ROADS AND DAMS: INFRASTRUCTURE-DRIVEN TRANSFORMATIONS IN THE BRAZILIAN AMAZON

EMILIO F. MORAN[1]

I. Introduction

Ever since President Emilio Medici launched the First Program of National Integration (PIN) in 1970, which called for a massive effort at road-building, directed settlement, and geopolitical integration of the Amazon into national development goals, the Amazon has attracted worldwide attention (Moran 1975, 1981; N. Smith 1982). Through this first PIN, huge investments in building the Trans-Amazon Highway and the Cuiaba-Santarem, opened up the region to settlers, developers, miners, ranchers, and urban commercial interests. Sleepy towns such as Altamira, Maraba and Itaituba were woken from their slumber, and they began to swell with population. First, the engineers and construction crews, then the wholesale and retail commercial sector arrived to provide for the swelling population coming to build the roads and then the many who came to settle in the region as farmers or service providers. Altamira went from slightly over 1,000 people in the urban area to over 10,000 in little over a year, reaching 85,000 by 1985. As one might have expected, the influx of people surpassed the capacity of services to meet demand. After all, this project was viewed as the equivalent of putting a man on the moon, at the time, and there were no precedents on how to prepare for it. The small SESP hospital could not keep up with the swelling population and the arrival of more medical personnel was slow in coming. Schools were built very fast but they too could not accommodate the swelling population. Classes were held in triple sections each day and it was still not enough. Teachers were recruited from all over the country with attractive double salary levels. Road accidents exploded in frequency, with road trauma the biggest source of morbidity for adults; followed by malaria. Over the next 30 years, after 1985, the urban area stagnated in population size, commercial activity, and promise until 2010.

In 2010 once again the President of the nation, this time Dilma Roussef, called for a massive effort at infrastructure development on the Xingu—the construction of the Belo Monte Hydroelectric Dam, third largest in the world according to the press releases (see papers by Maira Borges Fainguelernt and Vanessa Boanada in this special issue for details). The stated goals were to meet the energy needs of a nation growing rapidly in demand for energy. The dam, or some version of it, had been under discussion since the

1. Emilio Federico Moran, John A. Hannah Distinguished Professor, Michigan State University, USA. Email: moranef@msu.edu

1970's. Since that time it had been the magnet of opposition from indigenous groups who would have had portions of their lands flooded, from environmentalists who saw the dam as blocking the fish runs and fisheries of the Xingu, and the likely attraction of massive migration of people to the area that would set off a new wave of deforestation. Altamira went from 85,000 to an estimated 150,000 in less than four years. Once again, and this time inexcusably, even though this time there had been discussion of building the dam for 30 years and there have been several dam building experiences in recent decades, the authorities at all levels were unprepared for the arrival of this doubling of population for what was an even larger infrastructure project than the Trans-Amazon highway and all services—medical, educational, roads, police, and health—found themselves unable to meet the explosive growth and the ensuing chaos that resulted. Sanitation got so bad that for a while Altamira was dubbed in Brazil's newspapers as the city of the urubus, birds of carrion that could be seen everywhere eating the uncollected trash. Dengue spiked and whole neighborhoods were stricken with this debilitating illness. Altamira city, that in the late 70's and early 80's had been fully paved by a mayor with a progressive agenda and with schools and hospitals sufficient to meet its normal needs, returned to being a city full of potholes that ruined vehicles, and to cycles of either mud or dust which characterized the early 70's when Altamira was first transformed by the arrival of the Trans-Amazon Highway builders and settlers.

How could this happen? Did officials not know the history? Was this willful ignorance? Was the explosive growth not predictable from earlier dams built in Brazil and the world? In this paper we look back a bit, in order to look forward, at the story of infrastructure development in this region of the Amazon in the hopes that one can find ways that society can be better prepared for the many planned infrastructure projects coming up (more than 40 hydroelectric dams are in the planning stages for the Brazilian Amazon).

II. The Transamazon Highway, and the Altamira experience

The announcement of the building of the Transamazon Highway and the accompanying settlement projects was noticed globally. The military government at the time said it was "the equivalent of putting a man on the moon." Indeed, building a highway across the entire Brazilian Amazon (from Joao Pessoa and Recife to the frontier with Peru) entailed building a 5,400 km road through territory that had not been surveyed before. One of the first things that had to be done was to use sideways-looking radar to map the region (RADAM), and to send topographers and geologists by helicopter in some cases, to begin to survey the area geologically, an opportunity to learn about the biophysical characteristics of half of Brazil's territory. It was done with breakneck speed and with a remarkable high level of quality-- such that to this day researchers use the data from RADAM as the best data on the basic resources of the Amazon region. No comparable effort had been undertaken before or since to comprehensively understand the natural resources of the Amazon. Embrapa was charged with mapping the soils along the highway, and soil scientists accompanied the road crews and elaborated the first maps of soils (Falesi 1971, 1974). There was nationalistic fervor ("ocupar para nao entregar";

"voce constroi o Brasil") driven by geopolitical goals (Couto e Silva 1957) that were promoting a Giant Brazil—a country with ambition to be among the economic engines of the global economy. There were social goals too ("dar a homens sem terra, uma terra sem homens") and the first PIN was announced as a response to another devastating drought in Northeast Brazil where large populations and inequitable land distribution had always been a source of social tension. While other countries in Latin America were pursuing other roads of national integration (Tambs 1974), only Brazil was up to the task of building a road this big in a matter of 4 years. This was not a cost/benefit analysis-based undertaking as World Bank loans required. It was nation-building and ambition-driven.

The Trans-Amazon Highway followed on the Belem-Brasilia Highway that had opened up the Amazon to road traffic in 1965 (paved only in 1973) and which first opened up the eastern Amazon and the largest city in that region to the new capital in Brasilia. Both were efforts at moving the nation and its people from the coastline they had hugged for centuries and into the interior. The huge Amazon frontier represented hope for a Giant Brazil, and one with a vigorous agricultural sector (Schuh 1970). Earlier efforts by SUDENE, the agency to help develop the Northeast, Brazil's poorest region, had emphasized industrial development and when the 1970 drought struck, it was evident from the misery in the region that a different hope (i.e. land) had to be offered. 400,000 people were reported to be at the verge of famine, and were resorting to assaults on trains and trucks to obtain food (Brazilian Information Bulletin 1974). The Transamazon highway provided an escape valve for this population, largely landless by offering land along the Trans-Amazon highway.

The government hoped that 75% of the people would come from this poor and overpopulated NE region. Instead, less than 6,000 families were resettled in the first four years, a figure much lower than the 100,000 families forecast by the government in its PIN plan. The government seemed to forget that the people in the Northeast had come to the Amazon before (in 1878 alone more than 54,000 had migrated from the northeast to the Amazon (Tambs 1974), and that they knew from popular culture about the debt slavery experienced by past migrants; of the rubber tapping work that was the great economic boom of the late 19th century and during the Second World War (when they were brought to help tap rubber for the war effort after the Malaysian fields were cut off by the Japanese). The people from Northeast Brazil had been moving for years out of that drought -stricken area: to the Southeast, to the Center-West but much less to the Amazon except during those rubber booms. In fact, many of the migrants from the South and Southeast were Northeasterners who had moved South to work on coffee plantations and other agrarian and urban employment.

While social considerations are not out of the question, the military government was driven more by political and economic considerations. The spectacular iron ore deposits of the Serra dos Carajas were already known, the presence of other important minerals had been discovered by infrared photography, the presence of good soils in parts of the Amazon had been identified, and the largest wood reserves in the world with an estimated yield of 178 cubic meters per hectare (SUDAM 1974:11) also lent impetus to the infrastructure project. Economists at the time at SUDAM even suggested that the

Amazon was such a rich minerals province that mining was its "natural" mission, not agriculture or forestry (RADAM identified large deposits of iron, tin, copper, lead, zinc, aluminum, gold, silver, chromium, manganese and other ores (Kleinpenning 1975:13). The development efforts of SUDAM were, however, diversified. Holland's Bruynseel and Germany's Volkswagen acquired rights to exploit lumber, as did Georgia Pacific and Weyerhauser. Alcoa began to build a processing facility to exploit a bauxite-rich area. King Ranch and Swift-Armour began to look at the potential for beef production for export. Many of these projects never materialized, but some did. Carajas did develop into one of the biggest mines in the world, with railroads taking the ore to Sao Luis do Maranhao for export. More than one bauxite mine and processing facility was built and brought into production. Most significant in terms of land cover impacts were the internally generated development projects: two thirds of the projects approved by SUDAM (the Amazon Development Agency) were for livestock production - the beginning of what has been the biggest transformation in the Amazon - where for the past three decades 90% of the area deforested is in grazing land for cattle. SUDAM, and subsequent financial groups, have provided favorable subsidies, tax holidays, and credit for the development of this sector of the economy (Moran 1981; Kleinpenning 1975; Hecht 1998; Walker et al. 2000).

III. Settlement along the Transamazon Highway

Over the past 40 years there have been quite a few publications examining the process of settlement along the Transamazon Highway (Moran 1975,1981, N. Smith 1976,1982; Fearnside 1976; Ozorio de Almeida et al.,to name just a few). Promoters of the settlement program held meetings all over the country and told potential migrants that the soils were fertile and produced "cotton balls the size of grapefruits" in the region, and that the soils were as rich as those of Parana. They were promised agricultural tools to get started with farming, credit at below inflation rates, and free transportation from their home regions to the settlement areas—in some cases by jet plane. The landing strip in Altamira was expanded to accommodate large Boeing jets that came with remarkable frequency in 1972 and 1973 to bring settlers from various regions of the country. Farmers were provided accommodations on arrival, taken to various parts of the road, and given a chance to pick their property. Each lot or property was 100 hectares, usually 500 by 2,000 meters. Some asked to return home because they did not like what they saw, but many stayed and started farming. The project had a modular design with planned communities (agrovilas) at regular 10 km intervals along the main road, and the side roads. Larger centers were foreseen to provide expanded services to farmers (agropolis and ruropolis). To this day only one agropolis (Brasil Novo) and one ruropolis were ever built (Medicilandia), not the many foreseen. The agrovilas in many cases went from being the homes of the farmers on nearby land, to largely dormitory communities for temporary laborers, as farmers built homes on their properties. What happened? Like so many other large-scale infrastructure projects, the ambition of the projects was greater than the capacity of government to deliver on the promises made. Surprises were many and frequent. Within two years of the start of the construction, the first oil shock of OPEC

took place in 1973, resulting in a sudden increase in costs of everything due to the high dependence of Brazil on Middle Eastern oil imports at the time. While the main trunk of the Trans-Amazon was completed, the government abandoned the plans to keep up the side roads (travessoes) that provided access to most farms. This resulted in most farmers being unable to get their production to market (Moran 1975, 1981). This meant that many of the services to farmers could not be delivered, teachers would not go to communities left in isolation, and the service functions of the agrovilas away from the main highway could not be fulfilled, making the communities less than desirable.

Barely four years into the settlement scheme, Geisel replaced Medici as President, and he promptly declared in 1976 that the small farmer settlement scheme along the Transamazon had failed, that farmers had not lived up to the hopes of the government to produce bountiful harvests, and that the directed colonization program would no longer receive special assistance. This came as a surprise to farmers. The production of rice in those early years was substantial, but it rotted in temporary shelters built to store the production while waiting for the roads to be built or maintained, and where much of it spoiled since such promised roads did not materialize. What really happened was that an association of Sao Paulo entrepreneurs conducted a campaign from 1971 to 1975 to convince political leaders in high places that small farmers were not able to produce the dramatic increase in GDP desired by the architects of a Giant Brazil, and that the government should turn over the development of the Amazon to them. They succeeded in this lobbying effort. From 1976 to the present, the Amazon entered a steady process of deforestation and conversion of land from forest to pasture that has resulted in 20% of the region now being deforested and 90% of deforested land being in pasture.

The smallholders did not disappear. Many who picked good soils have remained on their land all these years, some have expanded and are now small to medium size cattle ranchers, or cocoa farmers. Over the years, they built ever better homes, their children studied in the city, and many own homes in town while still continuing to manage their rural properties. In other words, over a generation, a not insignificant number of them moved from being landless to being middle class. Bank managers in cities like Santarem spoke in glowing terms of the entrepreneurial spirit of Altamira region farmers and the success of their agropastoral farms. Not all succeeded, however, as happens in all frontier regions. Over the past 40 years there has been land consolidation, as less capable farmers have sold their land and moved either to new frontiers or settled in the city to seek nonfarm employment. The local economy has grown and it has gone up and down with the price of major commodities particularly beef and cocoa. Over the years what they said they lacked the most was the highway being paved, so as to cut on the time and cost of getting their production to market, especially when the rainy season starts and roads become difficult to cross, until they are re-graded with the start of the dry season. By the time Belo Monte arrived, the rural sector was stable and consolidating, the area was considered a productive region for beef and cocoa, and the city provided a haven for investment for rural people and opportunities for young people to get an education. A campus of the Federal University of Para had been built up, and also one for the State University of Para, offering opportunities for local students who went on to study

throughout the country when scholarships were available from CAPES (an agency that provides funds for master and doctoral education) and CNPq (another agency that funds research and scholarships). Altamira became a regional center for health care when a Regional Hospital was built at the start of the 21st century, to treat difficult cases referred by smaller communities.

IV. Belo Monte and the new era

Belo Monte was long in coming. It is part of a larger grand plan to ensure energy for Brazil's ambition to be a major world power. Rich in rivers, it has always looked to hydropower as a way to meet this ambition. Around 100 dams were built in the 1950's, 103 in the 1960's, 151 in the 1970's and 1980's (Khagram 2004: 142 cited in Boanada 2015). The pace slowed to a trickle after the 1980's, as it did worldwide especially in Europe and North America. World Bank and other international organizations stopped pouring funds into large dams out of concern for the environmental costs of these large infrastructure projects.

We can look back to the military government era for the origins of Belo Monte. The state-owned Eletrobras, and its North Region subsidiary, Eletronorte, began to propose a series of dams: one or more on the Xingu; Balbina; Tucurui on the Tocantins. Some were built like the Tucurui and Balbina, while others were postponed for decades, like Belo Monte (Conservation Strategy Fund 2006).

Roads connect the Amazon to the rest of the country and guaranteed its borders, dams ensure that the occupation has power for the industrial development of the country as a whole. It also provides the foundations for an urban Brazil, one that transitions from a rural-based to an industrial economy. That process was fully realized decades ago in the south and southeast, and it is now unfolding in the Amazon (see the paper by Leturq in this special issue comparing dam building in the North and South of Brazil). The industries that first entered the Amazon were energy-intensive: gold, iron, aluminum and copper. Tucurui provided the initial energy to support Carajas, and then the bauxite mining areas. The Xingu from the 1970's was of interest to the electric sector. An inventory of the hydroelectric potential of the Xingu Basin was produced in 1979 in which the optimal exploitation was said to be five dams on the Xingu and one in the Iriri, an important affluent of the Xingu (Netto et al. 2007 in Boanada 2015). Together they were estimated they could generate 20 GW of energy, half of the capacity of all other hydroelectrics in Brazil at that time. This study did not consider the impact on indigenous areas even though it mentioned in passing that national parks, indigenous areas, and other environmentally sensitive areas would go underwater. The constitution of 1988 began to change the receptiveness of people to dams by giving them rights that they did not have before.

Momentum built as coalitions were formed that included indigenous peoples, settlers along the Transamazon highway, environmentalists, and other academics who began to question the plans for Kararao, as the first dam was called at the time. They began to see and learn of the problems that arose in earlier dams such as Tucurui and Balbina: lack

of transparency, displacement of people, and flooding of indigenous territories (Fearnside 1989, 1999). Tucurui flooded 2,430 sq km, 36% of that area within the territories of the Parakana. In Balbina, the Waimi-Atroari were displaced and villages were forced to move (Castro and Andrade 1988 cited in Boanada 2015). The proposed Xingu hydroelectric complex was estimated would flood 20,000 square kilometers, and would have affected 37 indigenous groups. Past experiences with dams and the proposed project resulted in growing opposition to the dam on the Xingu, now backed by the provisions of the 1988 Constitution. The First Summit of Indigenous people of the Xingu took place in Altamira in 1989. The meeting brought together indigenous persons, journalists, environmentalists, labor associations and academics and came to worldwide attention due to the presence of celebrities such as Sting. The protest by an indigenous woman who expressed in dramatic form the opposition of indigenous people to dams in the Amazon, and to the Xingu dams in particular, led to reconsideration of the design of Kararao and during the 1990's the project was shelved but not abandoned by Eletronorte. The name was changed from an indigenous name to a "white man's name" as demanded by indigenous people. The real reason for the stoppage was, however, the temporary stop of funding for large dams by the World Bank, under pressure worldwide to reconsider dam financing due to social and environmental costs.

In the first decade of the 21st century, Eletronorte developed what became a new thrust to build Belo Monte: now concerned with blackouts nationwide such as those that took place in 2001; and moving the dam to the Volta Grande of the Xingu near Altamira; use of run-of-river technology designed to operate using the flow of the river itself to power the turbines; and reducing the size of the reservoir. These changes and a political decision by the government to engage in a nationwide effort at infrastructure construction to try and ride out the worldwide recession despite the national indebtedness that this would imply (as with the 1970's megaprojects undertaken by the military government) was seen as a return to the Giant Brazil development goals of the past. In 2010 the new PT government gave clearance to start Belo Monte and selected Norte Energia, a consortium of firms, to undertake construction and then to run the dam for the next 35 years (Boanada 2015).

Much of the debate over Belo Monte centers on the priority given to the industrial exploitation of minerals, and of energy that will benefit other parts of Brazil more than those directly affected by it—and the environmental costs which have been discussed at length by scholars such as Fearnside (1999) and Ecre and Senecal (2003). What has been less a focus of attention is the unpreparedness of municipal, state and federal agencies to take the necessary steps to reduce the negative social impacts of large-scale infrastructure projects such as Belo Monte. It is well-known that once a dam is approved the engineering firms in charge of building it move very fast because it is in their interest to use the equipment on a 24-hour basis, rotate work crews through just such a daily schedule, and then move to the next large project. They even have built-in incentives to finish ahead of schedule. Not so for the government agencies in charge of building hospitals, schools, health posts, and local roads. They have unclear boundaries as to what each level of governance is responsible for, or they have overlapping responsibilities, which is even more

of a problem. They are reluctant to use their budgets (which rarely would have foreseen the eventuality of a major dam coming), but postpone taking action because they hope that the construction company will pay for some or all of these additional costs, and the federal government claims it is unable to allocate additional funds for the increase in population because the basis for the allocations is the decadal census—and in the case of Belo Monte the census happened in 2010 and within months the data was no longer relevant due to the explosive growth in population. The lack of official figures for population has resulted in unwillingness by governments at all levels in providing emergency funding to meet these urgent needs, hiding behind the cover that they have no official census information to base decisions on how much funding to provide. Just how should government decision-makers go about making these important policy decisions?

V. Boom Economies or Bust Economies?

The neoclassical economics literature on decision-making assumes rational behavior, unlimited capacities in processing information, and exogenous and fixed preferences. Thus, these rationality-based models have difficulty in explaining many micro-level decisions, especially when facing uncertainties typically present during boom and bust cycles (Camerer, 2003) such as those created by a large infrastructure project. Further, in this case, and in other dams like it, the population is likely to have very different ways to make their calculus: some will assume the dam construction is a short-lived bubble and ignore it in terms of their long-term plans, while others will believe that this is just the beginning of a long-lived boom in regional economic development and make decisions with that assumption. Some will optimize based on available information while others will resort to rules of thumb in making their decisions. For some this is a once in a lifetime opportunity to advance economically, and for others it will be one more failed dream. Which segments of the population will have which vision of the future? How will the vision of old Altamira residents, newcomers, rich, or poor differ? How will solidarity change with all these new residents? Who chooses which future scenario? How will social trust change during the construction? How will agents interact when their beliefs and rationality are heterogeneous? What happens to these different agents, and how will these different effects translate into overall economic and social impacts on the region? What will be the spatial distribution of these decisions and the outcomes for the landscape?

These are subjects of great interest in economics, sociology and the geospatial sciences. The economics literature specifically has not dealt with a case such as this, despite the intense interests of economists in understanding macroeconomic business cycles and the booms, busts, and possible recoveries associated with natural resource-based economies (van der Ploeg 2011) Economic growth due to resource discoveries, large projects such as hydro dams, or commodity or resource price hikes does not always end in economic busts or stagnation. With the right institutions and government policies, economies can take advantage of "agglomeration effects" when capital and labor flow into a region during the boom periods, thereby sustaining economic growth over the long run (Kline and Moretti 2012, and Allcott and Keniston 2013). Such effects can be

enabled by learning by doing or economies of scale, and are characterized by spill-overs of economic growth from resource related sectors to other sectors.

The empirical literature on the "natural resource curse", and boom bust cycles is dominated by *reduced form* estimation relying on cross-national or cross-regional *aggregate data*, and the estimation results are found to be sensitive to sample periods and variable definitions (van der Ploeg 2011). It rarely relies on local data sensitive to the transformations in costs and benefits created by a boom economy. Relying on aggregate data implies that these studies fail to identify the decision processes of economic agents and government agencies, and how their interactions generate economic booms or busts. Belo Monte project offers a unique opportunity to study how uncertainties and government policies associated with the project impact household decisions such as employment and education, real estate investment, and land uses. Insights from research on Belo Monte with this focus can suggest ways forward to address the combined needs of people and government goals.

Looking back to the earlier experience presented by the Trans-Amazon Highway, we could see that in those early years, the boom in population, and the flow of money into the local economy created scarcity of supply and inflated prices. An egg cost a dollar in the first year or two, rice came from far-away Goias, and bread and most everything came from Sao Paulo despite the high transportation costs at the time and the poor road connectivity. Within a decade, prices became close to normal (although Altamira always seems to have had a lack of labor and the cost of labor is higher than elsewhere in Brazil). The regional economy kept a steady rate of growth driven by beef cattle and cocoa production, with a robust local market for other agricultural products. And it remained in this stable point from 1985 to 2010. In other words, there was a short-lived boom of less than a decade, and then three decades of stable economic agro-pastoral activity.

Looking at the Altamira economy since 2010 we see the reproduction of the phenomenom of a boom economy, this time even at a grander scale but still familiar. Eggs costing a dollar, food having to come from outside to satisfy demand of the booming population, the insufficiency of local production to meet demand (not surprising given the focus on cattle ranching) and the short-lived nature of the dam worker population, housing prices inflated beyond reason (a three bedroom house renting for 5,000 reais per month, and still difficult to obtain), the price of labor driven up by the demands of the Norte Energia construction effort to levels unimagined in the local economy, and criminality reaching levels not seen even in large Brazilian cities. It is not very different from the chaos and violence seen in garimpos (wildcat gold miners found in the Amazon). No one in Altamira imagined that its town would become one large garimpo-like community. Altamirenses fear for their lives today as they go about their work and many fear going out at night. Will Altamira's economy bust? Only time will tell, but the current boom will last at most another three or four years. At that time the bulk of the construction crews, and those hoping to be hired, will pick up and go to the next infrastructure project. Already the crews are down as much as 10,000 workers. The economy will stabilize at a higher level of regional economic development than before Belo Monte, or it will return to the course on which it was before 2010. Which of these two scenarios will take place will depend on

how well the resources provided by Norte Energia to the community are used to produce lasting improvements in the regional economy. So far there is little evidence that the resources are being used in ways that will ensure regional development.

VI. Conclusions

Among other large infrastructure projects, developing countries are pursuing hydropower infrastructure construction to improve their position in the global economy and as an important component of their socio-economic development to produce food, generate energy, employment, and income; and improve the overall quality of life of their citizens (Tortajada et al. 2012; Richter et al. 2010; Rosenberg et al. 1997). Most of the developed world constructed large-scale hydroelectric dams up to the mid-1970s. During this early era, the Tennessee Valley Authority (TVA) was viewed with admiration worldwide because of the positive regional economic development attributed to it. TVA was created in 1933 to serve portions of Tennessee, Alabama, Mississippi and Kentucky that brought electrification to largely rural areas, one of the first of its kind and widely imitated thereafter, is given credit for attracting business and research to a vast area, and for controlling floods. It became a poster child for the hydropower industry as the way for government to assist in the modernization of agrarian societies. TVA consisted of 29 power--producing hydropower facilities. TVA remains today as the largest public power utility in the USA and one of the largest producers of energy in the country—but hydropower constitutes only 9% of all the power it generates today (the rest being nuclear, coal, and gas). Worldwide, a reversal of policies after 1975 led to a virtual stoppage of dam construction in the US (see above the shift in TVA) and elsewhere; further, the World Bank and the Regional Development Banks ceased funding these projects around the world.

After decades of neglect, organizations like the World Bank are once again providing support for large hydroelectric projects; such World Bank funding has increased from 1.6 million USD in 2000 to 6.2 million USD by 2009. "The world as a whole is generally coming to appreciate the fact that large water-infrastructure is essential for economic development as long as social and environmental issues are given appropriate consideration" (Tortajada et al. 2012: ix). The question today is not whether hydroelectric dams will be built, but how they can be built in a way that mitigates deleterious social and environmental consequences. Among developing countries, Brazil stands out as firmly committed to hydroelectric development.

One of the clear needs to reduce negative impacts on the population affected by a large infrastructure project, is to realign the chronology of the dam (or road). Once it is decided to build large infrastructure, the various levels of government need to go into emergency mode for a year or two and reallocate funds to build the basic services for what we know will occur: more population requires more hospitals, schools, improved roads, sanitation, and policing in advance of the arrival of the population increase. An increase in population as is expected with a large dam results in a boom economy that affects rents and real estate prices, prices of food, and criminality. That means that additional police needs to be trained and be put in place in advance of the arrival of the construction

crews. Schools and teachers need to be put in place to keep children in school and avoid vagrancy, drug use and criminal behavior. Additional health services capacity needs to be provided, including attention to areas often neglected such as sewage, and sexually--transmitted diseases or STDs. The minimum frame to have these facilities in place is two years, if emergency mode is undertaken that permits the use of educated projections, and budget reallocations for this short period independent of the inevitably outdated census data collected only every ten years. Without this type of rethinking on how projects are implemented, we will continue to decry the human suffering and nothing will change. We have abundant evidence of what is wrong with how projects are designed and implemented—but the timing is the one thing that is forgotten and without reforming the scheduling of service provisioning ahead of construction, we will continue to hear the litany of what is wrong—and things never put right.

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ROADS AND DAMS: INFRASTRUCTURE-DRIVEN TRANSFORMATIONS IN THE BRAZILIAN AMAZON

EMILIO F. MORAN

***Abstract*:** From the construction of the Trans-Amazon Highway in the 1970's to the current construction of the third largest hydroelectric dam in the world at Belo Monte, the Brazilian Amazon has experienced the impact of large-scale infrastructure projects. When announced, all these projects purported to be the means to achieve progress, national integration, and economic development. The outcomes after several decades are less clear: national indebtedness, significant social and environmental impacts, and regional development taking second place to other goals such as energy production and national GDP. Solutions are suggested to reduce the negative impacts and achieve the goal of improved livelihoods and sustainable development without giving up on national development goals.

***Key words*:** Road-building, hydroelectric dams, development, sustainability, infrastructure, socio-environmental impacts

***Resumem*:** Desde los años 1970 cuando fue construida la Carretera Transamazonica hasta hoy con la construcción de Belo Monte, la tercera mayor hidroeléctrica del mundo, la Amazonia brasileña ha sentido los impactos de los grandes proyectos de infraestructura. Cuando fueron anunciados todos estos proyectos prometían progreso, integración nacional, y desarrollo económico. Después de varias décadas los resultados son otros: endeudamiento nacional, impactos negativos sobre la sociedad y el medio ambiente, y el desarrollo regional asumiendo un segundo lugar en relación a otros objetivos tales como la producción de energía y el Producto Interno Bruto. Sugerimos en este trabajo soluciones para reducir los impactos negativos, promover mejoranzas en las condiciones de vida de las personas, y desarrollo sustentable, sin abandonar los objetivos de desarrollo nacional.

***Palabras claves*:** Construcción de carreteras, represas hidroeléctricas, desarrollo, sustentabilidad, infraestructura, impactos socio-ambientales

***Resumo*:** Desde os anos 1970 quando foi construída a Transamazônica até hoje com a construção de Belo Monte, a terceira maior hidrelétrica do mundo, a Amazônia brasileira tem vivido os impactos de grandes projetos de infraestrutura. Quando foram anunciados, todos

esses projetos prometeram progresso, integração nacional, e desenvolvimento econômico. Depois de muitas décadas, os resultados são outros: endividamento nacional, impactos socioambientais negativos, e o desenvolvimento da região tomando um segundo lugar ao crescimento do PIB. Soluções são propostas neste trabalho para reduzir os impactos negativos, promover melhorias no modo de vida das pessoas, e um desenvolvimento sustentável, sem abandonar o crescimento nacional.

***Palavras chaves*:** construção de estradas, hidrelétricas, desenvolvimento, sustentabilidade, infraestrutura, impactos socioambientais.