading to deforestation (Laurance, Goosem & Laurance, 2009). In Brazil, 60% of cargo is transported by road and there is a great demand for new roads, despite the extensive road network that already exists.

To protect water resources, Brazil's first environmental protection law, known as the Forest Code, was passed in 1934, with the main objective of preserving natural resources, maintaining biodiversity, and promoting water security. The most recent modification of the Forest Code was published in 2012 (Federal Law 12.651/2012). One of the most important conservation tools of the Forest Code is the creation of permanent preservation areas (APPs) in sensitive areas, especially in and around aquatic environments. The Forest Code defines an APP as a 'protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations'. However, road impact assessments in Brazil have systematically focused on impacts on biodiversity, without first understanding the role of APPs in the landscape from the perspective of the physical environment, especially in relation to hydrological processes. The quality and availability of aquatic resources directly affects biodiversity (Tickner et al., 2020), and poorly planned road construction damages aquatic ecosystems (Laurance, Goosem & Laurance, 2009).

The Forest Code also states that vegetation in APPs needs to be maintained at a minimum width of: (i) 30 m, for watercourses that are <10 m wide; (ii) 50 m, for watercourses that are 10–50 m wide; (iii) 100 m, for watercourses that are 50–200 m wide; (iv) 200 m, for watercourses that are 200–600 m wide; and (v) 500 m, for watercourses that are wider than 600 m. The width of riparian vegetation of small watercourses in APPs seems adequate for the passage of animals, and widths for larger rivers were proposed not only from the perspective of biodiversity conservation but also to protect ecosystem services. In most economically developed countries, a risk analysis of extreme weather events is accounted for in road design, resulting in strategies that preserve riparian areas. Such strategies inhibit environmentally and economically bad practice and reduce infrastructure damage during extreme floods.

In Brazil, however, especially in the Amazon and in regions prone to flooding, roads are built using earthworks that bury APPs under access ramps to bridges or, in the case of culverts, completely bury the APPs and watercourses (Figure 1). In extreme weather events, this results in bridges and culverts being washed away, leading to a waste of public resources and associated environmental and social impacts. Road construction areas should be among the safest because they have been designed by engineers and evaluated through an environmental licensing process that is interdisciplinary, rigorously follows legal requirements, and proposes modifications that preserve the

FIGURE 1 Example of an APP and stream buried by earthworks and a culvert on the BR-319 in the Amazon. Photo by Hidroveg/PPBio

environmental and social quality of the area. It is much cheaper to build roads by means of earthworks, but in the medium and long term the costs of maintenance or for the replacement of bridges and culverts, road pavement repair, maintenance of vehicles travelling potholed roads, costs of accidents resulting from a lack of maintenance, and losses to businesses caused by transport delays need to be taken into account in decision making. We contend that burying APPs should not be the 'default method' and should only be used after careful consideration of the costs and benefits of all other options.

Brazilian engineers describe culverts as 'current works of art', but there is nothing artistic about burying an APP. In extreme climatic events the pipe forms a jet of water, causing erosion downstream and in the ground that supports the road itself, often causing damming upstream, killing trees and changing the physical, chemical, and biological conditions of the watercourse. These constructions also impede the migration of fish that normally use the calm waters of APPs to migrate during floods (Riis et al., 2020). Furthermore, the protected areas are generally too small to sustain most species, so APPs assume a critical role in biodiversity conservation, as they transform isolated fragments of native vegetation into integral parts of an effective conservation system. If APPs were respected in road construction, fewer special fauna passages would be necessary, because much of the terrestrial fauna and flora disperses along riparian zones (e.g. Rosa, 2020). Although fauna passages, which are usually dry-culvert underpasses or bridge overpasses, work for some individuals of some target species, they are ineffective for many others in the biological community.

An example of the lack of consideration of APPs is the environmental impact report for Km 250.0 to Km 655.7 of the Amazonian road BR-319 (Departamento Nacional de Infraestrutura de Transportes, DNIT, 2020). The report foresees the burying of APPs, and the only alternatives presented are to strengthen the dykes to slow any road collapse resulting from inadequate engineering or to abandon the road. There is no suggestion of using the inventiveness and innovation of engineers to avoid the problems intrinsic to APP burial. The problem is mainly that the BR-319 crosses low areas subject to periodic flooding that sustain unique biodiversity dependent on the flood cycle (Stegman et al., 2019). Natural flooding in this region extends for hundreds of kilometres, so the impact is not restricted to the immediate vicinity of the road. The BR-319 reconstruction is a historic opportunity for Brazil to implement an ecologically sustainable road in the interior of the Amazon. We encourage road engineers to suggest alternative technologies that conserve APPs in line with current legislation and make infrastructure development less harmful to water resources and riparian zones in Brazil.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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