Water and Deforestation in Brazil: Future Challenges for Policy Implementation

R. K. Phillips[1] and E. Grubert[2]

[1]Department of Political Science, St. Edward's University, 3000 University, Austin, TX 78705; email: russell.k.phillips@gmail.com
[2]Environmental and Water Resources Engineering, The University of Texas at Austin, 1 University Station C2200, Austin, TX 78712; email: gruberte@mail.utexas.edu

ABSTRACT

Brazil is likely to face impacts from global climate change over the next century. One of the most significant ways it will be impacted is through changing water availability: Brazil's ability to supply water to its people for domestic use and economic activity will be affected by its response to water conditions, deforestation, and growth. Brazil's policies in relation to climate change, water and deforestation will likely have a significant impact on Brazil's water supply in the long-term. This paper examines several of the challenges facing Brazil's water and forestry polices, with focus on the effects of climate change, societal forces, and deforestation on the robustness of Brazilian policy. It also analyzes some of the structural advantages and deficiencies facing policymakers. Brazil's policy decisions will have economically and climatologically impacts worldwide and Brazil will face international pressure and internal need to manage its resources wisely.

INTRODUCTION

Brazil is the world's fifth largest country,, and a growing economy with unusually low carbon intensity. However, Brazil's future is threatened by global climate change and water supply issues (Parry, 2007). Brazil's policy choices have far-reaching consequences both globally and domestically, so the nation seeks to balance its own priorities of development and increasing citizens' standards of living with international goals of preserving Brazil's Amazonian ecosystems. One of Brazil's gravest environmental challenges is deforestation. As the Amazon rainforest loses area to farmland, carbon emissions from burning plant matter and decreased carbon storage capacity contribute to global climate change. Simultaneously, the loss of forest cover changes water storage patterns and allows for increased erosion and surface water sedimentation. Brazil's rural population has limited access to improved water supplies, and the large urban population is particularly challenged by water constraints and contamination from untreated sewage.

Even as Brazil's policymakers and water planners address these supply and treatment issues, climate change threatens to worsen the situation with reduced precipitation in drought-prone areas and heat-driven forest die-off that exacerbates the

problems of deforestation. The nation's water policy is charged with protecting human health and standards of living even as it is asked to protect Brazilian water resources. Brazil's policymaking is characterized by split federal, state, and local jurisdiction that allow for tailored local policies but can impede large national and international efforts, particularly when local economics contradict environmental goals. Climate change threatens Brazil's water resources and its ability to adequately meet the challenges of development and environmental protection. Though Brazil's water policies are progressive, the nation is correct to worry about the impact of global climate change on its water.

WATER RESOURCES

Brazil has over 40,000 m^3/year of renewable water resources per capita, well above the global average of 8,000m^3/year, but most of the water resources are in the Amazon basin, far removed from the eastern population centers and southern agricultural regions ("Brazil", 2010). The Amazon Basin is also a major global carbon sink whose forests are threatened with large scale die-off if rising temperatures and declining rainfall from climate change continue (Bates, 2008 Marengo, 2009). Brazil's policymakers have recognized challenges, and Brazil has implemented progressive water and forestry policies (Government, 2010). While Brazil's policies are strong, more must be done to integrate local needs like economic development, national goals like effective resource management and long-term growth, and international priorities like climate change mitigation and biodiversity preservation.

The need for integrating numerous, occasionally clashing perspectives into Brazilian forest and water policy is as vast as the importance of Brazil's forest and water resources. The Amazon river basin is the largest river basin in Brazil, with the majority of Brazil's freshwater resources. The rest of the country is covered by 7 other major river basins (Junior, 2005). These river basins have seasonal droughts and their water resources are already strained. Brazil's highly concentrated population exacerbates the problem. The State of São Paulo contains the largest city in Latin America and one quarter of Brazil's population, but it only has access to 1.6% of Brazil's water resources (Junior, 2005). This disconnect between the location of water resources and population is widespread in Brazil (Benjamin et al, 2005).

Unlike urban users, rural agricultural and industrial users have limited water supply constraints. This is due to two major factors. First, Brazil uses a smaller fraction of its water supply on agriculture than the Latin American average due to crop differences (United, 2005). Second, agricultural lands tend to be in upstream regions, which means that farmers face fewer water quality problems from untreated sewage than coastal urban dwellers (Junior, 2005). Despite these advantages for agricultural and industrial users, rural domestic users face major access constraints with regard to improved water supply and sanitation, as will be discussed later in this paper.

Although Brazilian farmers account for a smaller percentage of water use than their Latin American neighbors, agricultural water use is rising along with water use from all sectors. As Brazil's economy grows and matures, the water demands grow as well. Brazil is the eighth largest economy by some measures and is still growing

(McKinsey, 2010). The growth has been typical of most developing countries, with a large income gap and huge disparities in resource and infrastructure allocation. Atypically, however, Brazil has developed with low carbon intensity, in large part due to its vast hydroelectric resources. Brazil has emerged as a developing-country leader in transitioning to a low-carbon economy (Government, 2010). It has done this by utilizing hydroelectric power generation, sugar-based ethanol fuel, and progressive regulations (McKinsey, 2010). Nevertheless, Brazil will still need to make significant changes to certain economic sectors to meet its own greenhouse gas reduction goals.

GREENHOUSE GASES AND DEFORESTATION

Brazil has set these aggressive greenhouse gas reduction goals because of the clear and apparent threat to Brazil's ecosystems and economy from global climate change (McKinsey, 2010). Climate change could significantly impact all of the major river basins of Brazil (Bates, 2008). However, the impacts on the Amazon River Basin and the coastal river basins are most critical. Rising surface sea temperatures are expected to cause a decrease in summer rainfall in the Amazon (Solomon, 2007). This could have significant ecological impacts as "up to 40% of the Amazonian forests could be affected by even slight decreases in precipitation" (Bates, 2008) and decreased rainfall could also increase the risk of wildfire, increase river runoff, and reduce the size of the Amazonian carbon sink. These stresses on the forest will force it to adapt as more fire- and drought-tolerant species take over. This process, savannization, could dramatically reduce the biodiversity, carbon sink capacity, and economic value of the Amazon (Parry, 2007).

The same forces decreasing summer rainfall in the Amazon cause similar effects in the northern river basins. The aquifers and surface water supplies are already at risk due to the high population densities and low sanitary standards in the large coastal cities, especially their slums (Junior, 2005). Northern Brazil's coastal poor will be some of the most affected globally by climate change due to the projected declines in water availability (Parry, 2007). Conversely, in the southern coastal cities predicted increases in precipitation could be very problematic (Bates, 2008). Large sections of the population live in unregulated slums, often on the edges of hills or mountains. These homes are at high risk of damage or destruction in mud slides or heavy rain. However, the increase in rainfall for southern Brazil does indicate that it is unlikely that agricultural withdrawals for water will grow in the region (Parry, 2007). For the Amazon, where subsistence and tropical specialty agriculture dominate agricultural activity, the future of agricultural withdrawals depends largely on another factor: the rate of deforestation.

Deforestation due to land use change is the largest single contributor to Brazilian greenhouse gas emissions (McKinsey, 2010) as carbon is released from burning trees and deforested land loses its capacity to take up carbon. The main driver of forest conversion is the expansion of farmland for cattle pasture and soybean production into the forests (Metz, 2007, Izquierdo, 2008). The land is often considerably more valuable as farmland than as untouched forests or sustainable timber land, creating economic incentive for deforestation. Deforestation (and continued incentives for deforestation) is especially problematic due to the important

role of the Amazonian forests in the global atmospheric carbon balance. The Amazon forest is one of the world's largest carbon sinks (Solomon, 2007). However, deforestation threatens this offset in the future (Metz, 2007). Since some Amazon die-off due to increased heat and decreased rainfall is expected in even the most conservative climate models, then additional anthropogenic deforestation will only further amplify the feedback loop of increased temperatures due to greenhouse gases, Amazonian die-back, and increased greenhouse gas emissions due to die-back. One study predicts that 20-40% of the Amazon rainforest could die from the effects of a 2° Celsius global average temperature increase, widely considered a best-case scenario (Adam, 2009).

In an attempt to slow anthropogenic damage to forests, Brazil has implemented several forestry policies to curtail deforestation and promote forest sustainability (Government, 2010). Primarily, these are incentives to land owners, sustainable forestry initiatives, and crackdowns on illegal logging (McKinsey, 2010). The incentives to land owners work to offset the economic advantage of creating farm land by cutting down forests, helping to eliminate benefits from deforesting small plots of land. Brazil strongly supports the Forest Stewardship Council and has been pushing for certification of the Brazilian timber industry (United, 2005). Finally, using realtime satellite imagery and local reports, Brazilian law-enforcement has begun to seriously attack the problem of illegal logging (McKinsey, 2010). These efforts appear to be beginning to pay off, as 2010 and 2009 had the lowest levels of deforestation since monitoring began in the 1980s (Government, 2010). The international community has also attempted to use financial incentives to reduce deforestation globally, with attention to the Amazon and other rainforests, with payments for forest protection under a system called Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries (Copenhagen Accord, 2009).

A local threat to these national efforts comes from recent political proposals from business interests and moderate politicians seeking to reform and limit the power of the Brazilian Forest Code (Tollefson, 2010). State actors and local stakeholders argue for more local flexibility in achieving national goals. Suggested reforms would place more land under state instead of federal management, exempt smaller landholders from forest reserve provisions, and provide amnesty to some landholders violating the Forest Code provisions. However, inconsistent conflicting resource management strategies in a single watershed could lead to ineffective protections, as forest reserve land is less effective at sustaining biodiversity when split into smaller swaths. For example, a federally administered stream bed could be protected while state-administered hillsides on either side are logged, diminishing the ecological value of stream protection (McKinsey, 2010). A combination of local, regional, and federal jurisdiction over Brazilian policy actions allows flexibility and important official acknowledgement of local differences, but it can also slow implementation of wide-reaching policies aimed at major global challenges like deforestation and climate change. Local input, participation, and acceptance is vital to the success of forest policy: since national and international directives often dictate actions that bar local access to immediate economic opportunity, successful implementation depends on local cooperation. However, without a national- and

global-scale perspective to identify priorities and consistent policy, efficient and effective forest protection is challenging.

BRAZILIAN WATER POLICY

While split state-federal control is a new concept in Brazilian forest policy, it is not new to Brazilian water policy or many of Brazil's other national policies. Though the split control can slow implementation of sweeping reform, it can also aid long-term success. Brazil's split control water policy could be a strength in the face of rapidly changing water conditions under climate change and population growth, as it allows for highly localized policy tailoring while retaining the strength of a coherent national plan. Brazil has a long history of split local-national policy making. This likely stems from a longstanding problem in Brazilian governance: provinces are too remote from each other for local policymakers to understand the national picture, but national policymakers are unable to accurately determine the needs of local stakeholders and to overcome strong local objections acceptably. This is because of Brazil's size and its limited centralized power. The Brazilian government is unable to overcome local objections because of the economic and physical power of the community in its states. Instead, local stakeholders must be cooperatively engaged by federal law and actors in order to ensure the successful enactment of federal guidelines. This arrangement has been employed in the development of Brazilian water policy. Brazilian water policy is administered by three levels of actor: the municipality, the state, and the federal government.

The federal government sets national policies, goals, and programs. Brazilian water policy is driven by the National Water Resources Plan, which is determined by the National Council on Water Resources and implemented by the National Water Authority. The National Water Authority is the primary regulator for river basins that flow over more than one state ("Brazil", 2010). States only control water resources that are completely within their territory. However, decisions about individual river basins are made by River Basin Committees, which combine stakeholders to decide how to allocate resources and meet national guidelines within an entire watershed, regardless of political boundaries. These committees often include representatives from all levels of government, water users, NGOs, and community members.

The River Basin Committees are guided by Brazil's progressive National Water Resources Plan of 2006, which has several unusual features. It is Latin America's first national water plan and is among the world's first national water plans (WWF, 2006). The National Water Resources Plan directs attention to the relationships among water, forests, and soil usage, acknowledging the need for integrated water management (WWF, 2006). Through the National Water Resources Plan, Brazil recognizes a human right to water; the United Nations did not declare a human right to water until 2010 (South Centre). Brazil's Plan also declares that river basins are the best unit for water resource management and that management needs to be decentralized and involve all stakeholders. According to the National Water Resources Plan, the goals of water management should be to allow for multiple uses for water resources and to manage water resource quantity and quality according to use (United, 2005). The policy also states that water should be managed as a resource

with economic value. However, in times of shortage, preference is given to human consumption, thus valuing the small amount of water needed to sustain individual life and health highly without having to employ complicated rate structures.

These provisions are fairly progressive and have fostered bulk tariffs for all water use in Brazil along with voluntary consumption reduction in some communities. In addition, the federal government has created numerous programs to help municipalities improve their water supply infrastructure while supporting other community goals ("Brazil", 2010). The highly decentralized nature of Brazil's water policymaking structure means that there is wide variance from state to state and river basin to river basin. In addition, while programs from the federal government and states have been successful in increasing access to water and sanitation, there has been little progress towards resolving Brazil's pending urban water crisis (United, 2005).

The Brazilian government is not the only stakeholder in Brazil's water policy. There has been a strong grassroots movement in Brazil to find ways to improve Brazilian standards of living without degrading the nation's natural resources. Farmers' groups have been strong supporters of the currently strict water and forestry laws because strict laws protect small farmers against larger agribusiness operations (United, 2005). International NGOs have also provided technical and financial support to Brazil's water infrastructure. Most notably, the World Bank has loaned over $100 million USD to Brazilian states for water development ("Brazil", 2010).

POLICY CHALLENGES

Even with these combined domestic and international resources, Brazil faces several critical challenges in structuring its environmental policies. First, while Brazil has made significant strides in providing access to basic water supply and sanitation, there are still vast underserved segments of the population. Second, Brazil has to resolve the conflict between negative effects of climate change and expected population growth in coastal cities. Finally, Brazil's current rates of Amazonian deforestation and land use change present major challenges to attainment of national greenhouse gas and water resource protection goals. The easiest solutions to these problems, including a halt to deforestation and development, can conflict with Brazil's economic goals and societal trends. Solutions that prioritize global concerns like ecological conservation and reduced emissions at the expense of Brazil's economy are likely politically unachievable. More complicated solutions will have to be designed, but there is precedent for combining ecological goals with development and cost-savings. For example, New York City was able to replace plans for a US$4 billion wastewater treatment plant with a US$2 billion investment in protecting upstream watersheds (Bradley, 2010). Similar programs in the Amazon could help Brazil meet climate, ecological, and water quality and supply goals simultaneously.

Brazil's current water infrastructure problems have two main prongs: rural domestic access and national sewerage and sewage treatment infrastructure. While 99% of urban domestic users have access to improved water systems and 87% of urban domestic users have access to improved sanitation systems, these figures are 84% and 37% for rural domestic users, respectively. Only 53% of urban and 5% of

rural domestic users are served by sewerage systems: the remaining improved sanitation systems are more rudimentary. Further exacerbating water quality problems, including widespread waterborne illness, only about 35% of Brazil's collected sewage is treated (UNICEF, 2009). Particularly in urban areas, this assessment is complicated by the large numbers of illegal residences, often built improperly, that increase the number of residents without sewer access above the official numbers. In São Paulo, a metropolis of 40 million people, an estimated 30% of water intended for human consumption is lost to leaks and thefts in slums. São Paulo's water treatment costs have quadrupled since 1996 as levels of water pollution and sedimentation increase (Bradley, 2010).

The lack of adequate sewage treatment creates a two-fold problem. First, the reduced sanitation is a problem for residents, and the health effects stemming from improperly treated wastewater can have significant societal impacts. Second, as São Paulo has experienced, the untreated wastewater creates issues for downstream users by substantially reducing water quality. This problem is exacerbated by Brazil's high population density in downstream coastal regions. This coastal density allows small, upstream urban communities with less capacity to treat sewage to contaminate the water supply for a much larger city downstream (United, 2005). Access to improved water supplies and sanitation is predictably worse in rural Brazil,.This lack of access not only limits the standard of living of rural Brazilians: it also creates health concerns, as a significant portion of Brazil's rural population is at risk for waterborne illness from substandard drinking water. Though Brazil's overwhelmingly (86%) urban population (Global Water Intelligence, 2010) somewhat mitigates the impact of rural supply constraints, it magnifies the significance of urban sanitation deficiencies and upstream (urban and rural) sewage-based water contamination. Additionally, the impacts of climate change and rapid deforestation are likely to further reduce opportunity and standard of living for Brazil's rural population, which largely depends on subsistence farming in the Amazon Basin.. This creates an unfortunate feedback loop, as the rural poor have the greatest incentive to engage in destructive slash-and-burn agriculture because of the lack of alternatives.

In addition to current concerns with urban sanitation, Brazil's population centers are also facing predicted water supply constraints in the future. Most of the population of Brazil are in river basins with already strained water resources (Parry, 2007). These basins, are expected to have significantly decreased rainfall levels in the next thirty years due to climate change (Solomon, 2007). However, demographic models show continued growth in these Brazilian cities. This will become a major issue for Brazil. Solutions like marshaling local water resources more effectively, reducing local demand, or importing water are insufficient to solve the problem individually. Success will likely require a combination of all these options. In particular, northeastern Brazil is expected to undergo an ecological shift from semi-arid to arid, making it one of the locales most impacted by climate change (Parry, 2007).

While some ecological shifts are inevitable, Brazil needs to prevent more of the Amazon from being deforested by drought or human action in order to preserve ecological and water resources while slowing its contributions to climate change. Brazil is a disproportionate greenhouse gas emitter, and to prevent Amazonian die-

back due to locally reduced rainfall caused by global climate change, Brazil must cut its emissions (McKinsey, 2010). The largest single emissions category from Brazil is in land use change. By deforesting the Amazon and burning land cover, Brazil both decreases the amount the forest can capture and increases Brazil's actual emissions (Metz, 2007). Brazil has made considerable strides in reducing its deforestation as technology has helped the government enforce the Forest Code, but these advances could be undone quickly by any relaxing of regulation.

Brazil has made some strides towards achieving ambitious goals, but those goals are far from achieved and Brazil's policies still face significant social and political obstacles (McKinsey, 2010).The first obstacle to overcome is establishing whether environmental goals are worthwhile investments for Brazil: in particular, whether they are worth the opportunity cost of prioritizing over other dire socioeconomic issues (Metz, 2007). While Brazil's urban water issues must be addressed, Brazil's economy could adapt to an Amazonian savannah and farmland. However, that land use shift could have dire consequences for Brazil's water supply, as forests help to capture, store, and filter water (Bradley, 2010). Such a shift also has implications for global climate change and the international community is pressuring Brazil to prevent anthropogenic hastening of the land use transition. Due to Brazil's decentralized policymaking process where state and local bodies have considerable say in how local resources are allocated, the most affected populations must approve of any federal government responses to international pressures. The Brazilian government should then ensure that all stakeholders are educated on the positive impacts of federal policy in the long-term and should continue to provide alternatives for stakeholders whose livelihoods are impacted by conservation efforts (Metz, 2007).

CONCLUSIONS

Even if the population and the government support the expansion of Brazil's water infrastructure and the protection of forests, these two goals themselves will compete for limited financial and human resources. This situation will be complicated by the fact that urban water infrastructure issues directly affect a larger portion of the population than Amazonian deforestation, though Amazonian deforestation indirectly affects all of Brazil and the world. Brazil's National Water Authority is a body with limited resources that is responsible both for water protection and water supply and treatment, and climate change could threaten the effectiveness of Brazil's water policy by overtaxing its ability to respond to major problems.

To resolve these conflicts Brazil must utilize all of the structural advantages of its decentralized policymaking while leveraging the ability of the federal government to set standards and incentivize behavior. The decentralized policymaking process allows for considerable input from stakeholders and creativity in resolving issues (Metz, 2007). This can create more efficient policy as local conditions are taken into account. Since stakeholders have a say in the process, they are more likely to support the polices that result. However, unless the stakeholders are properly educated about the depths and complexities of the issues at hand they will be unable to make efficient decisions. The federal government is the actor best equipped and positioned to do that task for the country as a whole, especially because the federal government is equipped

to interact with the international community. Through educational programs and outreach efforts, the federal government can give stakeholders the big picture perspective required to make long-term decisions (Metz, 2007). However, if the system of economic and social incentives favors short-term decisions over long-term decisions, then stakeholders will tend to choose the short-term advantages. To achieve its environmental and social goals, the federal government must also structure national policy and incentive programs to counteract natural short-term incentives caused by markets, instead incentivizing sustainable and long-term goal focused policies.

REFERENCES

Adam, D. "Amazon could shrink by 85% due to climate change, scientists say." *The Guardian*. N.p., 11 Mar. 2009. Web. 10 Jan. 2011.

Bates, B. C., Z. W. Kundzewicz, S. Wu, and J. P. Palutikof, eds. *Climate Change and Water*. Tech. no. 6. Geneva: IPCC Secretariat, 2008. Web.

Benjamin, A H, C L Marques, and C Tinker. "The Water Giant Awakes: An Overview of Water Law in Brazil." *Texas Law Review* 83 (2005): 2185-2244. Web. 10 Jan. 2011.

Bradley, T. "Brazilian Water Protection a $100 Million Market?" *National Geographic News*. N.p., 4 June 2010. Web. 10 Jan. 2011.

"Brazil." *Aquastat*. United Nations Food and Agriculture Organization. 2010. Web.

"Brazil approves national water plan." *WWF*. N.p., 8 Feb. 2006. Web. 10 Jan. 2011.

"Brazil." *Global Water Intelligence*. Pinsent Masons, 2010. Web. 10 Jan. 2011.

"Brazil." *Joint Monitoring Programme for Water Supply and Sanitation*. WHO/UNICEF, Mar. 2010. Web. 10 Jan. 2011.

"Copenhagen Accord." 15th Conference of the Parties to the United Nations Framework Convention on Climate Change, December 2009. *UNFCCC*. Web. 10 Jan. 2011.

Government of Brazil. Portal Brazil. *Brazil Urges COP 16 Countries to Do More, Faster*. Brazil.gov.br. 12 Feb. 2010 Web.

Izquierdo, S. "Amazon Deforestation Rises Sharply in 2007." *USA Today*. N.p., 24 Jan. 2008. Web. 10 Jan. 2011..

Junior, Judicael Clevelario. *Water Statistics in Brazil: an Overview*. Vienna, Austria: International Work Session on Water Statistics. 20 June 2005.

Lindsey, R. "From Forest to Field: How Fire is Transforming the Amazon." *Earth Observatory*. NASA, 8 June 2004. Web. 10 Jan. 2011.

Marengo, J. *Regional Climate Change Scenarios for South America-The CREAS project*. United Nations, 2009. Web. 10 Jan. 2011

McKinsey & Company. *Pathways to a Low-Carbon Economy for Brazil.* São Paulo, Brazil: McKinsey & Company, 2010

Metz, B., O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer eds. *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press, 2007. Web.

Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson eds. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press, 2007. Web.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller eds. *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press, 2007. Web.

Tollefson, Jeff. "The Great Beyond: Proposal to Scale Back Brazilian Forest Code Advances." Web log post. *Nature.com Blogs: Home*. 06 July 2010. Web. 10 Jan. 2011.

"UN Recognises Water As A Human Right." *South Centre*. N.p., 2010. Web. 11 Dec. 2010..

United Nations Development Programme, United Nations Environment Programme, The World Bank, and World Resources Institute. "World Resources 2005 -- The Wealth of the Poor: Managing Ecosystems to Fight Poverty." World Resources Institute. Web.