Exploraciones/Explorations

The Impact of Arco Norte on Northern Amazonia and the Guiana Shield: Methodological Reflections

Pitou van Dijck

The Problem

Communication and transportation systems play a key role in stimulating economic growth by facilitating production and trade, thus generating income and employment. Roads, like other forms of infrastructure, can have positive external effects that become available to investors as a public good. Consequently, public investment in infrastructure may trigger private investment in directly productive activities, thereby generating a crowding-in effect. This holds particularly for roads in areas where alternative means of transportation are of only little economic significance.

At the same time, however, roads may also generate negative external effects resulting in a loss of welfare. In special circumstances, these negative externalities of infrastructural works may not be confined to the local or regional level, but may even affect welfare at the global level. This may specifically be the case with roads penetrating pristine and highly vulnerable eco-systems that provide eco-services by contributing significantly to the world's stock of genetic resources and to the sequestration of carbon.

Arco Norte is a road project designed and created by Brazil, linking the northern part of Brazil with the three Guianas: Guyana, Suriname and French Guyana, and with the Caribbean Sea. As shown in the map, the road will link Boa Vista in Roraima to Georgetown, Guyana, continues parallel with the coastal line to Paramaribo, Suriname, and Cayenne, French Guyana, re-enters Brazil and ends at the mouth of the Amazon River in Macapá, Amapa. This road is still under construction, even though the link along the coast between Georgetown, Paramaribo and Cayenne has existed for a long time.

On 31 July 2003, President Lula da Silva of Brazil and President Bharrat Jagdeo of Guyana met in Brasilia to officially confirm the decision to construct a bridge over the Tacutu River and build an asphalted heavy-duty road linking Boa Vista to Georgetown. The road project is part of a larger programme to integrate the state of Roraima with Guyana through the construction of a deep-water port, a hydro-electricity facility in Guyana and the development of high-speed dependable communications systems in the region. Transmission lines will follow the course of the new road as well as a fibre optic cable that will link Boa Vista and, at a later stage, Manaus to the intercontinental fibre optic cable, which passes north of Georgetown. Improved infrastructure is expected to contribute to investment in the region in food crops, the tourism sector and particularly in the development of an

Arco Norte in the Guiana Shield Region

industrial zone in Boa Vista. Brazil claims that investment in a new pulp plant has already been agreed upon, and production is expected to start by the end of 2004. Seven other plants, including an aluminium smelter, meatpacking facility, soybean complex compressor, and a freeze-dried coffee plant, are projected to contribute to the natural resource-based industrial development of the region. The Inter-American Development Bank (IDB) agreed to finance the pre-feasibility study for the highway and for the deep-water port. In the same context, the heads of state of Brazil and Guyana have discussed the option to integrate Guyana in the Brazilian surveillance system Sistema de Vigilância da Amazonia (SIVAM), the System for Monitoring Amazonia, in order to improve protection of the area from illegal invasion and occupation.

The road will penetrate one of the most pristine and thinly populated stretches of rainforest in all of Amazonia and indeed in the entire world. So far, the region, characterized by an extremely high biodiversity, has been little affected by economic activities such as logging, agriculture, ranching and mining, as compared to many other parts of Amazonia. Large parts of this region are protected, at least in a legal sense, by several truly sizeable conservation units such as forest and biological reserves and by indigenous reserves, many of which have been established during the last two decades. The Guiana Shield Initiative taken by the Netherlands' Committee of the International Union for the Conservation of Nature (IUCN) is among the most recent initiatives to foster protection of this unique wilderness. It aims at financing protection and sustainable development through the Global Environment Facility (GEF), administered by the World Bank. However, notwithstanding these major initiatives to protect the region's eco-system and habitat for the tribes of Indians and Maroons, gold and nutrient mining activities are encroaching upon the region.

In the following, we shall present the Arco Norte as part of a Brazilian strategy to integrate Amazonia into a national economic and security system. Next we shall briefly discuss changes in the use values of Amazonia as registered so far, particularly in relation to the construction of roads. Finally we shall refer to some methodological problems that hamper a full assessment of the economic and environmental impact of roads on the forest.

Roads in Amazonia

From the late 1950s onwards, the development of the Amazon region and its integration in a national security system have become part of Brazil's overall strategic development plans. This vision on the role and place of the Amazon wilderness of Brazil was captured by the phrase *'integrar para nao entregar'*, or integrate not to forfeit. The national priority from the military perspective was reflected by the establishment of the Superintendência de Desenvolvimento da Amazônia (SUDAM) – the Superintendency for the Development of Amazonia – and the start of Operation Amazonia in 1966, and by many plans and programmes throughout subsequent decades. The Plano de Integração Nacional (PIN) – the National Integration Programme – was started in 1970 and reflected in particular the military geopolitical priorities of the time.

Development of the region has been supported by federal governments with a combination of investment programmes in roads, airports, telecommunications and energy, and packages of fiscal and monetary incentives for private enterprises in mining, agriculture and cattle ranging, including income tax holidays for 10 to 15 years for qualifying firms, investment tax credits for plans approved by SUDAM, subsidized rural credits, and PIN financing of irrigation schemes.

The introduction of a massive programme of highway construction throughout the region has been a key component in this overall strategy to permanently move back the frontier of Amazonia, and to bring people without land to a land without people, as put at the time of President General Medici. These government programmes have strongly impacted upon land use in Amazonia and have rapidly changed the direct and indirect use values of the region. By penetrating the forest, roads make land more accessible, hence cheaper, and link distant production sites to markets. The PIN boosted the construction of highways and roads throughout Amazonia and made resources available to construct 15,000 km of roads.

Subsequently, the Calha Norte Project, officially called the Development and Security in the Region North of the rivers Solimões and Amazonas, was initiated in June 1985 under President Sarney as a military project, aimed primarily at national security. The plan was to enhance external and internal security by delimiting a protection zone along the western and northern boundaries of Brazil from Amazonas to Amapá, covering an area of approximately 14 per cent of the total land area of Brazil. Political instability in Brazil's northern neighbouring countries, particularly Guyana and Suriname, was referred to as a potential threat to be contained. To stimulate security and economic development, the Calha Norte Project focused chiefly on improving communication and transportation in the northern regions of Brazil. Funds were spent specifically on the construction of roads, on airfields near Funai posts, and on the control of waterways. Apart from the national security dimension, the plan aimed at developing Amazonia through the creation of mining-related growth poles. A third objective of the Calha Norte Project was the containment of drug smuggling. From that perspective, the military was not in favour of attracting small farmers into northern Amazonia.

More recently, the project Avança Brasil, initiated in the late 1990s, intends to invest over 24 billion real over the period 2000-2007 in western and northern Amazonia, and an additional 50 billion real in the areas south and east of the centre of the Amazon region. Probably up to 60 per cent of these amounts are related to infrastructural works. The programme focuses on road improvement and the con-

struction of bridges, railways and other types of communication systems, rather than the construction of new roads (Andersen et al. 2002, 33 and 34).

All together, a significant system of roads crossing Amazonia and linking it with the rest of Brazil has been created during the past four decades. In 1960 there were only 6,000 km of road in Brazil's classic Amazonia, of which only 300 km were paved (Mahar 1989, 12). A major step towards opening up Amazonia was the start of the construction in 1960 of an all-weather highway running 1900 km north to south between Belém and Brasilia (BR 010), which was paved in 1974. The Cuiabá-Santarém connection of 1,600 km also belongs to the early components of the trans Amazonia road network. In the context of Operation Amazonia, legislative acts and decrees in 1966 and 1967 created the foundation for a comprehensive attempt at opening up and colonizing Amazonia, particularly through the extension of a road system. The construction of the 2,300 km Transamazon highway, linking the northeast to the western area of Amazonia, was part of the Plan for National Integration completed in 1974.

Work on a second east-west trans Amazonia connection – the Northern Perimeter Highway (BR 218) – was started in 1973 to link Macapá with Boa Vista (2,700 km), but the project stagnated. Other major road links are the north-south connection BR 319 between Manaus and Porto Velho of nearly 900 km, and the 1,500 km road BR 364 running north-east connecting Cuiabá and Porto Velho, which was completed in 1967 and paved in 1984. There are other roads going northwards that are partly realized and/or under construction. Manaus road BR 174 of almost 1000 km goes toward the Venezuelan border and connects Manaus to Caracaraí and Boa Vista, ending ultimately in Caracas; BR 401 links Boa Vista and the border of Guyana; and the Macapá-Oiapoque road BR 156 of almost 700 km runs up to the border of French Guyana.

Remarkably, in its report 'Rio + 10: Brazil on the Way to Sustainable Development' (1992, 40), the Brazilian government, by way of example of subcontinental eco-efficiency in infrastructure investments, refers to '…the proposed railway interconnection between the states of Roraima and Amapá, in the extreme north of the subcontinent'. That is the railway version of the Arco Norte road link which is 'almost completely paved', as the report puts it.

The plan to construct a railway link in that region is not entirely new: in 1927 the American explorer Alexander Hamilton Rice proposed the construction of a railway link between Manaus and Boa Vista. In the 1920s and 1940s the British proposed a 1200 km long railway stretch linking Georgetown with Boa Vista and Manaus.

Changes in land use and in use values

Spatial analysis of economic activities in Amazonia and the Guiana Shield supported by satellite images indicates that the northern frontier of Amazonia is still as yet among the least affected regions in Amazonia. In Brazilian Amazonia, agriculture – both subsistence and commercial – and cattle raising are particularly concentrated in the southern and eastern parts of Amazonia, along the Amazon River and in Roraima. Mining activities are dispersed throughout Amazonia, except for the western part, and are strongly concentrated in the eastern part of Amazonia. North of the Amazon River, both large and small-scale gold mining activities are dispersed throughout Roraima, as well as in Guyana and Suriname. As a consequence

of these economic activities, deforestation has progressed in the eastern and southern stretches of Amazonia specifically, while the western and northern parts are still among the least affected regions. In Brazilian Amazonia, the three states of Matto Grosso, Pará, and Rondonia together account for approximately 65 per cent of all deforestation, while the state of Amazonas it accounts for only 5 per cent (Gascon et al. 2001, 24-25). Thus, the northern part of Amazonia and large sections of the Guiana Shield Region are among the best-preserved wildernesses of tropical South America. Moreover, here we find a large concentration of nature reserves and Indian tribal reserves, be it that these reserves differ in status and are not necessarily entirely effective in preserving the habitat.

To assess the true value of the region, a comprehensive inventory of the many different functions of the forest needs to be made, including the array of direct and indirect use values as well as optional and existence values of the rain forests. The rain forest is truly multifunctional in the sense that it simultaneously provides direct and indirect use values, the latter becoming available as public goods. Exploitation of some or more of the direct use value capabilities of the forest may result in ecological degradation and limit the capability of the forest to provide some of its indirect use values. Among its direct use values are its supply capability of timber, commercial supply of non-timber products such as nuts, palm hearts and meat, its value as a habitat for various Indian tribes and groups of Maroons, and its educational and its recreational potential that may serve as a basis for eco-tourism, reflection and research. Among its indirect use values may be included a variety of ecological services provided by the forest to the region or to the world, such as its contribution to the nutrient cycle, as a water control that protects watershed, as a carbon sink and as a habitat for a diverse flora and fauna. Its future economic potential is as yet little known.

What makes the region, and particularly the Guiana Shield area, so special is the diverse endemic flora that has evolved on this Precambrian geological formation. IUCN estimates that the north-eastern part of Amazonia, including the Guiana Shield Region, hosts an estimated 20,000 plant species and at least 4,000 vertebrate species, several of which are found no where else. Thus, deforestation in this part of Amazonia and the Guiana Shield will affect the regional hydrology, reduce the carbon sink, and result in biodiversity loss, leading to aberrations in regional and extra-regional rainfall, and an increase in the likelihood of fires.

Although the Guiana Shield region and northern Amazonia have been relatively unaffected by economic activity in comparison to those areas south of the Amazon River, the region is being increasingly threatened by large-scale open pit mining and highly contaminating and destructive wildcat mining by *garimpeiros*, as well as by several forms of nutrient mining, most specifically large-scale cattle ranching and small-scale slash and burn agricultural activities. Moreover, the disruption of the forest canopy will also heighten the likelihood of forest fires.

Nutrient mining, conceived of as the unsustainable extraction of nutrients from the forest soil through cropping, ranching and logging, is both an incentive and market response to road building and one of the main causes of deforestation (Schneider 1995, 15). The rain forest in central and northern Amazonia may increasingly come under pressure for reasons related to the expansion of nutrient mining activities. First, with the depletion of worldwide stocks of timber, higher prices will stimulate exploitation in the last great tropical timber reserves. In varying degrees, this may also hold true for other natural resources, although the impact

of pit mining activity on the integrity of the forest may be more locally confined than large-scale timber exploitation is. Second, infrastructural investments embedded in new governmental projects to develop Amazonia, particularly in new roads, will increase the likelihood of deeper penetration into the forest (Gascon 2001, 25).

Nutrient mining and wildcat gold mining activities in the forest interact to the extent that smallholders account for over half of the garimpeiros, according to two surveys undertaken in Pará and Roraima. Moreover, interviews with garimpeiros in Boa Vista indicate that they invest gold in properties between 800 and 2000 hectares, located in the forest (MacMillan 1995, 56-104).

Statistical studies of deforestation in Amazonia show its concentration along the expanding road network. This does not come as a surprise when taking into account the specific rationale of road building in the context of Brazil's successive plans and projects to develop Amazonia, as discussed earlier. In the period 1991-95, 33 per cent of deforestation was concentrated in an area within 50 km of the eastern road network, 24 per cent within 50 km of the central road network, and 17 per cent within 50 km of the western road network. All together, 74 per cent of deforestation was concentrated within a range of 50 km around roads, creating long corridors through the forest. Most new clearing takes place in areas adjacent to areas already cleared, on a moving agricultural frontier, often along a so-called fishbone pattern (Alves 2002; see Andersen et al. 2002, 55).

Moving back the frontier by building new roads in pristine forests has a tendency to lower land prices by making new land available, hence stimulating colonisation, while, on the contrary, improving existing roads may increase land prices by stimulating the intensification of land use. Investment in network expansion results in more deforestation than investment in network improvement (Andersen et al. 2002, 145-147). To the extent that Avança Brasil does not aim so much at expanding the road system in the north of Amazonia but on improving it, its contribution to moving back the frontier may be limited, and, as a consequence, this may also hold true of its impact on deforestation. Abolishment of fiscal and monetary incentives for agricultural development and cattle ranching may further reduce the impact on deforestation and so may the improvement land use regulation.

To reduce deforestation in the northern sections of Amazonia and in the Guiana Shield region, and indeed in Amazonia as a whole, the incentive for nutrient mining and wildcat gold exploitation must be reduced essentially by limiting physical and economic accessibility to land. Key policy measures in that respect are the reduction of investment in roads, reduction of fiscal and monetary incentives, and improved land tenure policies. These measures may be combined within the context of a zoning strategy for vulnerable regions, including the establishment of nature reserves and strengthening of their conservation function (Schneider 1995, 37**).**

Methodological challenges

Although the construction of the Arco Norte started in the 1980s, the impact on the forest that the road penetrates seems to be limited. The road sections that connect the coastal area with Boa Vista and Macapá are as of yet in a relatively poor state, requiring a four-wheel drive to traverse. As a consequence, traffic has been limited. Assessing the potential impact of the new sections of the Arco Norte on the forest it penetrates in environmental and economic terms is complicated by a number of methodological obstacles, three of which are referred to below.

First, an adequate assessment of the effects of infrastructural investment on changes in land use in a forested area requires a long-term analysis. The response of economic subjects to improved access to a region in order to invest in economic activity such as nutrient and mineral mining – and by doing so changing the ecology and economy of the area – depends on a number of factors, only one of which is the road itself. It may require some years to assess the investment response to the construction of the road. Second, measuring deforestation, fragmentation, and edge effects as a consequence of improved access and investment in economic activity may in itself be complicated and expensive. The Sistema de Vigilância Ambiental (SIVAM) may be useful in the future for monitoring changes in forest coverage. However, Andersen et al. (2002) show that combining information from satellite images with land surveys may be complicated. Third, an economic assessment of the consequences of changes in land use is hampered by imperfect functioning of many of the markets involved and by the absence of markets for several eco-services provided by the forest at the local, regional and global level. This holds particularly for the economic valuation of biodiversity and carbon sequestration. These complications must be tackled in order to make a comprehensive valuation of the forest to enable comparison of alternative options for its exploitation. Moreover, longer-term forecasting of variations in direct and indirect use values, resulting from future patterns of demand and supply of natural resources and ecological services, are difficult to make (Trindade de Almeida and Uhl 1999; Van Beukering and van Heeren 2003). Hence, a rational assessment of the costs and benefits of alternative types of exploitation of available resources in the area is seriously hampered.

Some of these complications must be tackled at the very least in order to design rational payment systems based on some sort of cost-benefit analysis related to the eco-services that are provided by northern Amazonia and the Guiana Shield, as proposed by the Guiana Shield Initiative taken by the Netherlands' Committee of the IUCN (2003). Such payments for eco-services, particularly to regional and global markets, may alter the balance when choosing between different options for exploiting the rainforest in this unique part of Amazonia.

* * *

Pitou van Dijck is Associate Professor of Economics at CEDLA, Amsterdam. For more information on the Arco Norte research project at CEDLA please contact: vandyck@cedla.uva.nl.

References

Alves, D.S. (2002) 'An Analysis of the Geographical Patterns of Deforestation in Brazilian Amazonia in the 1991-1996 period'. In C. H. Wood and P. Porro (eds) *Land Use and Deforestation in the Amazon.* Gainesville: University Press of Florida.

Beukering, P. van, and A. van Heeren (2003) *Economic Valuation of the Iwokrama Forest, Guyana – A Stakeholder Perspective*, IVM. Amsterdam: Vrije Universiteit, internal report, March.

Andersen, L. et al. (2002) *The Dynamics of Deforestation and Economic Growth in the Brazilian Amazon.* Cambridge: Cambridge University Press.

Gascon, C. et al. (2001) 'Deforestation and Forest Fragmentation in the Amazon'. In R.O. Bierregaard, Jr et al. (eds) *Lessons from Amazonia, The Ecology and Conservation of a Fragmented Forest*. New Haven and London: Yale University Press.

MacMillan, G. (1995) *At the End of the Rainbow? Gold, Land and People in the Brazilian Amazon.*

London: Earthscan Publications Ltd.
Mahar, D. (1989) *Government Policies and Deforestation in Brazil's Amazon Region*, A World Bank Publication in cooperation with World Wildlife Fund and the Conservation Foundation, Washington, DC: The World Bank.
Ministry of Planning (of Brazil) (2002) *Rio + 10: Brazil on the Way to Sustainable Development*, Texts from Brazil, Number 09.
Schneider, R. (1995) *Government and the Economy on the Amazon Frontier*. World Bank Environmental Paper, Number 11.
The Netherlands'Committee of IUCN (2003) The Guiana Shield Initiative, project proposal, Amsterdam.
Trinidade de Almeida, O., and C. Uhl (1999) 'Developing a Quantitative Framework for Sustainable Resource-Use Planning in the Brazilian Amazon'. In P. May (ed.) *Natural Resource Valuation and Policy in Brazil, Methods and Cases in Conservation Science*. New York: Columbia University Press.