ROADS TO DEVELOPMENT

A geospatial study of the political economy
of road building in Haiti

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May 8, 2008

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Acknowledgments

In the grand scheme of things, an honors thesis is a small project. For me, however, it represents the culmination of my academic experience at Stanford and has proven immensely rewarding. To this end, I would like to thank the following individuals for their help along the way. I first owe thanks to Gili Drori. Beyond her intellectual insight throughout the project, she sent an email to me while I was doing research in Haiti that basically said, “You can’t quit. I know research is hard, but you can’t quit.” So I didn’t. Her encouragement and guidance has been invaluable. I also want to thank Kathryn Stoner-Weiss for her help and influence through the CDDRL track, particularly for explaining that a thesis is “just a combination of several extended papers. Just start writing.”

I would also like to thank my advisor, Zephyr Frank, who believed in this project from its inception. In addition to his positive attitude and encouragement, I have been grateful for his acute understanding of the project. I am also indebted to Mithu Datta for her infinite patience and technical savvy. From geo-referencing to researching databases, she made everything work somehow. I owe a big thanks to Erik Steiner, too, for going the extra mile. His help in the project’s later stages with the maps and tables not only helped me synthesize the data, but also helped me understand my thesis better. Finally, I am grateful to my family for supporting me all the way from research to editing.

My profound thanks to all of you.

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List of Abbreviations

AFD	Agence Française de Développement
CNIGS	Centre National de l'Information Géo-Spatiale
ESAL	Equivalent Standard Axle Load
ESRI	Environmental Systems Research Institute
EU	European Union
FER	Fonds d'Entretien Routier
GIS	Geographic Information Systems
HDI	Human Development Index
IDA	International Development Agency
IDB	Inter-American Development Bank
IHSI	Institut Haitien de Statistique et d'Informatique
IMF	International Monetary Fund
NAD	North American Datum
SEPPRN	Service d'Entretien Permanent du Reseau Routier National
TPTC	Travaux Publics de Transports et Communications
USAID	United States Agency for International Development
UTSIG	Unité de Télédétection et de Systèmes d'Information Géographique
UTE	Unité Technique d'Execution

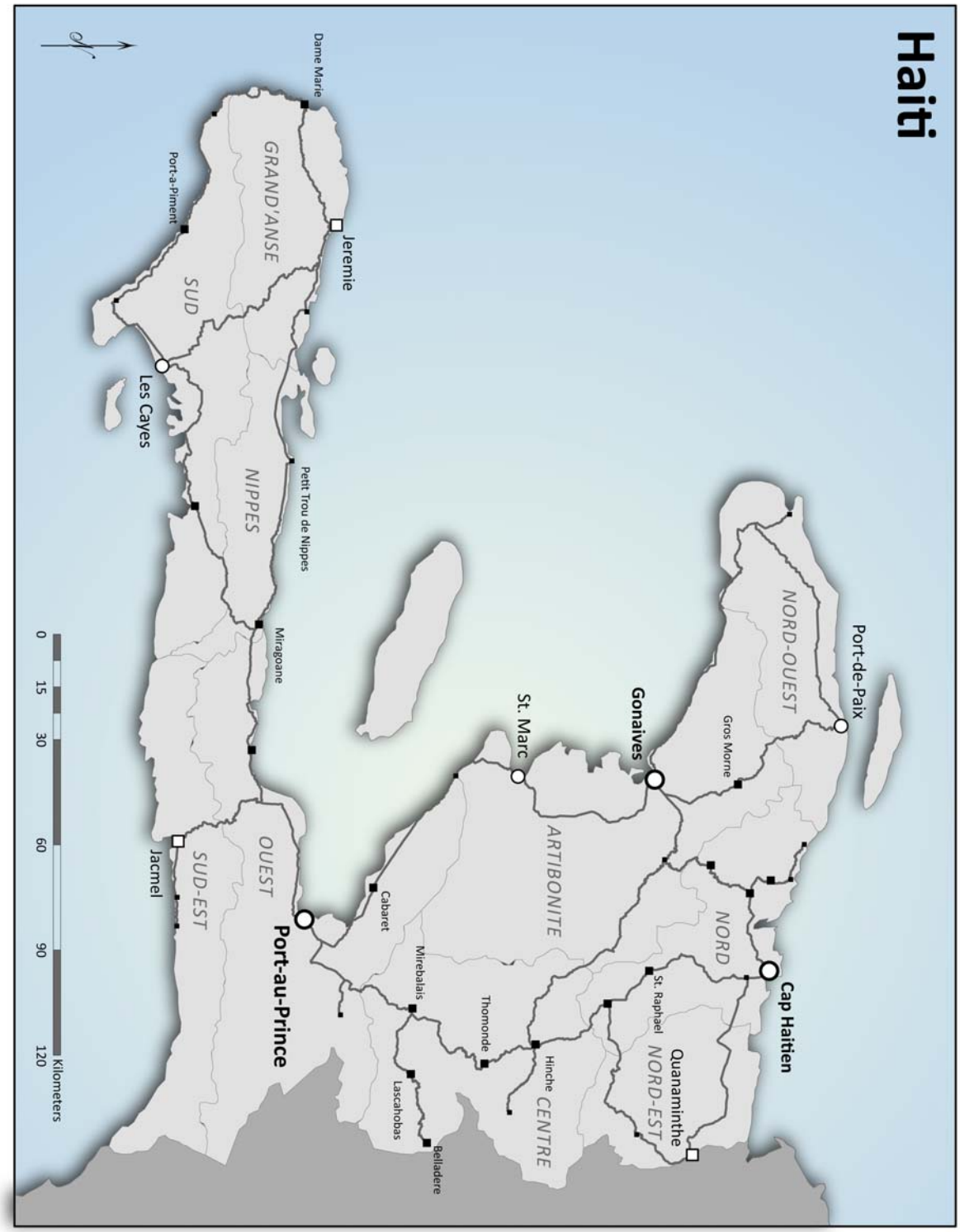
Foreword

"Woy, wout la di!"

On December 4, 2003 I landed in Port-au-Prince, Haiti to do missionary and humanitarian work. That night, I learned my assignment: a city in Southwestern Haiti called Les Cayes. When my Haitian colleagues learned where I was going, they said, "Woy, wout la di!," Haitian Creole for, "Wow, that road is bad!" When I awoke the next morning, it was raining and humid. We packed the Land Cruiser and began our journey at 7 am. Thirty minutes into the trip, I told the driver in broken Creole, "Please pull over the car. I feel sick." For several minutes, I bent over in the rain, vomiting in the trash-filled streets. It was the sight, the sound, and the smell. But it was also the road. I had never been on a road like that – and I had traveled to many impoverished places. We did not arrive until after dark. It took the entire day to travel just a little over 100 miles. My back was sore, my head ached, and my spirit was effectively broken.

December was a tense month. In January of 2004, Haiti celebrated its 200-year anniversary of independence; but political tensions were high. By February, things got worse. The US embassy declared it unsafe for Americans to be in Haiti. Finally, on the afternoon of February 24, the church made the decision to pull all of its volunteers out. The next morning, we awoke at 3 am to make the trip back to Port-au-Prince before things got out of hand. I will never forget the sense of danger on that road: wishing we could drive faster, but unable to because of the conditions. At one moment we were nearly forced to stop due to a huge bump in the road. A man appeared behind a broken down truck and pulled out a revolver. He aimed at our front right tire, below where I was sitting. He fired but we kept driving. As slow as we had been moving, it was a miracle we weren't hit. After hours and hours of driving past burning tires and angry mobs, we finally arrived in Port-au-Prince. We boarded the last American Airlines flight off the island for next 2 weeks. The next day, President Aristide was in exile.

Haiti's deplorably bad roads had nearly dramatically affected my life. With this, I began to attempt to understand why these conditions persisted in spite of all the aid given over the years.


Haiti
Port-de-Paix
NORD-OUEST
Gros Morne
Gonaives
Cap Haitien
NORD
St. Raphael
Quanaminthe
NORD-EST
St. Marc
ARTIBONITE
Hinche
CENTRE
Thomonde
Mirebalais
Belladere
Lascahobas
Cabaret
Port-au-Prince
OUEST
SUD-EST
Jacmel
Miragoane
Petit Trou de Nippes
NIPPES
Jeremie
Dame Marie
GRAND'ANSE
Port-a-Piment
SUD
Les Cayes
0 15 30 60 90 120
Kilometers

CHAPTER 1
TRANSPORTATION INFRASTRUCTURE

This paper is about incentives that drive developmental aid. It examines Haiti's road network as a case study for understanding the political economy of road building in Haiti and other developing countries. The following four conclusions can be drawn from this investigation. (1) The source of financing most meaningfully accounts for variation in road quality. (2) The Haitian government – ordinarily known for corruption and neglect – is, in fact, responsible for financing the most kilometers of high-quality roads. (3) Foreign donors have historically neglected road maintenance due to weak incentives for sustainability. (4) To the extent that recent road projects have included maintenance in their priorities, money is likely to be spent on sections an agency originally financed. These four findings have important implications for the sustainability of infrastructure projects in the developing world – and for those who finance them.

Chapter 1 discusses road infrastructure and situates it in a discussion of foreign aid. It also identifies road maintenance as a major sustainability problem and introduces Haiti as a compelling choice for a study of this nature. Chapter 2 discusses a history of transportation in Haiti and provides the context for understanding how road quality is reflected in the difference between foreign and domestic interests, a conclusion confirmed by this study's results. Chapter 3 discusses the methods by which these results were reached. Chapters 4 and 5 present and explain the variation in road quality, respectively. Chapter 6 discusses the political economy of roads and situates the thesis in the literature about development aid.

Observations and Hypothesis

I am interested in whether external aid is fueled by the needs of foreigners and divorced from the needs of the local population. My initial specific observations in 2003, 2004, and for research in 2007, were that the road network in Haiti was in disrepair and characterized by great inconsistency. Many sections of highway had quite literally fallen apart, while other sections were, in fact, in good condition. This was surprising, given that most deteriorated sections hardly deserved the to be called “roads” at all, let alone “national highways.” Others were as smooth as any in the world. Based on these observations, my general hypothesis was that there were “human” variables that were affecting road quality. In particular, I hypothesized that there was a relationship between the quality of a section of road and who financed it. This hypothesis led to a corollary: that variability in placement, construction, and overall quality of the transportation network was not entirely the result of environmental differences. Moreover, I hypothesized that variability across larger projects could be *explained by* differences in financier.

Foreign Aid

In the aftermath of World War II, as the Marshall Plan proved successful in rebuilding Western Europe and helping contain Soviet expansion, money sent overseas was not only seen as a way to help in rebuild war-torn Europe, but also as a way to strengthen relations with the United States. This was foreign aid’s dual purpose from the beginning. By 1949, President Harry Truman announced foreign aid as an important component of United States foreign policy, calling assistance to developing countries a "bold new program." In 1961, President John F. Kennedy established the United States

Agency for International Development (USAID), an agency whose designated purpose was to administer foreign assistance. Yet, in the context of the Cold War, aid was a means of both reconstruction and influence. In the ensuing decades, spending shifted to allies in the Middle East and Asia and to poor countries in sub-Saharan Africa and South Asia. As multilateral agencies became more prominent, including the World Bank and the International Monetary Fund (IMF), foreign aid not only took the form of money, but of ideas and advice with conditions and penalties.

This is not to say that foreign aid has only financed the self-interest of the developed world. For decades, many committed philanthropists, economists, and humanitarian workers have been trying to develop ways for poor countries to become rich like the developed countries in North America and Western Europe.[1] While this type of commitment was not new to this century, the end of World War II and the subsequent independence of former European colonies, encouraged by developments in finance and technology, created widespread interest in finding the cure for the "development problem."

Of all the strategies implemented for promoting development, foreign aid has been the most pervasive. Over the past 60 years, US $2.3 trillion in grants and loans have been made to developing countries.[2] In 2002 alone, total gross foreign aid from all donors to all developing countries was $76 billion[3] (in 2003 dollars).[4] Despite this

[1] Development implies a sustainable increase in living standards. Common measurement includes per capita income. Also see Human Development Index (HDI), a composite index that measures a country's average achievements in health, knowledge, and standard of living.
[2] William Easterly, *The White Man's Burden: Why the West's Efforts to Aid the Rest Have done So Much Ill and So Little Good* (New York: Penguin Press, 2006), 11.
[3] Jeffrey D. Sachs, *The End of Poverty: Economic Possibilities for Our Time* (New York: Penguin Press), 2005, 298.
[4] With debt relief grants and loan repayments, net flow of foreign aid was lower at $59 billion

enormous transfer of money and passage of time, however, the impact on sustainable economic growth remains largely inconclusive:

> The precious objects we offered ranged from foreign aid to investment in machines, from fostering education to controlling population growth, from giving loans conditional on reforms to giving debt relief conditional on reforms. None has delivered as promised.[5]

Indeed, despite foreign aid (and other development strategies including domestic political and economic reform),[6] abject poverty is still a global problem: over half of the human race lives on less than US $2 per day.[7]

Despite the prevalence of such underdevelopment, many argue that the developing world would have been much worse without foreign aid. Part of what makes the literature so inconclusive is that certain projects have largely been considered successful, particularly in health and education.[8] Buoyed by reports of success, development agencies seize the opportunity to call for more aid. The logic of these agencies is that more investment would fix the problem – that the critical point of investment is always just around the corner. In fact, since 1997, foreign aid has been on the rise.[9] In 2000, the World Bank estimated that low-income countries could immediately absorb some $30 billion per year of additional aid.[10] In 2002, the Millennium Challenge Corporation (MCC) was created to administer a five-billion-dollar

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[5] William Easterly, "Why Growth Matters - To Help the Poor," in *The Elusive Quest for Growth: Economists' Misadventures in the Tropics* (MIT Press, 2002), 1.
[6] I should mention here that there are also plenty of examples of countries and individuals that choose to trade off income for other virtues: equality, leisure, or any other number of cultural practices or traditions. However, these ambiguities do not account for why extremely poor countries are so destitute; they are not poor by choice.
[7] United Nations Development Programme, "Overview: UNDP and Poverty Reduction," http://www.undp.org/poverty/overview.htm.
[8] World Bank, "The World Bank in Action: Stories of Development," (Washington, D.C.: World Bank Publishers, 2002).
[9] Easterly, 2006, 183.
[10] Sachs, 301.

increase in U.S. foreign assistance, about a 50 percent increase. More recently in 2005, the UN Millennium Project called for a doubling of official development aid by 2015,[11] which would mean an increase to $152 billion by 2010 and $195 billion by 2015.[12]

Jeffrey Sachs and others make the argument that after a period of time, enough investment will cause a takeoff into self-sustained growth:

> Most of the developing world will have been freed from the poverty trap onto a path of self-sustaining growth… Many of the key infrastructure investments will have been made with massive improvements in roads, power grids, telecommunications, seaports, and airports. The extent of new investments needed to eliminate the remaining poverty will be much less than during the Millennium Development Goals phase. Although many public investments will still be needed, the key thresholds to operate infrastructure networks should already have been met.[13]

Sachs recognizes that economies are complex systems that each may require different diagnoses. He also recognizes that aid projects require careful monitoring and evaluation. The problem with his logic, however, is that it not falsifiable. To be freed from poverty, money needs to be invested in infrastructure investments, he says. But if people are still in poverty after the predicted transfer to self-sustained growth, either (1) not enough money was poured in (conclusion: increase aid) or (2) some other condition was not met (conclusion: we'll get it right next time). This type of reasoning is especially alarming in cases where aid has not only proven highly ineffective, but in some cases, even harmful.

Roads

The mention of infrastructure investment as one of the key components to development by Sachs is not new. In the 1950s and 1960s, perhaps a function of aid's birth and relative success in rebuilding Europe, donors believed that countries could get

[11] UN Millennium Project, "Investing in Development: A Practical Plan to Achieve the Millennium Development Goals," (New York, 2005), 60.
[12] Sachs, 298-301.
[13] Sachs, 303-304.

their foot on the development ladder if they only had enough physical infrastructure.[14] Thirty years later, the notion was still strong. In 1994, the World Bank titled its annual report: "Infrastructure for Development." By the early 1990s, developing countries were investing $200 billion a year in infrastructure – a fifth of their total investment.[15]

Despite mixed results, infrastructure investment is still a virtual tenet of development economics. Moreover, within total infrastructure investment, it is transportation that generally receives the largest proportion of funding. During the 1960s, for example, the IDA, spent 30% of its total investments in developing countries on transport infrastructure, notably trunk roads.[16] Today, after loans to improve law and public administration (25%), transportation infrastructure is allotted the greatest share (16%) of total annual World Bank lending. From FY2003-2005 alone, the World Bank loaned over US$9.5 billion dollars to improve aviation, shipping, railways, and roads. Of this aid, by far the largest share (73%) was for highways and roads.[17]

The justification for spending such large sums of money on roads comes from several perspectives. In his book, *States and Power in Africa,* Jeffrey Herbst provides historical evidence of the role of roads in broadcasting state power. He argues that during the eighteenth and nineteenth centuries, the Ashanti Empire (roughly present-day Ghana) was able to extend control over large distances due to an extensive series of roads that converged on the capital, Kumasi. He explains that roads were vital because they

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[14] Infrastructure is for so-called capital goods that are not consumed directly; they provide services, generally in conjunction with labor. These services primarily include *transportation* (roads, bridges, tunnels, rail tracks, harbors, airports, etc), *water supply/disposal* (dams, reservoirs, pipes, irrigation, treatment plants, sewers, etc), *power* (power plants, transmission and distribution lines, oil and gas pipelines) and *telecommunication* (telephone exchanges, telephone lines, etc).

[15] World Bank, *World Development Report 1994*: *Infrastructure for Development* (Oxford: Oxford University Press, 1994).

[16] Bent Thagesen, ed., *Highway and Traffic Engineering in Developing Countries* (Taylor & Francis, 1996), 16.

[17] World Bank, "Transport Lending," http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT.

"allowed for the quick movement of troops and bound the territory into a relatively coherent economy." Herbst explains that other pre-colonial African tribes understood this, too. After a war with the Ashanti, a neighboring tribe known as the Fante adopted a constitution that outlined the primary goals: promote friendly relations, improve the country, and build "good and substantial roads." Herbst writes, "In an exercise of (quite literal) constitutional engineering, the Fante detailed how wide ("fifteen feet broad") the roads should be. They understood that without these roads, they would have no way to broadcast their authority and were therefore so concerned with the development of the political infrastructure that they prominently featured it in their constitution."[18]

Today, the discourse has shifted away from simply articulating the need for roads; instead, state planners speak to the need for high-quality roads. The stated reason for this is that poor roads significantly raise transport costs, limit the flow of goods and services, inhibit mobility, and decrease opportunities for off-farm employment.[19] In addition to lowering production costs and creating new markets, transportation infrastructure is generally recognized as an important feature of a reasonable standard of living by providing mobility and access to food, health services, education, and employment. It is the mechanism whereby people, goods, and ideas can be exchanged. Therefore the impetus to improve main (and rural) roads is frequently cited as a means for large numbers of people to gain access to the market economy and thereby lift themselves out of poverty.[20]

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[18] Jeffrey Herbst, *States and Power in Africa: Comparative Lessons in Authority and Control* (Princeton: Princeton University Press, 2000), 42.
[19] Wilfred Owen, *Transportation and World Development* (London: Hutchinson, 1987), xi.
[20] Peter Warr, "Roads and Poverty in Rural Laos," *Research School of Pacific and Asian Studies*, Australian National Universtiy, No. 04, 2005, 18.

These conceptual underpinnings resonate with the observation that low levels of public infrastructure, especially roads, characterize large parts of the developing world. Many of these countries lack year-round transport; and, when it is usable, movement is expensive, dangerous, and unreliable. The fact that the majority of the world's poor live in spatially limited local systems and a relatively static state has suggested a relationship between immobility and poverty.[21] Thus, it is argued that any new, extended or improved transportation infrastructure will enhance mobility, thereby improving economic and social opportunity.

Indeed there are a number of case studies that suggest that improvement of infrastructure in rural areas can contribute to agricultural productivity and economic welfare. Examples include Binswanger et al. (1993), van de Walle and Nead (1995), van de Walle (1996 and 2002), Lanjouw (1999), Jacoby (2000) and Gibson and Rozelle (2003). In *Roads and Poverty in Rural Laos*, for example, Peter Warr reports that from 1997-98 and 2002-03 the improvement in road access in Laos took the form of providing wet weather access to areas that already had dry season access. His analysis suggests that this strategy reduced poverty and generated additional investments that offered the opportunity for further poverty reduction.[22]

Not everyone agrees. For as long as there has been investment in transportation infrastructure, there has been debate over the extent to which links exist between the investment in transportation infrastructure and economic development. First, there is no guarantee that local communities will respond to increased mobility. Second, it is difficult to establish causation between transportation and economic growth. Other

[21] Simon David, *Transport and Development in the Third World* (London: Routledge, 1996), 59.
[22] Warr,18.

regional variables including education and health facilities, for example, could affect the measurement of a reduction in poverty. If better-off areas are favored by the government for the construction of roads, then the existence of a correlation between their provision and the associated economic indicator may not suggest that road causes better economic performance, but rather the reverse. Consequently, much of the evidence from empirical sources is contradictory. In short, there are few clear statements of ways in which variable components of transport improvement and economic advancement are related. [23]

Even in case studies where locals seem to have taken advantage of improved mobility, researchers have been careful to qualify their arguments:

> It is a necessary but not sufficient element in the development process, and many costly transport undertakings have turned out to be extremely wasteful of resources because they were not accompanied by other actions to further economic progress.[24]

It is well known that comparisons of income and mobility do not imply good transportation alone is capable of provoking economic development. In 1996, the World Bank even took this one step further in saying that "inappropriately designed transport strategies and programs," can result in "networks and services that aggravate the condition of the poor, harm the environment, ignore the changing needs of users, and exceed the capacity of public finances."[25] In other words, not only have some transportation projects not lived up to their expectations, they have done harm. Thus, while transportation infrastructure is generally recognized as an important feature of a

[23] Howe, J. and Richards, P. (eds) *Rural Roads and Poverty Alleviation*, London: Intermediate Technology Publications, 1984.
[24] Owen, 11.
[25] World Bank, *Sustainable Transport: Priorities for Policy Reform* (Washington, D.C.: World Bank Publishers, 1996), 15-16.

reasonable standard of living, transportation projects do always ensure positive outcomes, nor are they a stand-alone answer.

Rocky Roads: A Sustainability Crisis

In 1960s and 1970s, however, the belief that infrastructure (particularly transport) would bring development to the world's poor had become a mantra of developmental aid policy. By the mid 1980s some US$10 billion per year were being spent for road construction in developing countries.[26] Despite enormous disbursals of foreign grants and loans, however, it became apparent that the results were disappointing: the poor were still poor – some even poorer than before. The problem: roads were deteriorating. The benefits that should have ensued from last year's road construction were being eroded by a failure to maintain them.[27] This is because new paved roads, if inadequately maintained, deteriorate slowly and almost imperceptibly during the first half to two-thirds of their service life, depending on the traffic. After 10 to 15 years, however, pavement deteriorates rapidly.[28]

Brooks, Robinson and O'Sullivan (1989) describe this realization in the 1980s:

> The World Bank called a meeting in Paris in February 1980 to exchange views on the difficulties faced by governments and funding agencies in the road maintenance field, and to seek consensus on ways to overcome them… The aid donors met again in March 1985 in London to review progress since the Paris meeting. Whereas the theme for the Paris meeting had been the road maintenance problem, delegates now found themselves discussing the road maintenance crisis. That a problem had worsened into a crisis in a period of five years reflected not only the magnitude of the task confronting the donor community but the apparent inadequacy of traditional methods of project implementation to address it. [29]

One of the problems discussed at these meetings was that road maintenance projects

[26] Proceedings Institution of Civil Engineers, "Priorities in Improving Road Maintenance Overseas: a check-list for project assessment," Part 1, 1989, 86, Dec., 1129.
[27] Ibid., 1130
[28] World Bank Policy Study, "Road Deterioration in Developing Countries: Causes and Remedies," (Washington, D.C.: World Bank Publishers, 1988), 1.
[29] Proceedings Institution of Civil Engineers, 1131.

possessed few of the characteristics which made road construction projects so simple. Whereas construction projects could be measured relatively easily (in terms of quantity and quality), maintenance projects often included management and institution building in addition to components relating to judgment and procurement. In an effort to better understand the problem, the World Bank published *The Road Maintenance Problem and International Assistance* in 1981. This study was followed by another in 1988: *Road Deterioration in Developing Countries: Causes and Remedies.* In this report, the failure to maintain roads was described as "tantamount to an act of disinvestment, for it implies the sacrifice of past investments in roads." An estimated US $45 billion worth of road infrastructure had been lost owing to inadequate maintenance in the eighty-five developing countries reviewed in the report, a loss which could have been averted with preventive maintenance costing less than $12 billion.[30]

The effects of bad roads have important implications for poor, in that they have to spend a greater percentage of their income on repairs than do the wealthy. This was also documented:

> Bad roads seldom deter users or curb the volume of traffic. Instead, they raise the cost of road transport – the dominant mode of transport for both people and freight in most countries. A dollar reduction in road maintenance expenditures can increase the cost of vehicle operation by two to three dollars. Insufficient spending for maintenance thus exacts hidden costs several times the cost of maintaining and restoring roads. Road users bear the brunt of these additional costs, which dwarf the savings to a road agency from deferring or neglecting maintenance.[31]

Thus the road projects of the previous decade were now doing more harm than good, particularly among the poor. This did not bode well for aid agencies.

[30] World Bank, 1988, v.
[31] Ibid.

However, despite the Bank's recognition that road maintenance was critically lacking in developing countries, the Bank's conclusions display an extremely limited understanding of their own role in the crisis they observed. The policy study says, "…developing countries have lost precious infrastructure worth billions of dollars through the deterioration of their roads. If they do not immediately begin to do much more to preserve their roads, they will lose billions more."[32] W. David Hopper, Senior Vice President of Policy, Planning, and Research at the World Bank, offered the following explanation of the principle causes of road deterioration and the reasons the problem has become so widespread:

> Economic adversity is part of the explanation, past mistakes in investment choices are another, but a large part of the problem has to be attributed to institutional failure in the countries themselves.[33]

It is odd that while the Bank was responsible for construction of the roads, the developing countries were responsible for "losing" the capital required to build them. Ownership transferred hands as the transportation "quick fix" failed to produce the expected results. The above conclusions are especially odd considering the justification for building them in the first place was to promote economic development, accessibility, efficiency, and social inclusion,[34] to name a few – all of which were conditional on the good working order of the investment. With roads having been built for millennia, this oversight seems baffling.

In truth, the reason why this was not obvious to aid agencies was because they had, in fact, taken care of maintenance: by delegating it to the recipient governments. The World Bank's assessment that the developing country's weak institutions, in particular

[32] Ibid., 1.
[33] World Bank, 1988, v.
[34] OECD, "Impact of Transport Infrastructure Investment on Regional Development," (Paris: OECD Publishing, 2002), 9.

their road maintenance agencies, were responsible for not maintaining the roads was entirely accurate. Weak incentives characterized the separation of responsibilities and control between road maintenance providers and road users. Predictably, in the midst of a constrained budget, lack of accountability, and history of corruption, money that was to be spent on preventative, or even restorative, maintenance was misallocated. Moreover, international donors seldom funded road maintenance projects because it was claimed that support of recurrent expenditure did not contribute to real long-term economic and social development.[35]

Research Question

If roads are a proxy for quality of life, why do some countries build and maintain good roads, while others do not? Road quality affects the cost of transport, so why are some sections of road in good condition while other sections are in terrible condition? Is this due to natural environmental variables where certain sections of road are eroded more quickly than others? Or is this due to political variables, a reflection of hidden domestic, donor, or foreign government incentives? Does, in fact, the quality of roads vary by financier, or by Department? [36]

Chapter 2 provides the historical context for answering these questions. As a general note, the history and analysis of the transportation infrastructure in Haiti means the road network, although other types of transportation will be included in the discussion, as they exist.[37] This chapter discusses the internal and external actors that have shaped Haiti as reflected through its transportation network. The following account

[35] Proceedings Institution of Civil Engineers, 1130.
[36] Departments are provinces, or regions. Haiti is composed of 10 Departments.
[37] In their 1995 loan agreement, the IDB indicated that despite very poor road conditions, roads remained the dominant mode for domestic transport (about 80%). Consistent with this observation, this study primarily focuses on roads.

is important for historical context; moreover, it is important for understanding the politics of road building that have shaped the Haitian landscape by 2008. Additionally, the principles discussed throughout this chapter are also likely to share common features with other developing countries. Haiti represents an important case study in the field of transportation aid because it has large periods of time where it was either dominated, or ignored, by foreigners. Its close proximity to the United States and its historical weakness have made it a good example of the cause and effect of shifting influence.

CHAPTER 2

THE HISTORY OF HAITIAN TRANSPORTATION

Colonial Extraction

The first transportation system in Haiti was built by the Arawakan people, known as the Tainos. They did not have large animals such as horses, oxen or mules; thus their road system was likely a simple network of small dirt trails. They used dugout canoes cut from single tree trunks for fishing and travel by sea.[38] After the Spanish arrived, however, the Tainos, were quickly put to work as slaves cultivating crops and, more especially, extracting gold from rivers and mines.[39] The work was arduous and their treatment was cruel. Whether by committing suicide or contracting fatal illnesses, those that did not escape to the mountains perished in a short period of time – victims of brutal treatment and disease.[40] As early as 1501, as the local population diminished, the Spanish brought in slaves from Africa to replenish the labor supply. Soon, black slaves from Africa were used throughout the colony.

Transportation in the sixteenth century was designed to get raw materials to port. In particular, the Spanish discovered that the island's climate was ideal for growing sugar cane. Thus, roads were primarily built from plantations to the closest port. This is significant in tracing the role of foreign influence on the island. It is plainly acknowledged that the African slaves were not being 'developed' by any standard; and,

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[38] Bob Corbett, "Pre-Columbian Hispaniola, Arawak/Taino Native Americans," *Cultures and Life Ways,* Caribbean Amerindian Centrelink, 1997.

[39] On December 6, 1492, Christopher Columbus made his second stop in the "New World" in northern Haiti, near Mole St. Nicholas A small group of sailors stayed behind in a fort as he made his voyage back to Spain to return with men and supplies.

[40] Benoit Joachim, *Les Racines du sous-developpement en Haiti* (Port-au-Prince: Deschamps, 1979), 9-10.

the road network mirrored their 'underdevelopment.' In fact, roads were the very mechanism of extraction. Likewise, ships were used to bring raw materials to Europe; the only oceanic transportation that the Africans experienced was from their homeland, as slaves.

By the end of the sixteenth century, Spain was becoming interested in the precious metals found in Latin America, particularly the gold and silver-rich colonies of Mexico and Peru. As interests turned to these regions, large tracts of land in the western part of the island were abandoned. Over time, marauding bands of European adventurers, many of French origin, began to settle and cultivate these vacant lands.[41] It was only a matter of time before the French became interested in the agricultural profits made possible by the African slaves. In 1697 Spain ceded the western third of the island to France, known thereafter as Saint-Domingue. Under French rule, the colony became immensely prosperous. Called "the Pearl of the Antilles," it began to produce vast quantities of sugar, coffee, cotton and indigo.

To keep up with this demand, and in anticipation of developing a permanent colony, the French invested much more heavily than the Spanish. Under their direction, a modern road was built between Cap Français and Port-au-Prince. French-developed irrigation transformed the basin of the Artibonite River; and French architecture dotted the land.[42] Port cities grew in population, and so did slave importation. In 1681 there were only 2,000 slaves; by 1730 there were 117,000, and fifty years later, over 250,000.[43] Nevertheless, although the French invested more in infrastructure than their previous

[41] Dantès Bellegarde, *La Nation Haitienne*, (Paris: J. de Gigord, 1938), 54-55.
[42] Philippe R. Girard, *Paradise Lost* (New York: Palgrave Macmillan, 2005), 33.
[43] C.L.R. James, *The Black Jacobins* (London: Allison & Busby, 1994), 45-46, 55-56.

colonizers, they did so largely using the same logic as the Spanish – a means for extraction.

Gratuitous cruelty and torture also continued under French rule. As many as one in nine slaves died within their first year; [44] only the very fittest could survive the punishing plantation life for long. While most slaves just tried to survive, some sought liberty or death; they either committed suicide or formed rebellious hideouts in the mountains (or died trying). Over time, however, more aggressive expressions of resistance were apparent. Several episodes of small, organized slave revolts finally culminated in 1791, when slaves in the northern plain launched a revolt that quickly spread across the entire country. [45] Under the leadership of Toussaint Louverture, the French fell to guerilla warfare tactics and the slaves secured native control over the colony. On January 1, 1804, an independent republic was declared after a 12-year violent and bloody revolution. It was the first and only successful slave revolution in history.

Independence

So strong was the hatred of everything French that the country's name, Saint-Domingue, was replaced with its pre-colonial name: Haiti (*mountainous land*). The new country's flag consisted of a French tricolor whose central white strip had been removed and the blue and red stitched back together.[46] Over the next few months, the former victims now exacted unspeakable tortures on their past oppressors by rounding up French planters, soldiers, and merchants and slaughtering them. As Philippe Girard writes:

> It was genocide with intent and successful implementation – and it put the young Haitian republic on an ill-fated course… As a majority black republic born of a slave revolt and a war of independence, Haiti would have been surrounded by

[44] Robert Fatton Jr., *The Roots of Haitian Despotism* (London: Lynne Rienner, 2007), 59.
[45] Alejo Carpentier, *The Kingdom of This World* (London: Penguin, 1957), 20-22.
[46] Girard, 55.

> wary neighbors in any scenario. The genocide replaced wariness with outright hostility, panic even. Throughout the nineteenth century, and to a lesser extent today, Haiti suffered from a diplomatic isolation that was anything but splendid. Potential trading partners that were vital to the country's economic health stayed away; immigrants that flocked to the New World refused to come to Haiti; European ambassadors chose to negotiate under the protective umbrella of gunboats stationed in the bay of Port-au-Prince; former allies delayed official recognition for decades.[47]

Thus as the previous two centuries were characterized by foreign abuse, the nineteenth century for Haiti was one of foreign neglect. Haitians had finally won their hard-fought independence; they had the chance to 'develop' without foreign intervention. Thus, for the purposes of this study, the nineteenth century provides a window into the opposite extreme. How would Haitians build infrastructure to provide services for the newly created black republic? Left alone, would Haiti reshape its infrastructure – and economy?

Domestic Neglect

The answer was yes: unfortunately, however, for the worse. After the French had been defeated and revenge exacted, unity among the newly independent Haitians predictably wore thin. The central power struggle was between blacks and mulattoes over the issue of ownership of agricultural land. The mulattoes, the small but powerful minority, who had been free men and property owners before the revolution began, hoped to inherit the power and wealth formerly enjoyed by the defeated colonists. The black ex-slaves, the majority of the population, however, wanted to farm their own land instead. Naturally, they carried a deep-seated antipathy towards work in the plantation system.[48]

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[47] Girard, 57.
[48] Charles Arthur and Michael Dash, eds., *A Haiti Anthology: Libète*, (London: Latin America Bureau, 1999), 45.

Faced with the prospect of reviving the devastated economy, President Jean-Jacques Dessalines saw the production of sugar as the only means of restoring the economy and creating wealth. He chose to place most of the land under state control and to revive the old plantation system.[49] Less three years later, however, he was assassinated. Former slaves were not prepared to return to repressive labor discipline.[50] The country was divided so strongly by the issue of ownership of agricultural land that in 1806, Alexandre Pétion led mulattoes in the south to secede. He chose to distribute state-owned land in an effort to buy political acceptance. In the north, however, the old system remained: a type of feudalism run by military and state officers and worked by strictly supervised-laborers. The subsistence economy in the south, however, gradually led to increased poverty as population pressures and utter governmental neglect further marginalized the peasantry. They were taxed but otherwise ignored by the state.

The nineteenth century was characterized by a powerful elite who maintained the best land and focused their efforts on staying in power. The fight for office to a very great extent became a fight for the spoils that came with it. Predictably, there was very little domestic investment. Infrastructure projects, including roads, factories, and sewer systems were routinely neglected as these were long-term projects whose effects would only be felt long after their initiator had left the presidential palace.[51] Haiti was as the French had left it, only more divided and far poorer. Political violence was commonplace. From 1843 to 1915, only two of the 21 administrations managed to complete their term in

[49] From this decision, it is assumed that the transportation network would also largely have remained the same as under French rule: from plantation to port.
[50] Fatton Jr., 5.
[51] Girard, 73.

office.[52] From 1908 to 1915, seven governments fell, and 1914 was marked by several violent insurrections that toppled three presidents.

US occupation of 1915-1934

After the final president, Vilbrun Guillaume Sam, was lynched and dismembered by an enraged crowd in July 1915, the United States responded in the immediate aftermath.[53] While stabilizing the political landscape became the public justification for the occupation, of more concern were the strategic and economic considerations following the opening in 1914 of the Panama Canal.[54] By this time the U.S. had developed the military and material means to impose the Monroe Doctrine, and would no longer tolerate European, particularly German,[55] competition in its backyard.[56] Bent on protecting maritime routes for an expanding navy, the US saw Haiti as having significant geo-strategic importance.[57]

Corvée

Due to the neglect of road construction and maintenance in the previous century, the United States marines found it difficult to move troops around the island. Consequently, they instituted a peasant labor conscription (corvée) to rebuild the roads. The US would not tolerate any form of disorder that would damage its strategic and economic aspirations: a sphere of influence in the Western Hemisphere and returns on American investment. Corvée was not only seen as a means of creating a viable network of transportation to spur economic and commercial development, but also as a means of

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[52] Heads of State, various sources.
[53] François Blancpain, *Haiti et les États Unis, 1915-1934* (Paris: L'Harmattan,1999, 46-56.
[54] Arthur, 210.
[55] The United States saw to the systematic deportation of German businessmen from Haiti by the United States in the early 1920s.
[56] Hans Schmidt, *The United States Occupation of Haiti, 1915-1934* (New Brunswick: Rutgers University Press, 1995), 6.
[57] Girard, 78.

broadcasting power across the island. The forced labor would help discipline and punish the peasants into building a more efficient system of transportation, which in turn served as a powerful policing network that would block their potential participation in the nationalist guerilla movement. By some accounts, the system was a success. Highways jumped from a deplorable 3 miles in 1915 to 470 in 1918, in which year the road between the capital and Cap Haitien reopened.[58]

The potential for abuse, however, was enormous, and stories leaked of peasants rounded up by soldiers and led to work tied up with ropes. Philipe Girard writes, "For Haitians mortified that 1915 had erased 1804, the symbol was too strong. The whites, it seemed, had brought slavery back with them." [59] The Haitians resisted. The most violent manifestation was the *caco* resistance movement that waged a guerilla war against the U.S. marines for several years. As Charles Arthur and Michael Dash explain:

> The overall effect of the occupation was to reinforce the existing structures of power and the resulting inequalities. Apologists pointed to the development of the country's infrastructure, notably the construction of roads… but in reality these works were guided more by the need to make the country attractive to foreign investment than to benefit Haitians." [60]

Haitians did not take kindly to the very nature of forced labor, but also resisted to what end their labor furthered: infrastructure built throughout their country to fit foreign strategic military and economic requirements.[61]

Railroads

In addition to corvée to build roads, the United States also built railroads. One instance, in particular, is illustrative of the way in which this was done. In 1910, James

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[58] Fatton, Jr., 161.
[59] Girard, 81.
[60] Arthur, 211.
[61] Marie-Agnes Sourieau and Kathleen Balutansky, *Ecrire en Pays Asseige Haiti Writing Under Siege* (Amsterdam – New York: Rodopi, 2004), 31-32.

McDonald was contracted to build a railroad from Port-au-Prince to Cap Haitien on extremely advantageous terms. The concession was to last 50 years, and the government guaranteed the payment of 6 percent interest and 1 percent amortization on the cost of construction, at a rate of up to $20,000 per kilometer of track completed. [62] Moreover, the concession granted McDonald 12 miles of land on both sides of the railroad to grow bananas, for which he obtained a monopoly on their export.

The Haitian government complained that the railroad had been very poorly built and even failed to connect Port-au-Prince to Cap Haitien. It turned out, in fact, that the company only laid 108 miles of track in three disconnected sections.[63] There was a gap of 40 miles between Saint Marc and Gonaives and another gap of 30 miles over the mountains between Cap Haitien and Ennery. This made through traffic impossible and necessitated the maintenance of three separate sets of rolling stock.[64] The railroad syndicate, however, argued that the project was completed and that political instability and revolutions were responsible for whatever imperfections existed. The company also requested $33,000, the highest possible rate – for each mile of track. Initially, the Haitian government threatened to foreclose on the completed portion, but found itself impotent in the face of US threats.[65] Moreover, under occupation, the United States compelled Haiti to pay the syndicate in full.

The point of this story, and of the corvée, is that the period of US occupation marked a drastic shift from the neglect of the previous century. It was a time when foreigners were manipulating the transportation infrastructure to suit their needs, not

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[62] Arthur C. Millspaugh, *Haiti Under American Control 1915-1930,* (Boston: World Peace Foundation, 1931), 238.
[63] There was a gap of 40 miles between Saint Marc and Gonaives and another gap of 30 miles over the mountains between Cap Haitien and Ennery.
[64] Schmidt, 38.
[65] Fatton Jr., 142.

those of the local population. Given the neglect of the nineteenth century and considering the deplorable state of the Haitian economy, the argument was made that any level of investment could only be beneficial. As these stories illustrate, however, the argument was simply untrue. With pressure from home and in Haiti, the U.S. finally withdrew troops in 1934.

Duvalier Dictators 1957-1986

While anti-American sentiment temporarily reunited the blacks and mulattoes, old antagonisms reappeared after the Marines departed. In 1957, however, "Papa Doc" François Duvalier came to power and 'united' Haiti with an iron grip and absolute despotic rule. He arrested his political opponents and organized a private presidential militia, the Tontons Macoutes. Terror, repression, corruption, and extortion were commonplace. Predictably, during this period, the transportation network (along with most public goods and services) was neglected.

In 1971, his son Jean-Claude, "Baby Doc," took power and the ruthless repression continued. With Jean-Claude stealing an estimated US $900 million from the Haitian people, [66] corruption reached new heights, with the percentage of the population living in extreme poverty rising from 48% in 1976 to 81% by 1985.[67] Ironically, in spite of this corruption, substantial road construction took place with foreign loans during this period. Many of the IDB debts, for example, were initially contracted during this time. In fact, more than half the country's debt was contracted by the Duvalier family dictatorship, particularly under "Baby-Doc." [68]

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[66] Debayani Kar and Tom Ricker, "IDB Debt Cancellation for Haiti," *Foreign Policy In Focus*, Monday, 18 December 2006, http://www.haitianalysis.com/economy.
[67] Arthur, 49.
[68] Kar, 2.

From the late-seventies until 1984, USAID financed directly Haiti's recurrent road maintenance expenditures through SEPRRN.[69] Although the functioning of a single foreign agency solely committed to road maintenance worked well temporarily, the program did not live up to its name. In the mid-eighties, annual transport expenditures averaged US$40 million, of which about half was allocated to capital expenditures, and half to recurrent costs. For "political and economic reasons," USAID withdrew both its technical assistance and its budgetary support in 1984.[70] Predictably, Haiti's road maintenance came to a screeching halt.

After 1984, road maintenance in Haiti was extremely limited. By 1995, the situation was nearing an outright crisis, especially in the wake of an embargo placed on Haiti from 1991 to 1995.[71] In 1995, the IDB approved a loan of $125 million dollars at 1-2% interest for a project titled the "Road Maintenance and Rehabilitation National Program." The project's goals included the rehabilitation and maintenance of urban and interurban roads, routine maintenance of roads and bridges, and investigation into the creation of a highway fund. The loan agreement, however, had a structural weakness: the operations were financed through the general budget of the TPTC.[72] As part of the general budget, funds were easily put to ancillary uses. The IDB later characterized the maintenance operations by their inefficiency, corruption, and neglect. [73] After twelve years, only $49 million of the approved $125 million dollars had been disbursed – and with little effect.

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[69] Permanent National Roads Maintenance Service
[70] Inter-American Development Bank, "Road Rehabilitation and Maintenance Program," Loan Proposal, January 1995, 18.
[71] Inter-American Development Bank, "Road Rehabilitation and Maintenance Program," Loan Proposal HA-0041, January 1995, 2.
[72] Ministry of Public Works, Transport, and Communications.
[73] Inter-American Development Bank, "Road Rehabilitation and Maintenance Program," Loan Proposal HA-0041, January 1995, 22.

Examining Haitian history by its transportation system reveals a pattern of flip-flopping between foreign and domestic initiations. The pattern goes something like this: foreigners build a transportation network to suit their needs on the island. Once they leave (or are forced to do so), the Haitian government largely neglects the existing network. The following table illustrates this:

Table 1. Haitian Transportation Development

PERIOD	DATES	ACTIVITY	INFLUENCE
Colony	1492-1803	extract resources	foreign
Independence	1804-1914	neglect	domestic
US Occupation	1915-1934	strategic influence	foreign
Dictators	1957-1986	neglect	domestic
		heavy reconstruction	foreign
"Failed State"	1987-2004	**neglect**	domestic
Today	2005-present	**sustainability?**	foreign/domestic?

The next three chapters are concerned with these last three periods, titled 'heavy reconstruction,' 'neglect,' and 'sustainability.' In 2007, I examined the state of the roads constructed during this 'heavy reconstruction' period. Chapter 3 presents the methodology by which this was done; chapters 4 presents the results and chapter 5 explains them. Chapter 6 then discusses the break in this flip-flopping pattern, and explores the implications.

CHAPTER 3
EVALUATING ROAD QUALITY

Surveys

I conducted a survey in order to ascertain the quality of the road network in Haiti. The primary method of developing the research sample was through snowball sampling, a research method where study subjects recruit further contacts from among their acquaintances. The logic of the study was to gauge road quality in Haiti; thus the principal subjects were civil engineers, and selected employees of the public works (Travaux Publics, Transports et Communications), national laboratory, and road maintenance agencies in Haiti. Upon making acquaintance with employees in each field, I asked them to give the simple survey to other contacts in their same field. In addition to snowball sampling, I also used convenience sampling as an inexpensive and easy method of choosing subjects. While this method was not as rigorous as probability sampling methods, I chose it as an inexpensive and easy method of offsetting potential bias. Employees of agencies with specific ties to the transportation network could have particular biases inherent in their responses; their responses could be inflated, for example, due to their personal involvement in the industry. Thus convenience sampling was an important way to expand the response pool, but also to reduce bias. About half of the subjects were found in Port-au-Prince; the other half in various Departments throughout the country.

The survey asked subjects to indicate the quality of major transportation arteries: either national freeways or Departmental highways. Both of these classes of roads are considered part of the 'trunk' network, thus likely to have been financed by large banks

and foreign governments rather than smaller agencies and NGOs (for which data is virtually non-existent). Moreover, I assumed that major roads would have a larger social and economic impact on a greater number of people than would the more rural, tertiary roads.

I divided the network into 46 sections of road, each identifiable by city endpoints.[74] I developed a simple scale in an effort to standardize the responses to the survey and to ensure that the results could be reproduced in future studies. The survey asked subjects to indicate road quality with a single number from '1' to '10' indicating worst (1) to best (10) quality roads. Directions indicated, in Haitian Creole and English, to put '1' for roads in 'unusable' condition, '2' for roads slightly better than unusable condition, and so forth. A number '5' was for roads in 'average' condition and a '10' for roads in 'perfect' condition. Each number corresponded with a non-technical description of varying degrees of potholes, debris, drainage, and pavement, as follows:

Table 2. Survey: Haitian Creole and English

1	kraze net	nich poul toupatou, labou, pa gen drenaj, wout la danjerè
2	pa bon	nich poul preske toupatou, labou, genyen anpil dlo sou wout la
3	pa two bon	anpil nich poul nan plizyè zòn, wout la pa asfalte, genyen dlo
4	preske moyen	nich poul toujou, kek zòn asfalte, genyen dlo, men mwens
5	moyen	nich poul tanzantan, pi gwo pati asfalte, ti kal dlo sou wout la
6	moyen plus	nich poul tanzantan, wout la asfalte, drenaj mache ase byen
7	bon	pa gen anpil nich poul, genyen ti wòch sou wout la, drenaj mache
8	anfom	pa gen anpil nich poul, wout la asfalte sof li gen ti wòch nan wout la
9	preske pafe	ti kras kantite nich poul, pa genyen ti wòch nan wout, drenaj mache byen
10	pafe	pa genyen okenn nich poul, wout la pave nèt, drenaj anfòm
1	unusable	potholes everywhere, mud, no drainage, debris, dangerous
2	terrible	potholes every few feet, mud, large sections under water
3	bad	potholes in concentrated areas every few miles, unpaved
4	less than average	potholes scattered throughout, inconsistent pavement, some water
5	average	occasional potholes, fairly consistent pavement, some water
6	better than average	occasional pot holes, consistent pavement, working drainage
7	good	few pot holes, paved surface, small pebbles on road, working drainage
8	great	few pot holes, paved surface, few pebbles on road, good drainage
9	near-perfect	very few potholes, no pebbles on road, good drainage
10	perfect	no potholes, completely paved with clean surface, good drainage

[74] See Appendix.

The combined efforts of snowball and convenience sampling resulted in 31 surveys. As each survey asked about the quality of 46 different sections of major roads, this represented a potential of 1,426 data points. In practice, due to the fact that some respondents were unfamiliar with certain geographic regions of the road network and thus chose not to complete certain sections of the survey, I collected a total of 831 data points. In no case were there less than 10 responses for a given section. I then calculated the average quality for every section (according to how many responses were received for a given section of road).

Average quality ranged from 1.6 ("unusable") to 7.4 ("good"). The average of the standard deviations of each road's surveyed quality was 1.22.[75] This indicates that the responses were fairly consistent, per section, giving more confidence to the survey results than if there had been a larger average standard deviation.

It is important to note that the financiers' average score takes spatial, not simply mathematical, information into consideration. For example, if a financier built 2 sections of road, a 1.0 quality 5 kilometer section and a 2.0 quality 10 kilometer section, 1.5 would not be a very useful average. Taking distance into account (Σ (section length * quality) / total length), the financier's average in this example would be 1.66. I calculated all quality-averages throughout the study in this manner: controlling for distance.

There is an extent to which this method overcompensates for distance, in the event that survey respondents indicated quality, not according to absolute descriptions

[75] See Appendix. I calculated standard deviations for each section of road (46). This indicated the extent to which the survey responses varied, per road. Some sections had higher standard deviations than others, indicating a wider range of opinions about that given road section's quality. Each section's respective standard deviation was then summed and divided by 46 to equal 1.22: the average standard deviation of the survey results.

assigned each number (1-10), but by their "overall riding experience" from one point to another. On bad roads, the respondent might feel worse over a longer distance, in comparison to a shorter distance, over two equally bad roads. In these instances, the respondent may have felt inclined to indicate a lower quality to otherwise equal road conditions.[76] Nevertheless, I assumed that due to the "textual standard" included in the survey, more often than not, respondents would visualize sections of road and give fact-based, instead of experience-based, judgments. Thus, I thought that mathematically controlling for distance was the better choice.

Spatial Compiling

The primary analytical tool used in this study was Geographic Information Systems (GIS), a technology that integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.[77] It also allows for the visualization of data in ways that reveal patterns would not otherwise not be readily visible, or even possible to observe. In this study, I used GIS technology[78] to synthesize and analyze different maps, surveys and charts because they all had a shared spatial component. Unlike an electronic copy of a map, for example, the technology provided the means to access and manipulate different cartographic features that would otherwise have been static. Each spatial component: political boundaries, roads, cities, and rivers, for example, could be accessed separate from the others. As feature classes, each component was able to store data about several attributes relating to

[76] A more technical "standard" may have been helpful in this case – or another method of ascertaining quality altogether, such as by physical examination.
[77] Guide to Geographic Information Systems. "What is GIS?," http://www.gis.com/whatisgis/index.html
[78] ESRI ArcGIS Desktop software

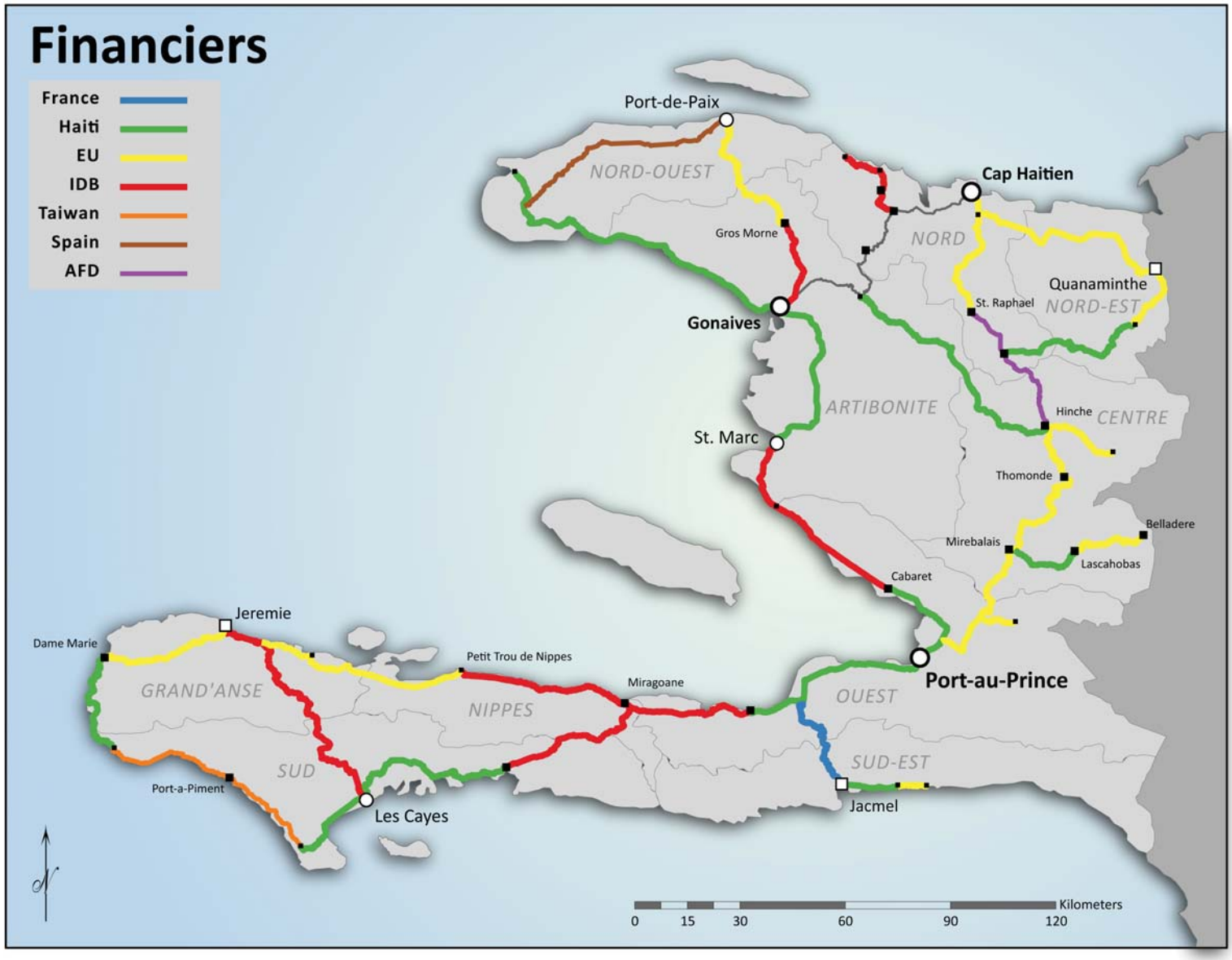
that layer. Using satellite imagery and sophisticated cartographic methods, the technology could then control for natural environmental variables.

Geo-referencing

Much of the information for this project came from different maps of Haiti. The base map, to which all other maps were referenced, was a scanned satellite image of Haiti taken in 1997, displayed at 1:300,000.[79] It was imported into ESRI ArcMap as a raster image (.tif) and geo-referenced. Geo-referencing is the process by which maps are assigned reference points. In the case of the base satellite image, I used latitude and longitude coordinates to assign it an absolute reference point: its location on earth, according to the NAD 1927 coordinate system. After this was completed, I geo-referenced additional maps by selecting the same feature in both maps and assigning the new map's point to the satellite image's corresponding feature. This was done for twelve to fifteen points, per map, to ensure scaling accuracy. Thus even maps that were different sizes could be scaled so that they (virtually) lie, superimposed, on top of each other. Map 2, "Road Quality," [80] and Map 3, "Financiers," [81] display the research and survey information:

[79] Centre National d'Études Spatiales (CNES), "Projet Utilisation de l'Imagerie Satellitaire pour l'Aménagement du Territoire," Distribution SPOT image, 1998.
[80] Map 2, "Road Quality," displays information gathered from the surveys. The ranges of average survey responses of the following indicators were as follows: 'very low' (1.6-2.8), 'low' (2.81-3.7), 'medium' (3.71-4.5), 'medium-high' (4.51-6), and 'high' (6.01-7.4).
[81] Map 3, "Financiers," was principally gathered from a map titled, "Projets Routiers et Leurs Sources de Financement" (Road Projects and their Sources of Financing), created by the UTE in February 2007.


Road Quality
Quality
VERY LOW
LOW
MEDIUM
MED-HIGH
HIGH
Port-de-Paix
Cap Haitien
NORD-OUEST
NORD
Gros Morne
Quanaminthe
St. Raphael
NORD-EST
Gonaives
ARTIBONITE
CENTRE
Hinche
St. Marc
Thomonde
Belladere
Mirebalais
Lascahobas
Cabaret
Jeremie
Dame Marie
Petit Trou de Nippes
Miragoane
Port-au-Prince
GRAND'ANSE
NIPPES
OUEST
SUD
SUD-EST
Port-a-Piment
Les Cayes
Jacmel
N
Kilometers
0
15
30
60
90
120


Financiers
France
Haiti
EU
IDB
Taiwan
Spain
AFD
Port-de-Paix
NORD-OUEST
Cap Haitien
Gros Morne
NORD
Quanaminthe
St. Raphael
NORD-EST
Gonaives
ARTIBONITE
Hinche
CENTRE
St. Marc
Thomonde
Belladere
Mirebalais
Lascahobas
Cabaret
Jeremie
Dame Marie
Petit Trou de Nippes
Miragoane
Port-au-Prince
GRAND'ANSE
NIPPES
OUEST
SUD
SUD-EST
Port-a-Piment
Les Cayes
Jacmel
N
Kilometers
0
15
30
60
90
120

The Natural Environment

In order to understand if there was a relationship between the quality of a road section and its source of financing, variation in the natural environment had to be controlled. This is because the natural environment affects road quality through erosion. Erosion refers to the processes by which surface and soil characteristics are shaped: by which material is "worn away." It is a natural environmental process, but also one that can be accelerated, or decelerated, by humans. Thus roads and the natural environment share an unusual relationship, one that can be mutually beneficial or detrimental. Road designers must be keenly aware of the risk of erosion when building roads.[82] Un-maintained roads are not only difficult to use, but are also sometimes responsible for environmental damage that in turn only worsens the road very condition. Of particular environmental concern is the large volume of sediment that un-maintained roads cause to be carried by water into streams.[83]

Erosion Risk

For analysis, erosion can be seen as the sum of several environmental processes that combine to produce varying degrees of erosion risk. The extent to which erosion occurs primarily depends on four variables: (1) slope, (2) soil, and (3) vegetation, and (4) climate.

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[82] TransSafety, Inc, "Maintenance Considerations in Highway Design," *Road Engineering Journal*, November 1997, http://www.usroads.com/journals/p/rej/9711/re971104.htm.
[83] USDA, Forest Services, and Technology & Development Program, "Riparian Protection and Restoration: Road Design Techniques," August 2002, http://www.fs.fed.us/eng/pubs/html/02251202/02251202.htm.

(1) Slope is given the most consideration in an erosion analysis.[84] Longer and steeper slopes are more likely to erode than shorter slopes, for example, because they will collect larger and faster volumes of stormwater runoff.[85] Slope also determines in large measure the size and shape of a watershed, which affects the amount and rate of stormwater runoff.

(2) Soil also has an important impact on risk of erosion. Textured sands and gravels are the least erodible because they are comprised of bigger and heavier particles that are harder to move. Conversely, silts and fine sands, due in large part to their small particle size, are generally the most erodible soils. Sand and gravel are more neutral, percolating water at a relatively fast rate resulting in less stormwater run off. Major transportation arteries that extend through rural mountains are also generally characterized by closely positioned embankments. This also can increase the likelihood of erosion as digging into mountainsides displaces large amounts of surface soil and vegetation.

(3) Vegetative cover works in the opposite direction: it has a restraining influence on erosion as it shields the soil from the impact of raindrops and protects the soil surface from scouring. Vegetation also helps reduce the speed and amount of surface water runoff, thus maintaining the soil's capacity to absorb water. Plant root systems also help hold soil particles in place.

(4) Climate is often erosion's catalyst, affecting the potential for erosion through the frequency, intensity, and duration of rainfall or wind. Water is the most common catalyst, causing erosion of varying degrees according to different susceptibilities. Thus

[84] IGN France International – Aquater S.p.A. "Project Utilisation de l'Imagerie Satellitaire pour l'Amenagement du Territoire," Notes Explicatives des Cartes Thématiques, 2002, 22.
[85] Kennebec County Soil & Water Conservation District (KCSWCD), 7.

for transportation engineers, the importance of adequate drainage to the structural integrity of a road cannot be overstated; indeed this has been appreciated for many centuries. When water is not diverted, it can cause erosion as surface or groundwater, causing washouts, tire rutting, and potholes.[86] The erosive process typically starts as falling raindrops hit and dislodge exposed soil particles. This can progress into sheet erosion as surface water runoff removes a layer of exposed soil. As water concentrates in small grooves and then cuts into the soil's surface, rills and gullies are created; if left to its natural course, this water can greatly undermine a road foundation. Potholes are familiar examples of water's erosive properties as it weakens the sub-grade or exacerbates pavement surface fatigue.[87] Washing away loose particles, the water can literally wash the road away.

Why Erosion Matters

Without human intervention, a road that is built across an area with high erosion risk, all other things equal, would be expected to have a lower quality, over time, than a road constructed in an area with low erosion risk. Thus in order to discover the human, and potentially political, impact on road quality, erosion must be controlled. To illustrate this point, consider Company A whose roads are found to be of a higher quality than those built by Company B. Company A's relative success may, in fact, be entirely due to differences in the natural environment of the regions in which their roads are built. Because company A builds roads in "better land," over time, their roads may also be of better quality. It may be that Company B's roads would have similar success under the

[86] Kennebec County Soil & Water Conservation District (KCSWCD), "Camp Road Maintenance Manual," 1999, http://www.coldstreampond.com/water_quality/camproadmaintmanual.pdf, 6.
[87] Washington Asphalt Pavement Association (WAPA), "Surface Distresses," *Asphalt Pavement Guide*, 2002, http://www.asphaltwa.com.

same atmospheric or topographic conditions. “Better land,” in this case, would be defined as low erosion risk: less rainfall, less erodible soil, flatter or shorter slopes, and plenty of vegetative cover. In other words a good road in a “bad” area has much more explanatory power than a good road in a “good” area (or vice versa).

To extend this reasoning further, if a particular government, bank, or development agency has a better “quality rankings” and if they are building roads in higher (or at least equal) areas of erosion risk than their counterparts, then the difference in quality would be attributed to “human” factors. These human factors can further be divided into three basic categories, related to stages in the road’s life:

(1) The first has to do with the road’s inception. This would include, for example, differences in construction design, workmanship, or materials.

(2) The second would include traffic, vandalism, animals, or any other difference that affects road during its “design life.”

(3) The third category bridges the second: the presence or lack of maintenance, either regular or periodic.

The aim of this study was to control for the non-human causes of road condition, and thus to reveal the human factors responsible. If it were determined that natural environmental processes were not responsible for variation in road quality, further investigation would need to be made into these three “human” variables. In a broad sense, the extent to which human factors can be shown to affect road quality is the extent to which the transportation network represents a political process. Nevertheless, not all of the human factors are explicitly political. If a given financier uses a consistent construction company that, for example, is found to be using a sub-optimal construction design, this would not necessarily represent a political process, but rather a technical one

(unless it were true that the company was knowingly employed as a cost-cutting scheme, or something else along these lines). Nevertheless, in controlling for erosion, and with reasonable assumptions that will be explained in Chapter 5, the results from this study suggest not only that human factors are responsible for the state of the Haitian roads, but which factors in particular.

Evaluating Erosion

I used a map of Haiti titled, "Carte du Risque Reél d'Erosion," [88] created by the UTSIG[89] at CNIGS,[90] as the base layer in the quantitative analysis. The map displayed six different erosion potentials at 1:100,000, in order of most serious: high, medium-high, medium, medium-low, low, and none. Erosion risk had been calculated as the weighted multiplication of the four previously discussed factors: slope, soil, vegetative cover, and climate.[91] UTSIG's model for the calculation of erosion risk was the following:

Erosion risk $= (\prod \chi i \text{^} pi) \text{^} (1/\Sigma pi)$

where:

χi is the factor "score" (based on its class)
pi is the assigned factor "weight"

Table 3. Erosion Methodology

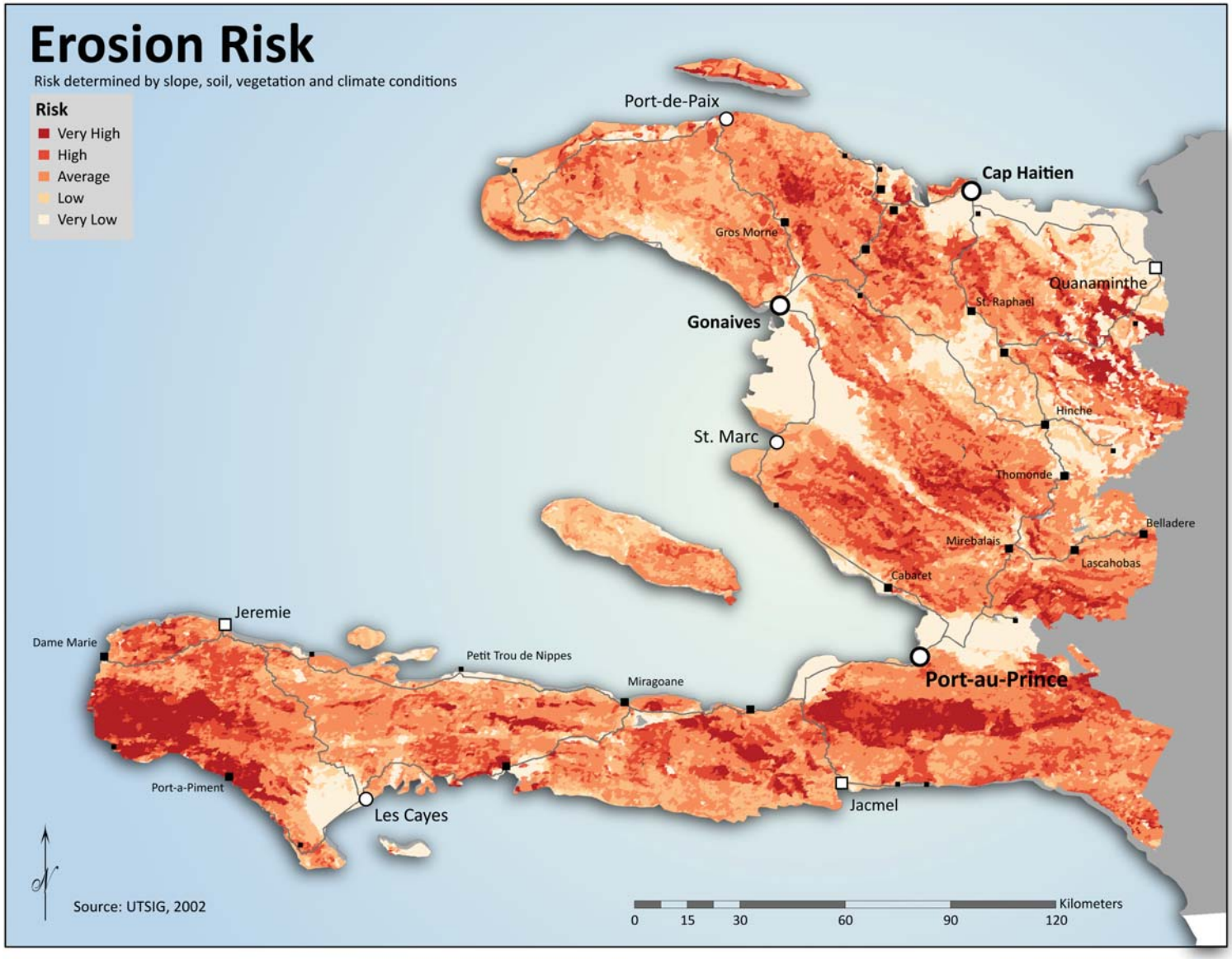
Factor	No. of Classes	Method of Observation	Weight
Climate	5	72 weather stations for 20 years of monthly rainfall intensity and variation	1
Slope	5	digital terrain GRID model, GIS topographic maps	5
Soil	4	587 aerial photos, 1998 SPOT satellite images, extraction and physical analysis	2
Vegetation	3		2

[88] Map of Erosion Risk
[89] Unité de Télédétection et de Systèmes d'Information Géographique, Remote Sensing and GIS Unit
[90] Centre National de l'Information Géo-Spatiale, National Center of Geospatial Information
[91] The exact process by which climate, soil, topography and vegetation were weighted and summed to produce five levels of erosion risk are contained in the map's accompanying document titled, "Notes Explicatives des Cartes Thématiques," also prepared by the UTSIG in 2002.

For this analysis, I consolidated each of the map's five different levels of erosion risk and then geo-referenced the new map into the GIS software. Only the 6 classes of erosion risk pixels were displayed. Then the road network was superimposed as a layer over the erosion risk map, as illustrated by Map 3, "Erosion Risk." I then created a digital buffer around the entire road network at a distance of 200 feet in every direction.[92] Using Hawth's Analysis Tools,[93] the program counted the pixels in the buffer zone, each according to its color. Of all the GIS analyses in this study, this was the most crucial. At the end, each of the 46 sections of road had five corresponding scores, each representing a different erosion potential.

To compare the sections, I created an erosion-index for each road by averaging each section's five risk scores. I multiplied the high-risk score by five, high-medium multiplied by 4, medium by 3, medium-low by 2, and low by 1. The totals were then summed and divided by five, producing an average index.[94] Because this index took into account the weighted effects of the sum of the natural environmental processes that affect road quality: (1) slope, (2) soil, (3) vegetation, and (4) climate, it was a measurement of the total environmental effect on road quality, per section.

[92] Upon close examination, only in very few instances did erosion risk change classes at a distance less than 200 feet away from the roads. Given these instances where this did occur, however, 200 feet was still thought to be the minimum distance at which a generous, erosion-maximizing index could be ascertained.
[93] H. L. Beyer, Hawth's Analysis Tools for ArcGIS, 2004, http://www.spatialecology.com/htools.
[94] There were 5 positive erosion risk potentials. The sixth class represented no erosion risk, therefore it was not weighted in the erosion-index.


Erosion Risk
Risk determined by slope, soil, vegetation and climate conditions
Risk
Very High
High
Average
Low
Very Low
Port-de-Paix
Cap Haitien
Gros Morne
Quanaminthe
St. Raphael
Gonaives
Hinche
St. Marc
Thomonde
Belladere
Mirebalais
Lascahobas
Cabaret
Jeremie
Dame Marie
Petit Trou de Nippes
Miragoane
Port-au-Prince
Port-a-Piment
Les Cayes
Jacmel
Source: UTSIG, 2002
0
15
30
60
90
120
Kilometers

Future Research

In future studies, the methodology could be improved or expanded. First, a greater number and higher diversity of survey sources may likely have given a more accurate reflection of road quality. The most accurate gauge of road quality would have been to employ civil or transportation engineers to conduct precise measurements of the sections themselves. In addition to increasing accuracy, this would have improved on a 'data scope' problem. Erosion is a local phenomenon affecting stretches of road anywhere from a few meters to a few kilometers. While the shortest sections of road were less than 20 kilometers, some sections were three or four times that long. Although many of the roads in Haiti are characterized by long stretches of these local phenomena, there is an extent to which quality data was not collected at the same level as natural environmental analysis was performed. This should be improved upon in future, and similar, studies. Nevertheless, it was beyond the scope of this project.

Information should also be gathered about any available financial data including each highway segment's total road cost and cost per kilometer per financier. This information was unavailable to me. The study may also expand beyond national and Departmental roads to include tertiary roads, built by the government and by smaller NGOs and banks. Moreover, any available demographic data such as median salary per Department (or sub-Departmental area) would also have been useful information.

Assumptions

Traffic also has an effect on road quality. In 1961, the AASHO road test conducted by the Highway Research Board set the standard for measuring the damaging

power of vehicles in Equivalent Standard Axle Loads.[95] On this scale, trucks may vary from less than 0.1 ESAL to more than 50 ESALS for (illegally) overloaded trucks. Typically, the average per truck hovers around 2-3 ESALS, with a typical legal limit of 5. [96] The study concludes by asserting that private cars have totally insignificant damaging factors.[97] Thus for this study, variable road damage by private cars was also considered negligible. Differences in truck traffic, however, were not accounted for. Although this study only included National Highways and major Departmental roads, some of these roads varied according to surface type.

Table 4. Road Surfaces[98]

	National	*Departmental*	*Rural*	*Total*
Paved	470	70	40	580
Gravel	120	675	700	1495
Earth	0	1840	2470	2470
Total (Km)	590	1375	2580	4545

Without traffic census data, I assumed that the damage caused by trucks would be roughly uniform across the National and most important Departmental roads. Nevertheless, this could be improved upon in future studies considering even major Departmental roads are surfaced with gravel – even earth.

Vandalism can also affect road quality. While Haitians do not intentionally destroy sections of road, nevertheless, setting tires on fire to burn on the asphalt is a feature of some political demonstrations. High temperatures have the potential to melt asphalt, leaving the door open for water to enter and to begin the process of erosion. This,

[95] 1 ESAL is equal to a load of 18,000 pounds of force
[96] David M. Newberry, "Road Damage Externalities and Road Usage Charges," *Econometrica*, Vol. 56, No. 2, (March 1998), 296.
[97] Ibid.
[98] World Bank, "Road Maintenance and Rehabilitation Project," Staff Apraisal Report No. 13849-HA, February 28, 1995, 5.

however, was also assumed to play a minor role in determining the quality of any section of road.

Future studies should also look for financial patterns across different "types" of financier, grouped here by similar average qualities. Financiers' average qualities per kilometer should also be examined across many countries, not just Haiti, in order to fully establish the point that these are meaningful differences in road quality.

Table 5. Quality by Type

FINANCIER	Avg. Quality per Kilometer	
France	Type 1:	7.20
Haiti	Type 2:	4.91
IDB		4.12
EU		4.05
Taiwan	Type 3:	3.59
Spain		3.50
AFD	Type 4:	2.57

If it can be shown that certain financiers are consistently responsible for lower quality work, a better understanding of what accounts for these differences can be reached.

The methods by which this study was conducted were conceived and calculated in an attempt to balance a natural tension between accuracy and pragmatism. With regards to the survey, a more detailed "absolute" standard in assessing road quality, may have ensured less variation, and therefore more accurate results. On the other hand, it may have resulted in fewer responses. More surveys in general would have been beneficial. The year in which the respondent traveled on a road in question could also have been included; responses before a certain date could have been excluded from the averages. Directions indicated, however, to leave blank any sections of road with which the respondent was unfamiliar. Despite the assumptions and limitations of the data retrieval,

the methods are sufficient to provide a reasonable overview of the variation in Haitian road quality, the results of which are displayed in chapter 4.

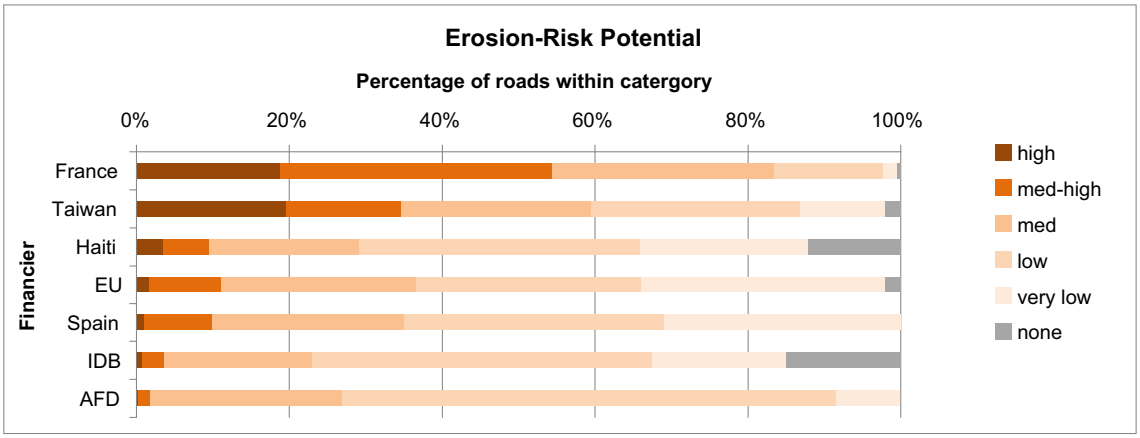
CHAPTER 4

VARIATION IN ROAD CONDITION

The Natural Environment

Figure 1 displays the percentage of roads, by financier, that fell within each category of erosion risk. All other things equal, these differences in erosive potential would be expected to be reflected in the conditions of the roads built by these financiers. According to the methodology outlined in chapter 3, Figure 1 predicts that France would be responsible for low quality roads, and the AFD would be responsible for high quality roads.

Figure 1. Risk of Erosion by Financier

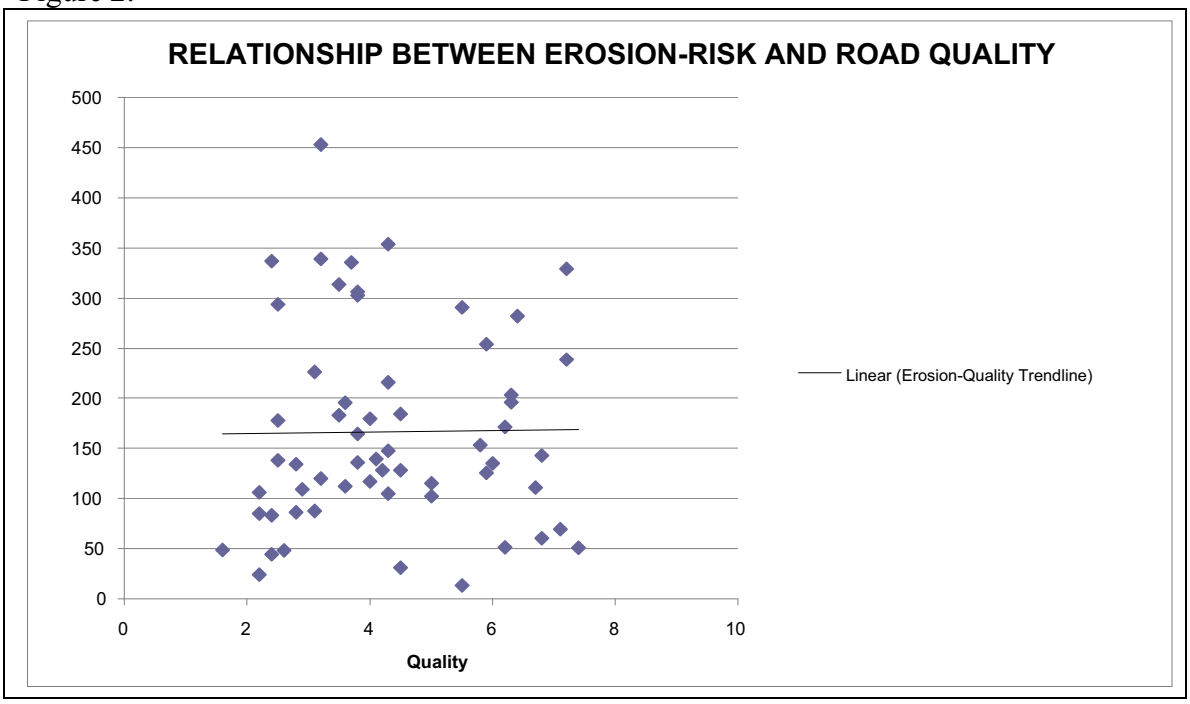


Whereas 50% of the roads built by France were in zones of the top two erosion potentials, only 10% of the Haitian roads fell in this category. The IDB, by comparison, only had 5%, the AFD even less.

Without including the financiers' average road qualities, a simple scatter plot proves useful in determining the relationship between erosion risk and road quality.

Figure 2 represents this as a scatter plot with the quality of each section of road on the horizontal axis, and its corresponding erosion-index on the vertical axis.

Figure 2.



By this analysis, the argument that erosion (the natural environment) is not responsible for the differences in quality is immensely strengthened. As figure 2 shows, there is no relationship between erosion risk and road quality in Haiti. This is a remarkable finding. In other words, there are just as many high quality roads built over "bad" ground as there are low quality roads built over "good" ground. The lack of correlation between the condition of the road network and the natural environment indicates that other factors – human factors –are affecting the outcome.

Financiers

Having established that differences in the natural environment cannot explain the observed variation in quality, I turn to the source of funding.

Table 6. Kilometers of Road Quality by Financier[99]

	Very low	Low	Medium	Med-High	High
France	0	0	0	0	37.34
Haiti	0	95.15	181.33	80.99	178.22
EU	130.65	122.64	69.51	49.13	77.27
IDB	115.33	0	103.22	76.61	44.88
Taiwan	0	68.02	0	0	0
Spain	0	69.22	0	0	0
AFD	28.11	16.22	0	0	0
Unknown[100]	0	0	93.32	0	0
Grand Total (Km)	274.09	371.25	447.39	206.73	337.71

Again, the ranges of average survey responses of the following indicators were as follows: 'very low' (1.6-2.8), 'low' (2.81-3.7), 'medium' (3.71-4.5), 'medium-high' (4.51-6), and 'high' (6.01-7.4). The data was broken into these categories according to the 'natural break' standard classification scheme where similar values are grouped in order to maximize the differences between classes.[101]

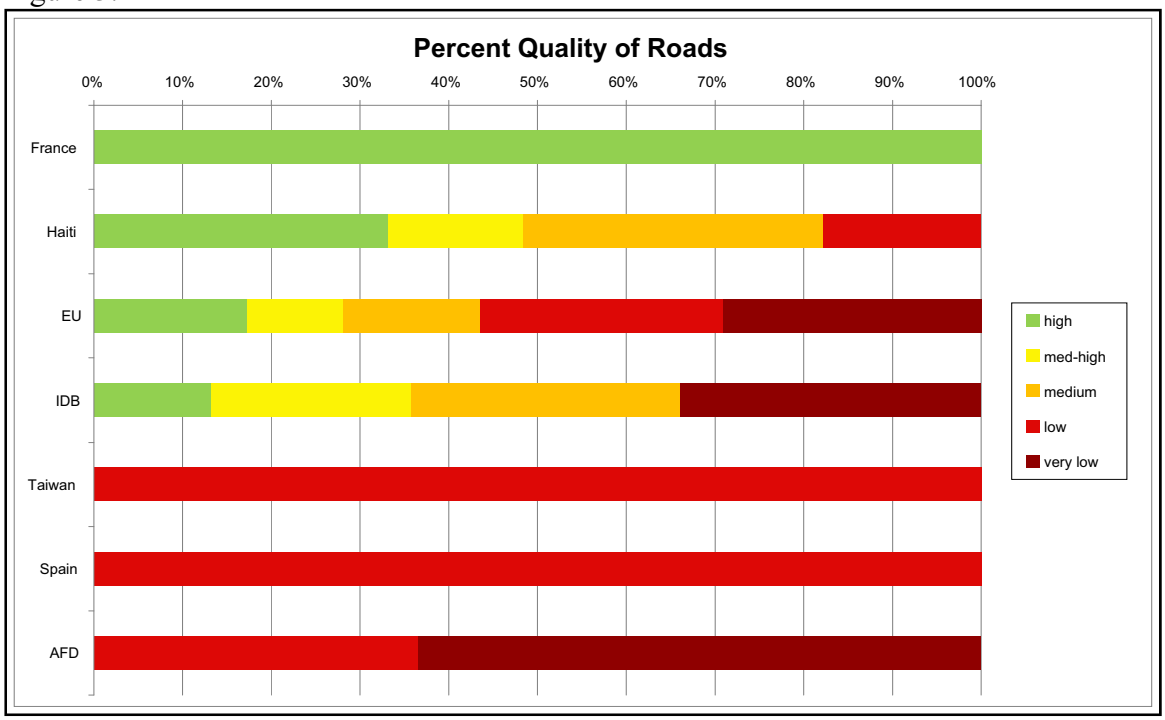
A primary important observation is that while France, Haiti, the European Union (EU), and the Inter-American Development Bank (IDB) have all financed varying amounts of high quality road, most of the roads in Haiti are not of high quality. Moreover the names are somewhat misleading. The "absolute" scale of 1-10 (with 5 as the average) should be kept in perspective. Thus even some roads included in the 'medium-high'

[99] Includes roads built during the 'heavy reconstruction' period described in chapter 2.
[100] The 'Unknown' financier may or may not include more than one financier; an agency not considered in this study may also have financed any portion of these roads.
[101] For a more detailed description of this process, see 'standard classification schemes' at http://www.esri.com/support.

category were, by simple absolute standards, “below average.” Nevertheless, as this study was primarily concerned with the relative differences within the Haitian transportation system, I consider the relative terms more useful. In both relative and absolute terms, however, Taiwan, Spain and the AFD are responsible for the worst roads in the system.

This is clearly illustrated in Figure 3, which measures the relative distribution of road quality, by percent, according to each financier.

Figure 3.



Variation by financier is extremely apparent. For roads built by France, the extreme outlier, 100% are of ‘high’ quality in Haiti. Conversely, 100% percent of the roads constructed by both Taiwan and Spain are of ‘low’ quality (2.81-3.7). This comparison of France and the AFD also confirms the lack of correlation found between erosion risk and road quality because by their respective erosion risk percentages, one would have

predicted opposite outcomes.[102] In fact, over 60% of all roads financed by the AFD are of the very lowest quality. Figure 3 also shows that, after France, the Haitian government is responsible for the greatest percentage of high quality roads. Moreover, over 80% of the Haitian government's roads are above 'medium' quality, whereas fewer than 45% financed by the European Union (the second closest) are above the same standard.

Distance and Quality of Construction

In addition to France having 100% of its roads in the highest quality, its average quality per kilometer is also the highest, by a large margin. After France at 7.2 is the Haitian government, with an average rating of 4.91 per kilometer, the only other financier above the nation's average. Table 7 indicates this.

Table 7. Average Quality by Financier

FINANCIER	Total Kilometers	Avg. Quality per Kilometer
France	37.34	7.20
Haiti	535.69	4.91
Unknown	93.32	4.18
IDB	340.04	4.12
EU	449.20	4.05
Taiwan	68.02	3.59
Spain	69.22	3.50
AFD	44.32	2.57
Grand Total / Average	1637.16	**4.34**

The average quality of roads in Haiti is 4.34, roughly corresponding to the survey text, which describes, "potholes scattered throughout, inconsistent pavement, and some drainage problems resulting in water on the roads."

[102] France built the greatest percentage of its roads in high erosion risk areas, yet 100% of its roads are of the highest quality in Haiti. Conversely, over 60% of roads built by the AFD are in 'very low' condition and yet the roads are in low erosion risk areas.

Although France has the highest average of road quality, Figure 4 gives this some perspective. The graph combines the information contained in Tables 6 and 7. It shows each quality class for every financier according to the total length of roads constructed.

Figure 4. Quality by Kilometer

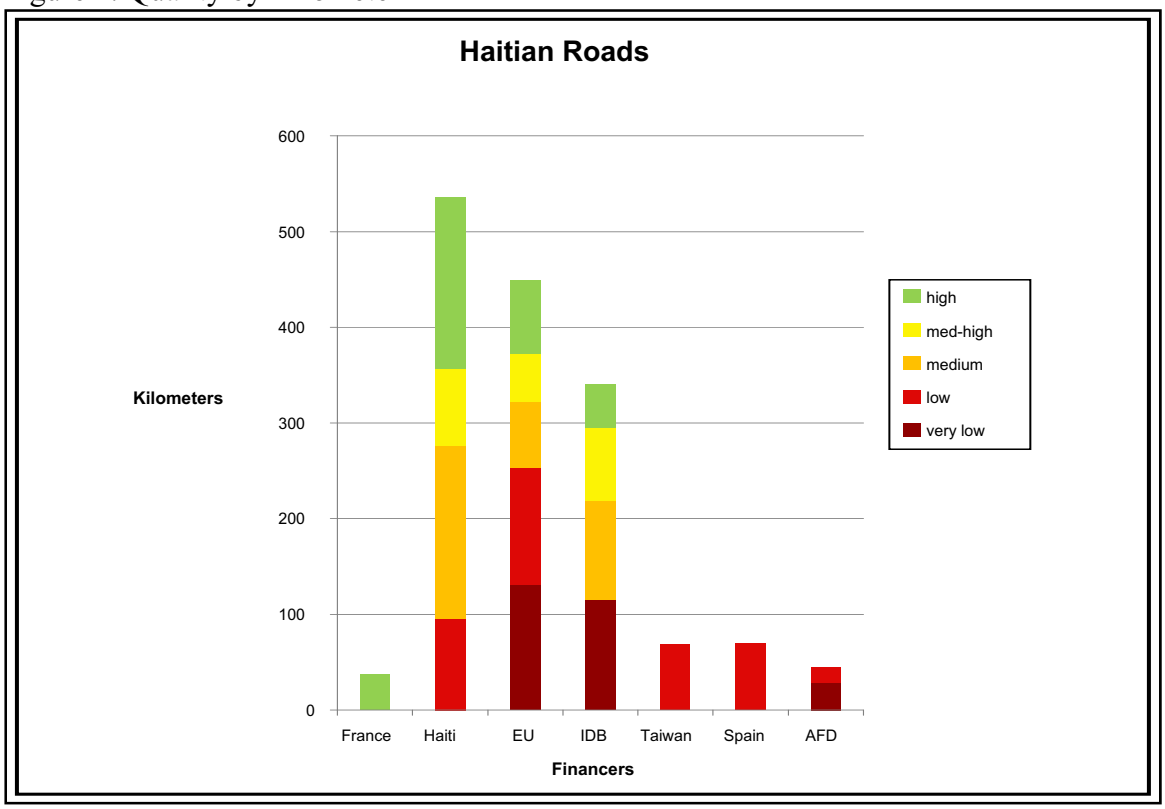


Figure 4 shows that even though France has 100% of its roads in the highest category, it is the Haitian government that has built the most kilometers of high quality road, by more than two times. Conversely, the EU is responsible for the most kilometers (over 100) of 'very low' quality roads. It also shows that the Haitian government, the EU, and the IDB, respectively, are responsible for the vast majority of roads built.

Demographics

GIS also facilitated the investigation of a relationship between financier, quality, and geographic distribution. Each of Haiti's 10 Departments shows considerable variation, by average road quality.

Table 8. Financier Quality by Department

DEPARTMENT	AVG_QUAL	France	Haiti	EU	Unknown	IDB	Taiwan	Spain	AFD
SUD-EST	7.20	7.20	7.10	7.40					
NORD-EST	6.06		5.90	6.14					
OUEST	5.35	7.20	5.83	3.35		5.23			
SUD	4.93		6.23			4.54	3.59		
NIPPES	4.06			2.80		4.58			
NORD	3.96		5.90	4.58	4.31	2.02			2.83
ARTIBONITE	3.89		3.73	4.30	4.02	4.14			
CENTRE	3.78		5.08	3.44					2.20
NORD-OUEST	3.74		3.80	4.30				3.50	
GRAND'ANSE	2.88		3.10	3.04		2.50			
AVERAGE by Department		7.20	5.19	4.37	4.17	3.84	3.59	3.50	2.51

The Departments are ranked in descending order according to their average qualities. The Sud-Est, for example, has an average quality of 7.2. The Grand'Anse, on the other hand, has roads on average of quality 2.88. To understand the patterns in Table 8, Table 9 displays the same information, but by financier rank, instead of actual averages. After France, Haiti and the EU share an average ranking. Both Haiti and the EU have four top rankings, while Haiti has three #2 rankings and the EU has four #2 rankings. In fact, Haiti and the European Union almost seem to vary according to a loosely inverse relationship. This pattern is either a matter of chance, or itself reflective of a geographic political pattern

Table 9. Financier Rank by Department

	Sud	Centre	Nord	G.A.	Ouest	Nord-est	Nord-ouest	Sud-Est	Art.	Nippes	Avg Rank_Dept
France					1			2			1.5
Haiti	1	1	1	1	2	2	2	3	3		1.78
EU		2	2	2	4	1	1	1	1	2	1.78
IDB	2		5	3	3				2	1	2.67
Spain							3				3
Taiwan	3										3
AFD		3	4								3.5
Unknown			3						4		3.5

To investigate this further, I compared every Department's road condition with its population, to see if there was any relationship. The prescriptive assumption behind this comparison was the following: with no foreign influence, a local government with limited resources would have road conditions vary in proportion to the population of the zones they served. Ideally, better roads would serve the more populous Departments because more populous Departments would likely produce more economic output. Arranged in this way, transport costs would be lower across more goods and services, and a cost-effective outcome could be achieved. Moreover, with limited resources, this would also provide the maximum mobility for the greatest number of people.[103] By these assumptions, Figure 9 has some prescriptive[104] value. In descending order of population by Department, the quality ranking should also descend, even if roughly, from 1-10.

[103] This assumes that the most populous Departments are the most productive, and that the government is rationally maintaining its roads. Chapter 5 discusses the second assumption.
[104] By prescriptive value, I draw a distinction with descriptive value. Figure 9 indicates how road quality "should" vary.

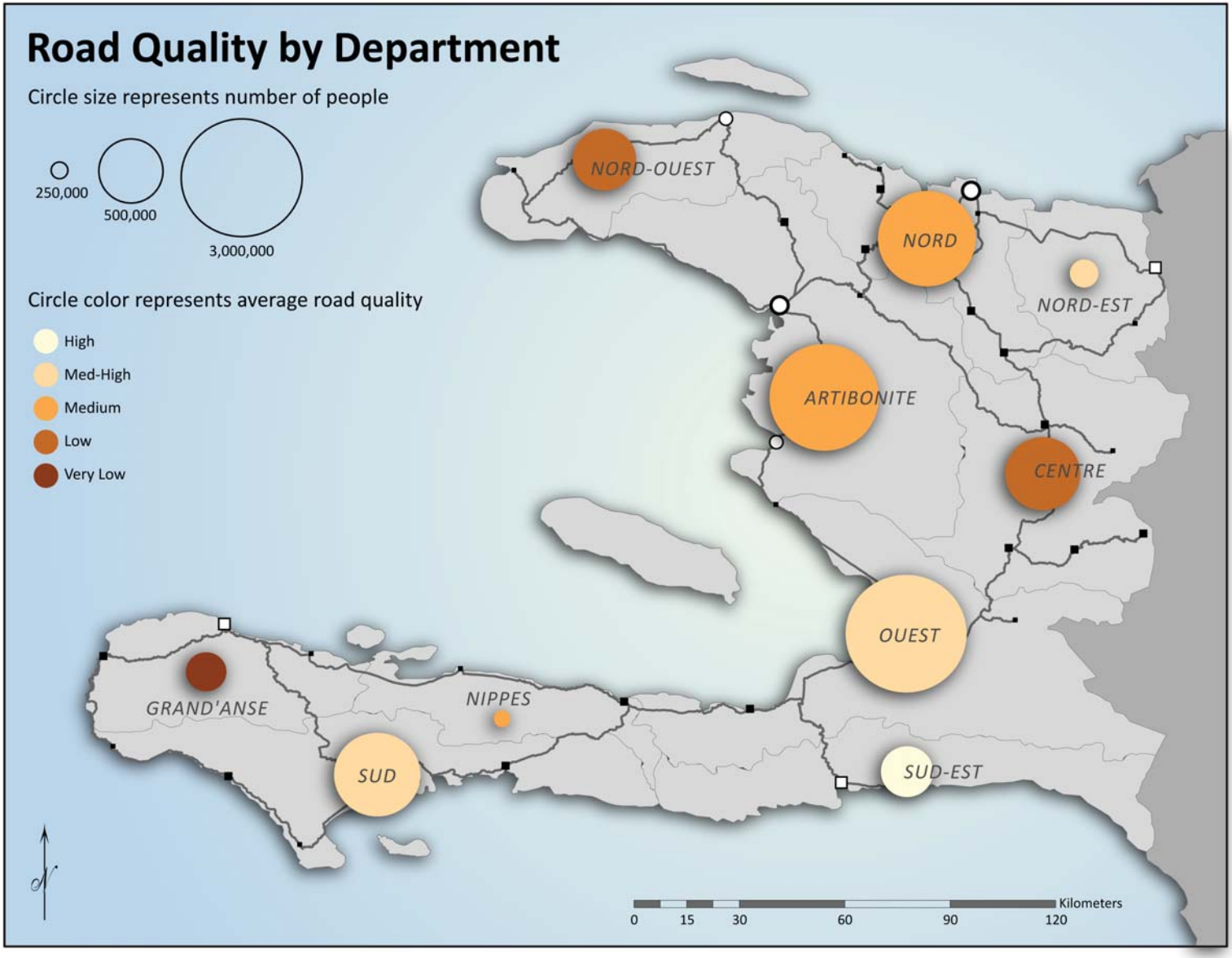
Table 10. Quality Rank by Department

DEPARTMENT	*POPULATION*[105]	*AVG_QUAL*	*QUAL_RANK*
OUEST	3,096,967	5.35	3
ARTIBONITE	1,299,398	3.89	7
NORD	823,043	3.96	6
SUD	621,651	4.93	4
CENTRE	**581,505**	**3.78**	**8**
NORD-OUEST	**531,198**	**3.74**	**9**
SUD-EST	**484,675**	**7.20**	**1**
GRAND'ANSE	351,928[106]	2.88	10
NORD-EST	308,385	6.06	2
NIPPES	265,000	4.06	5

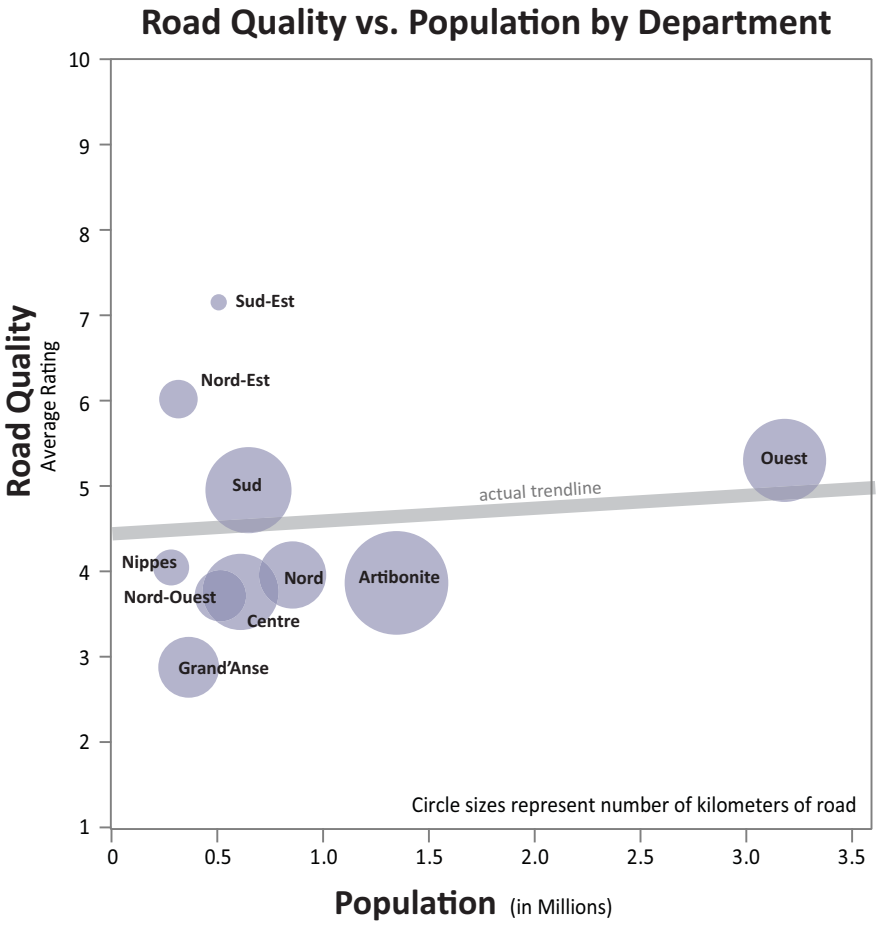
As Table 10 shows, however, road quality does not vary in proportion to population. The Sud-Est Department ranks seventh in road quality, but first in population. Next in population, Grand'Anse, ranks 10th in road quality. Furthermore, minimal differences in population correspond with drastic differences in road quality. Consider that the difference in population from Centre to Sud-Est is less than 100,000 people, but that road quality varies enormously, from 3.78 to 7.2.

Map 5, "Road Quality by Department," illustrates these relationships geographically. The relative size of each circle represents the Department population; the color represents the road quality. In this map, it is especially striking how equal size circles vary drastically in color, such as in the comparison of Grand'Anse and Sud-Est. This indicates that the same size populations are experiencing completely different road qualities. Moreover, larger circles (Nord and Artibonite) are generally darker in color, whereas smaller circles (Nord-Est and Sud-Est) are lighter. As previously explained, this is a sub-optimal developmental outcome.

[105] The census data was collected in 2003 by the Haitian Institute of Statistics and Information (IHSI).
[106] When the census data was collected in 2003, Grand'Anse had not yet been split to form the Department of Nippes. In 2003, Grand'Anse had a population of 626, 928. In this table, the population of Nippes has been extrapolated.


Road Quality by Department
Circle size represents number of people
250,000
500,000
3,000,000
Circle color represents average road quality
High
Med-High
Medium
Low
Very Low
NORD-OUEST
NORD
NORD-EST
ARTIBONITE
CENTRE
OUEST
GRAND'ANSE
NIPPES
SUD
SUD-EST
N
0
15
30
60
90
120
Kilometers

A visual analysis of Map 5, "Road Quality by Department," suggests that the population is completely unrelated to the quality of the roads. Figure 5, "Road Quality vs. Population by Department," however, reveals a very slight relationship. From 265,000 (Nippes) to 3 million (Ouest) people, the average quality does increase by 0.5. The graph also indicates the number of kilometers of road with relative circle sizes. Taking into account the total area represented by the circles, the graph illustrates that the quality of most of the roads clusters between 3 and 4. Perhaps the most important point, however, is that there are very few visible patterns between the horizontal, vertical, or circle-size relationships. As population increases, kilometers and quality do not vary consistently.



CHAPTER 5

THE SUSTAINABILITY PROBLEM

Who, How, or What Financed?

As Chapter 2 illustrated, Haiti is crippled by its inability to govern itself effectively and by a history of foreign intervention – even dominance. The answer to the question of why there is such disparity between good and bad roads in Haiti is not only important for the improvement of transportation, but also because it is reflective of a much larger development problem.

The results from this study indicate that differences in the natural environment do not account for the variation in road conditions in Haiti. This does not mean that the environmental laws of physics and chemistry are suspended; rather, the environment is acting on Haitian roads as it does anywhere in the world.[107] However, if one accepts the assumptions that (1) truck traffic is roughly equal over equal class roads and that (2) burning tires, animals, or other forms of vandalism are affecting the roads either negligibly (or uniformly), then the variation shown across different financiers is particularly meaningful – even extraordinary.

To say that the roads vary according to the source of funding is not enough. Financing a road has three basic components: (1) the workmanship, (2) the materials, and (3) the regimen of maintenance. On the one hand, perhaps different financiers are hiring different engineers or labor, and therefore the workmanship is reflected in the quality. This would mean, for example, that the difference between the French government's average quality of 7.2 and the French Development Agency's (AFD) average quality of

[107] In fact, the combination of generally mountainous topography, widespread deforestation and heavy rainfall is responsible in some measure for the total sub-average quality per kilometer: 4.34.

2.57 would be due to a difference in execution. Without knowing which companies constructed each road, it is difficult to know the extent to which initial quality accounted for variation several years later. Nevertheless, this does not seem to be the primary explanation. Foreign agencies generally do not export engineers or other labor from their respective nations. Instead, they contract one of several construction companies in Haiti (which may or may not be "Haitian") to build or reconstruct a designated road.[108] Thus, although it cannot be ruled out entirely, variation by engineers or initial workmanship seems like the least likely of the three components.[109]

The variation of road quality by financier may also be due to different materials. Materials are chosen according to design life, a function of predicted traffic, available budget, and climatic conditions.[110] Again, without knowing each road's total cost per kilometer, it is difficult to know the extent to which original design life accounted for variation several years later.[111] Admittedly, while most (81%) of the National and Departmental Highways considered in this study were surfaced with asphalt or gravel, some were dirt roads (19%).[112] Thus, while the vast majority of the roads in the study would deteriorate at similar rates, the Departmental roads built in dirt would certainly experience it faster.

Nevertheless, the remaining 81% of roads (where variation in quality cannot be explained by surface type) requires additional explanation. Furthermore, the average design life of roads in the tropics is approximately 15-20 years.[113] This study's results are based on a survey completed in 2007; therefore a difference in design life would account

[108] FER (Road Maintenance Fund), various interviews, Port-au-Prince, HT, August 2007.
[109] Though this is a potential area for future research.
[110] Thagesen, 120.
[111] In this case it would be assumed that more expensive roads would be designed to last longer.
[112] See Table 4.
[113] Newberry, 296.

much more strongly for quality of roads constructed in or after 1987. Prior to 20 years before the survey, however, all of the roads would have exceeded their design lives anyway. Given that the latest road building effort in Haiti took place in the 1970s, even if higher quality materials had been used for certain roads, it is reasonable to assume that this would not be the most important component in determining 2007 road conditions.

This is because the third, and far more likely, reason for variation by financier is due to different levels of maintenance funding. As chapter 1 indicated, when these roads were built, international donors seldom funded road maintenance projects because it was claimed that support of recurrent expenditure did not contribute to real long-term economic and social development.[114] This study suggests, however, that while maintenance has indeed been limited, certain agencies have financed maintenance even less often than others.

Maintenance Sources and Incentives

The question remains, however, whether the observed variation is simply a reflection of limited road maintenance that happens to vary by financier but is not *explained* by it. The answer to this question is difficult for the following reason: it is not always the case that the bank that constructed the road is the same one that finances its maintenance. In other words, it is theoretically possible (though not true) that the AFD, for example, had been highly involved in road maintenance in Haiti in the 1990s and that the agency happened to maintain roads built in the first place by the Haitian government.

One particular difficulty lies in the fact that the loans themselves are complicated. Money often comes from various sources. Of the $125 million dollar loan that the IDB approved in 1995, for example, the bank itself was only responsible for $45 million. The

[114] Proceedings Institution of Civil Engineers, 1130.

IDA (lending arm of the World Bank) financed $55 million, the KfW, German government-owned bank, financed $5 million, and the European Union financed $20 million.[115] Thus it is difficult to know which agency's dollars are being spent where. Moreover, not all of the money approved is usually disbursed: in this case, only $49 million had gone toward the project at its "completion" date in 2007.[116]

Without specific road maintenance data, it is impossible to determine causality. Nevertheless, the most recent loan approved by the IDB in 2007 is suggestive of a pattern. In the loan proposal for the "Rehabilitation of Road Infrastructure for Integration of the Territory," the number one objective of the operation was the rehabilitation of two main roads (a total of 146 kilometers), which would add up to the current road network renewal effort. The proposed roads were the Les Cayes – Jeremie road and the Miragoane – Petit Trou de Nippes road.[117] The reasoning for these improvements was that the "structure and condition of the road network in Southwest Haiti causes large parts of the territory in that area to be almost isolated from the rest of the country.[118]

While the statement that Southwest Haiti is true, it could also be said of virtually every other Department in the country. Much of the rural countryside in the north is also characterized by isolation. It is therefore not a surprise to discover that both roads proposed to receive the maintenance funding, and therefore form the primary objective of the entire proposal, were originally constructed by the IDB. What makes this more remarkable is that although the (1) Les Cayes – Jeremie road is in infamously bad

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[115] Inter-American Development Bank, "Road Rehabilitation and Maintenance Program," Loan Proposal HA-0041, January 1995, 1.
[116] Inter-American Development Bank, "Road Rehabilitation and Maintenance Program," 1995, http://www.iadb.org/projects/index.cfm?language=English.
[117] See Reference Map, page vii.
[118] Inter-American Development Bank, "Rehabilitation of Road Infrastructure for Integration of the Territory," Loan Proposal HA-L1019, November 2007, 2. http://www.iadb.org/projects/index.cfm?language=English.

condition, the (2) Miragoane – Petit Trou de Nippes road is in "medium" condition. Other roads in the same geographic area, built by other agencies, are in worse condition.[119] This does not constitute proof. Nor does it prove that other financiers pursue similar actions, or even that all construction and maintenance consistencies constitute political distortions. It is possible, however, that the IDB has its own development initiatives and incentives apart from the needs of the local population – and apart from an optimal developmental outcome.

In a similar fashion, the 37 kilometers of French road from Port-au-Prince to Jacmel were built as a "gift" from France to Haiti in the 1970s. Why did the French construct an expensive road to Jacmel? Allegedly, Jacmel had the highest concentration of Europeans, especially French, on the entire island; the architecture today reveals cast iron pillars and balconies purchased in France.[120] In 1998, the BCEOM Société Française d'Ingénierie – CECOM Consultants reported Jacmel ranked 7th in prominent economic centers.[121] Transport to and from Jacmel, however, remains the best in the nation. Both National Highways to the 2nd prominent economic center, Cap Haitien, on the other hand, are below national average. Without maintenance data, it is impossible to know whether the high Jacmel road quality is a function of better original materials or of a proper maintenance regimen. However, it is certain that its high quality today reflects incentives on the part of the French government.

While incentives are not inherently bad, when a stronger state and a weaker state

[119] The two roads are also not contiguous, a potential justification for cost-efficiency. See Reference Map, vii.
[120] Various interviews, Jacmel, HT, August 2007.
[121] BCEOM Société Française d'Ingénierie – CECOM Consultants, "Plan National de Transport," December 1998, 31.

negotiate, the weaker state generally makes concessions.[122] Haiti is one of only 28 countries to carry full diplomatic ties with Taiwan, an island republic that split from the mainland in 1949. While the international community acts in the logic of Beijing's "One China" policy, which states that no country can have relations with both Chinese governments, Haiti bucks the trend. Leslie Voltaire, a Haitian cabinet minister, has traveled to Taiwan with his country's last two presidents.[123] In return for diplomatic recognition, Taiwan gives badly needed aid to a country with barren soil, no minerals, no tourism industry to speak of and almost nothing to export. Much of that aid, however, is responsible for roads that after 20 years have an average quality per kilometer of 3.59: an average even below the abysmal national average.

Thus, while the other two "financier components" (workmanship or design life) cannot be ruled out, different maintenance regimens in the loan contracts are the most likely cause of the differences in road quality. Without specific financial data, however, it is impossible to paint the entire picture. While regular maintenance has certainly extended the design life of the French road to Jacmel, for example, the source, amount, and location of maintenance disbursals would be needed to make definitive statements about each agency's specific incentives. Even without knowing each agency's disbursals, however, the results suggest that road financing does not take the local population into account.[124] As a result, (1) vehicle-operating costs are not minimized and (2) mobility is not maximized for the greatest number of road users. In this sense, the political process that accounts for the funding distribution results in a sub-optimal developmental outcome.

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[122] As chapter 2 illustrated, this has particularly been true in matters of transportation infrastructure.
[123] Daguillard, Robert, "Haiti and Taiwan," *VOA News Report,* May 27, 2003.
[124] See Map 5, "Road Quality by Department," and Figure 5, "Road Quality vs. Population by Department."

CHAPTER 6

THE POLITICAL ECONOMY OF ROADS

The previous chapters have indicated that the political economy of roads varies according to financiers' incentives for sustainability. Because road quality is a function of maintenance, and donors have very little stake in quality, they have very little stake in maintenance. This pattern is likely to be observed in other infrastructure projects where the quality of the service provided is also not immediately measurable (unlike health or education projects, for example). In cases where sustainability poses the largest obstacle, such as transportation infrastructure, this study suggests that long-term success will most likely be achieved among the primary stakeholders.

This study indicates that the Haitian government is the most prolific and effective road financier in Haiti.

Table 6: Kilometers of Road Quality by Financier

	Very low	Low	Medium	Med-High	High
France	0	0	0	0	37.34
Haiti	0	95.15	181.33	80.99	178.22
EU	130.65	122.64	69.51	49.13	77.27
IDB	115.33	0	103.22	76.61	44.88
Taiwan	0	68.02	0	0	0
Spain	0	69.22	0	0	0
AFD	28.11	16.22	0	0	0
Unknown	0	0	93.32	0	0
Total (Km)	274.09	371.25	447.39	206.73	337.71

It has financed over 178 kilometers of 'high' quality roads, compared with the EU (77 km), the IDB (45 km) and France (37 km). In the second and third categories, 'high-medium' and 'medium,' the Haitian government has also financed the most kilometers of

roads. In the 'low' category, foreign financiers are responsible for 75% of the roads. Moreover, the Haitian government did not finance any of the 274 kilometers of road in the 'very low' category: all was foreign. In fact, off all three foreign financiers responsible for 'very low' quality roads (EU, IDB, AFD), this category represented the largest share of each of their total portfolios.

What accounts for the Haitian government's relative success? If the IDB has incentive to maintain the roads it constructed, the same logic only holds more true for the country's own government. Even amidst political instability and rampant corruption, this study indicates that no agency has more incentive to maintain roads paid for by the Haitian government than the Haitian government. This suggests that despite Haiti's "failed state" status, and despite a history of corruption and neglect, the Haitian government still exhibits more capacity for sustainability than its foreign counterparts.

Haiti's experience in 1984 with USAID (withdrawing its budgetary support of SEPPRN)[125] also reveals that it is not sustainable to have a single financier responsible for a developing country's maintenance. Easterly makes the argument that "aid donors should just bite the bullet and permanently fund road maintenance, textbooks, drugs for clinics, and other operating costs of development projects" so that politically dysfunctional governments can concentrate on other things.[126] While this can be a temporary solution, external forces cannot replace local constituencies for providing long-term services, as the locals for whom the roads are designed have higher stakes in maintaining them.

[125] Permanent National Roads Maintenance Service
[126] Easterly, 2006, 190.

Nevertheless, this is not to say that the indigenous governments should get a "carte blanche" for maintenance work. Money designated for sustainability functions can easily be misallocated. The IDB's negative experience in 1995,[127] for example, shows that funds for maintenance should not be sourced from government recurrent budgets. It is likely that one important reason for Haiti's relative success has been achieved in earmarking revenue collected by taxing petroleum and other road-related purchases for an *independent* fund: the National Maintenance Fund (FER). Since 2005, maintenance work has been accomplished on 116 kilometers of road with money designated for this very purpose.[128]

Broader Implications

This study confirms and extends several conclusions drawn by William Easterly in *The White Man's Burden.* Easterly argues that (1) foreign agencies are more likely to provide construction funds than money for maintenance and restoration because new construction has sharp political visibility, unlike maintenance.[129] When compared to the other donors, the Haitian government's relative success supports this observation. Easterly argues that aid bureaucrats have incentives to satisfy the rich countries doing the funding as well as (or instead of) the poor.[130] The illogical distribution of road quality in the Haitian transportation network supports this as a likely explanation.

Easterly also predicts that (2) aid agencies will embrace collective responsibility. Without a mechanism for delivering feedback, such as road quality (over time), no one agency can be held accountable for its actions. He argues, "Aid agencies are rewarded for

[127] Inter-American Development Bank, 1995, 22.
[128] FER (Road Maintenance Agency), various interviews, Port-au-Prince, August 2007.
[129] Easterly, 2006, 180.
[130] Ibid., 167.

setting goals rather than reaching them, since goals are observable to the rich-country public while results are not." [131] Easterly also describes how foreign aid is complicated by different aid agencies who answer to different constituencies. Because none of the agencies is responsible for a particular outcome, the effects of their individual efforts are unobservable. [132] In Haiti's case, the fact that seven (known) agencies have financed the construction (or reconstruction) of major trunk roads has reduced incentives for the others to finance maintenance. Ideally, the feedback problem could be solved and aid could be more "competitive;" in the meantime, however, this study suggests that having several aid agencies finance projects in the same sector can harm, rather than help, developing countries. It also suggests that donors should specialize more in solving particular problems in particular countries, rather than having each agency responsible for everything.

From a historical perspective, the operation of the FER[133] marks a change in the alternating pattern of influences that have characterized the Haitian transportation system.

Table 1. Haitian Transportation Development

PERIOD	DATES	ACTIVITY	INFLUENCE
Colony	1492-1803	extract resources	foreign
Independence	1804-1914	neglect	domestic
US Occupation	1915-1934	strategic influence	foreign
Dictators	1957-1986	neglect	domestic
		heavy reconstruction	foreign
"Failed State"	1987-2004	**neglect**	domestic
Today	2005-present	**sustainability?**	foreign/domestic?

[131] Ibid., 185.
[132] Easterly, 2006, 15.
[133] National Road Maintenance Fund

This historic change has several implications. First, instead of constructing new roads, financiers should help maintain old ones. This was true even before the FER was created; however, its current operation underscores the importance of doing so. Moreover, instead of maintaining previously financed sections, aid agencies and foreign governments should allow the National Road Maintenance Fund to determine which roads to maintain. At some point, donors have to trust recipients to be self-reliant enough to follow their own interests and seize the opportunities created by aid. [134]

Unfortunately, despite decades of participation and sustainability rhetoric, the balance of power in foreign aid has not changed. This study, however, should serve as a point of reference for future and similar studies that compare variation in matters of sustainability. If other road, transportation, or infrastructure projects show similar signs of variation by political proxies, reform will be that much more imperative – and likely to succeed.

This study's specific findings are the following. (1) The source of financing most meaningfully accounts for variation in road quality. (2) The indigenous government – ordinarily known for corruption and neglect – is, in fact, responsible for financing the most kilometers of high-quality roads. (3) Foreign donors have historically had weak incentives to finance road maintenance. And (4) to the extent that recent road projects have included maintenance in their priorities, money has likely been spent on sections that the donor originally financed.

These (4) results suggest that if foreign aid is to contribute to social and economic development, it can only do so with strong emphasis on project sustainability and recipient-country autonomy. To the extent that donors do not meet these criteria, as in the

[134] Easterly, 2006, 197.

case of the Haitian road network, it is likely that politics will play a larger role in the outcome than any other stated objective.

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Appendix 1. Survey Responses

Route	Road Quality																																	Avg	St. Dev
Port-au-Prince-Cabaret	8	7	5	3	5	2	5	6	4	5	5	5	4	4	6	3	7	7	5	5	5	4	4	5	5	4			7					5.0	1.4
Cabaret-Montrouis	7	6	5	2	5	2	7	5		6	7	5		5	4	4	4		4	5		5		5					7					5.0	1.5
Montrouis-St. Marc	6	6	3	3		2	5			4	4	4		5	5	3	4		3			4				4	4		6					4.2	1.2
St. Marc-Gonaives	6	3	3	2		1						3		2	6	3	3	3	2	4	3	3				4	3		4					3.2	1.3
Gonaives-Ennery	6	3	3	3		2						2			5	6	3	4	4	4	4	3							5					3.8	1.3
Ennery-Plaisance	7	4		3	4	3	6	3	4	5		2			5		5	5	5	5	6	4				5	4		5					4.5	1.2
Plaisance-Limbe	7	4	2	3		3	4	4	4			2			4		5					4				4	5		5					4.0	1.3
Limbe-Cap Haitien	7	4	3	2	4	4	6	4	5		5	2			5		5	5	5	5	5	4							5	5				4.5	1.2
Limbe-Port Magot	3	1	3	2		2						3			4		3	2	2	1	3	2				2	3		3					2.4	0.8
Port Magot-Bayeux	3	2	3	2		1						1			3		2		3	3	2	2					2		2					2.2	0.7
Bayeux-Borgne	3	2	1	2		1						1			2		1		2	2	2	1				2	1		1					1.6	0.6
Cap Haitian-Quanaminthe	8	7	3	3		3	4	7		4	8	6		7	9	8	8					7		6		7	7		8	4				6.2	2.0
Quanaminthe-Mont Organise		5	5			2	6	8		4	8	6		5	8	7	8					7		6		7	6		8	2				6.0	1.9
Mont Organise-Pignon		5	5			1		8		4	8	6		5	8	7	4	7	8	8		3		9		8	3		9	2				5.9	2.4
Gonaives-Gros Morne	4	5	3	2		3		5		5	5	5	3	4	5	4	5	4	4	3	4	4		5		3	5	4	5	3				4.1	0.9
Gros Morne-Port-de-Paix		4	5			4		6		5	5	4					5					3							2					4.3	1.2
Port-de-Paix-Mole Saint Nicolas		1	5	4		1	3	4		2	5	5		4	3	4	5					4		2		4	4	4	4	2				3.5	1.3
Mole Saint Nicolas-Gonaives		3	4			2		5		5	5	4		3	4	3	5					3		3				4	4	2				3.8	1.0
Croix des Missions-Thomazeau	7	2	3	2	3	2						4	2									4		4	6	5	3	3		4				3.6	1.5
Thomazeau-Mirebalais	3	3	2	1		1						3	2									2		4	3	1	1	3	3	4				2.4	1.1
Mirebalais-Thomonde	3	5	2	2	2	2						3	5	2	2	3	1	3				3	2	3	2	2	2	2	1	3				2.5	1.0
Thomonde-Hinche	3	4	3	2		2						4	5	1	1	1	3	3				2		3		2	2	3		3				2.6	1.1
Hinche-Pignon	3	2	3	1		2						3	5		1	2	2					3		3	1	2	2	1	2	2				2.2	1.0
Pignon-St. Raphael		4				3		3		4	3	5	5	3	3	3	4	3				3		2	4	3	3	1	3	2				3.2	1.0
St. Raphael-Carrefour des Peres		2				2		4		4	4			5	4	4	4	4	4			3		2	4	3	6		4	2				3.6	1.1
Carrefour des Peres-Pignon	4	3	2			3		4		4	4	5	2	5	5	5	4	5				4		2	5	4	4	5	5	2				3.9	1.1
Mirebalais-Lascahobas			2	5	5	4		7		7	7			5	8	6	5	9	7		6	7	6	7	8	6	5	4	8	8	8			6.3	1.6
Lascahobas-Belladere					5	3		6		6	6			5	8	7	6	6	6			6		7					7	3				5.8	1.4
Ennery-Hinche	4				1	1		5		5	5			3	5	4	6	5	5		5	6	4		5		4	6	4	5	2			4.3	1.5
Hinche-Thomassique	3				1	1		5		5	5			4	5	4	3	5	4			4	4	3	4	5	5	4	4	4	2			3.8	1.2
Port-au-Prince-Grand Goave	8				3	4	6					7						7				6		7		7	6	6		8				6.3	1.5
Grand Goave-Miragoane	6					4	5			5	6			6	6	6	5	5	4			5		7		5	5	6	6	7				5.5	0.9
Miragoane-Aquin	7					2		7		7	7			8	8	8	8	7	7			6		7				6	8	6				6.8	1.5
Aquin-Les Cayes					4	3		8		8	8			5	7	5	5	7	7			6	6	7	8	7	7	7	7	6				6.4	1.4
Les Cayes-Port Salut	7				5	5						6						7				6		6		7	7	8	8	8				6.7	1.1
Port Salut-Port-a-Piment	3				5	5						4						4				3		5		3	3	3	3	3				3.7	0.9
Port-a-Piment-Tiburon	3		3			1		4		4	2	3	5	5	3	5	4	3						4	5	2	3	4	4	2				3.5	1.1
Tiburon-Dame Marie			2			2		4		4	2	3	4	4	2	4	4	4						3	3				4	1				3.1	1.0
Dame Marie-Jeremie			1			1		4		4	2	4	3	4	2	4	4	4							4				4	3				3.2	1.1
Les Cayes-Jeremie	4		2			1	3					2					3	2	2	3	2			2	1	4	5	2		2				2.5	1.1
Jermie-Corail			3			1	1	4		4	4			3	3	3	4	3	2	3	3	4		4	3	2	3	2	3	2				2.9	0.9
Corail-Petit Trou de Nippes			3			1	1	4		5	5			3	3	3	4		2	1				3					3	1				2.8	1.4
Port-au-Prince-Jacmel	7		7	7		5	7								8									7		7	7	8	8	8				7.2	0.8
Jacmel-Cayes Jacmel			7			5	7	8	7	7	8	6	8	8	5	9	8	9	7	7			7	3	8	8	8	8	7	7				7.1	1.3
Cayes Jacmel-Marigot	8		7	6	7	4	7	8	6	7	8	8	9	8	8	8	8							7		9	8	7	8	7				7.4	1.1
Miragoane-Petit Trou de Nippes	4	4	5	4	2	3	3	5	5	3	5	4		4	4	4	7							5		3	4	3	5	2				4.0	1.2
																																avg_stdev:		**1.22**

Appendix 2. Erosion Risk Data

FINANCER	DEPARTMENT	QUALITY	HIGH	MED-HIGH	MED	LOW	VERY LOW	NO DATA	Erosion Index
AFD	CENTRE	2.2	0	0	57	180	0	0	106.2
AFD	NORD	2.2	1	9	28	123	54	1	85
AFD	NORD	3.2	0	3	92	154	4	0	120
France	SUD-EST	7.2	35	125	123	69	11	1	238.6
France	OUEST	7.2	116	160	110	46	3	3	329
Haiti	GRAND'ANSE	3.1	95	134	4	51	5	213	226
Haiti	SUD	6.7	0	44	58	22	161	6	111
Haiti	SUD	6.4	57	4	160	249	131	328	282
Haiti	SUD	3.1	55	15	18	24	0	10	87.4
Haiti	SUD-EST	7.1	0	0	27	130	7	0	69.6
Haiti	OUEST	6.3	2	3	40	331	213	26	203.4
Haiti	OUEST	5.0	0	14	55	95	165	15	115.2
Haiti	CENTRE	6.3	7	45	99	221	26	0	196
Haiti	CENTRE	4.3	1	3	58	377	133	0	215.6
Haiti	ARTIBONITE	4.3	1	77	220	344	107	0	353.6
Haiti	ARTIBONITE	3.2	0	4	280	217	405	26	339
Haiti	ARTIBONITE	3.8	0	38	213	282	176	357	306.2
Haiti	NORD-OUEST	3.8	0	41	167	400	50	3	303
Haiti	NORD	5.9	1	26	58	133	79	0	125.6
Haiti	NORD-EST	5.9	62	50	132	114	137	0	254.2
IDB	SUD	2.5	0	0	59	191	131	1	138
IDB	GRAND'ANSE	2.5	0	26	270	273	9	444	293.8
IDB	SUD	6.8	13	16	84	100	134	2	143
IDB	NIPPES	6.8	0	17	19	78	22	0	60.6
IDB	NIPPES	5.5	0	0	4	23	8	0	13.2
IDB	OUEST	5.5	17	25	192	326	41	12	290.8
IDB	NIPPES	4.0	1	0	38	318	142	45	179.4
IDB	OUEST	5.0	0	0	7	206	78	119	102.2
IDB	ARTIBONITE	4.2	3	1	75	196	5	42	128.2
IDB	ARTIBONITE	4.1	0	23	83	107	142	0	139.4
IDB	NORD	2.4	2	16	2	71	1	0	44.6
IDB	NORD	2.2	0	0	4	28	52	0	24
IDB	NORD	1.6	0	0	31	64	23	0	48.8
Spain	NORD-OUEST	3.5	8	64	184	247	226	0	313.6
Taiwan	SUD	3.7	138	77	160	98	5	0	335.8
Taiwan	SUD	3.5	32	54	56	140	91	18	183
UE	NIPPES	2.8	0	3	117	134	40	0	134.2
UE	GRAND'ANSE	3.2	29	245	261	174	9	20	453
UE	GRAND'ANSE	2.8	0	0	51	133	13	0	86.4
UE	GRAND'ANSE	2.9	20	12	67	98	0	63	109
UE	SUD-EST	7.4	0	41	9	32	0	9	51
UE	OUEST	2.4	1	5	38	139	0	0	83.4
UE	OUEST	3.6	0	0	1	91	376	1	112.2
UE	CENTRE	2.4	0	75	417	67	0	0	337
UE	CENTRE	5.8	0	29	134	119	9	2	153
UE	CENTRE	2.5	3	53	137	57	137	20	177.8
UE	CENTRE	2.6	0	0	6	46	131	1	48.2
UE	CENTRE	3.8	0	7	98	222	56	0	164.4
UE	ARTIBONITE	4.3	0	12	81	116	1	0	104.8
UE	NORD-OUEST	4.3	1	28	119	124	15	0	147.4
UE	NORD	6.2	6	0	0	1	224	2	51.2
UE	NORD	3.6	30	94	49	101	103	0	195.6
UE	NORD-EST	6.2	0	0	0	55	747	9	171.4
UE	NORD-EST	6.0	16	0	35	160	171	0	135.2
Unknown	ARTIBONITE	3.8	0	6	141	65	103	0	136
Unknown	ARTIBONITE	4.5	28	23	102	51	0	0	128
Unknown	NORD	4.5	2	0	25	35	0	0	31
Unknown	NORD	4.0	12	17	130	33	0	2	116.8
Unknown	NORD	4.5	58	4	39	173	153	0	184.4