

# Deforestation in the Brazilian Amazon

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## ABSTRACT

This essay takes a (green) criminological and multidisciplinary perspective on deforestation in the Brazilian Amazon, by focusing on the crimes and damages that are associated with Amazonian deforestation. The analysis and results are partly based on longer ethnographic stays in North Brazil (Amazon region). It focuses on the human victimization of deforestation such as violence against forest inhabitants, which is usually committed by large landholders (e.g., cattle and soy farmers, timber traders) or their henchmen. Ultimately, deforestation also leads to the disappearance of communities and traditional lifestyles. This essay takes a more sociological and political science perspective on the question of why (illegal) Amazonia is accompanied by so much deforestation-related crime and violence, and on the question as to how and why Amazonian deforestation has arrived on the political agenda. The prolonged drought of 2014 and 2015 in populous southern Brazil seems to change the Brazilian debate and discourse with regard to deforestation and development.

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*At first I thought I was fighting to save rubber trees, then I thought I was fighting to save the Amazon rainforest. Now I realise I am fighting for humanity.*

Chico Mendes

## 12.3.1 INTRODUCTION

On December 22, 1988, rubber tapper and defender of the Amazon, Chico Mendes, was murdered deep in the Amazon near the Brazilian–Bolivian border. Global news headlines made Chico Mendes an internationally recognized icon and martyr for the protection of the Amazon rain forest—also called Amazonia—which is by far the planet’s largest tropical rain forest that covers parts of nine countries.

Chico Mendes' murder, committed by the son of a rancher, led to a wave of international concern and protests about Amazonian deforestation. Deforestation in Brazil—where two-thirds of Amazonia lie—received much attention from scientists, journalists, NGOs, policy-makers, writers, celebrities, and the general public (Shoumatoff, 1990). A few years after the unfortunate incident, the 1992 Earth Summit in Rio de Janeiro took place with over 100 heads of state or government present. One of the three major outcomes was the Statement of Forest Principles, aimed at attaining sustainable forest management worldwide.

Despite Amazonian deforestation being the focus of widespread attention since the late 1980s, the process has not stopped. The speed of Amazonian deforestation has since decreased considerably, but deforestation through logging, burning, and land conversion nonetheless continues. One human generation after Mendes' murder, Amazonian rain forest still disappears with an average speed of more than one football pitch per minute.<sup>1</sup> A substantial part—according to different estimates for the timber, cattle, and soy between 60% and 90%—of this deforestation in the Brazilian Amazon has been illegal; it thus concerns crime. However, Brazil's new Forest Code of 2012 granted amnesty to some illegal deforestation prior to 2008, which makes it difficult to determine how much deforestation can now be considered illegal. (Boekhout van Solinge, 2010a,b, Lawson, 2014, 24–36).

The violence against people trying to protect the Amazon rain forest has continued during the 27 years that have passed since Mendes' murder. As Amazonia is home to millions of people, deforestation meets resistance, first and foremost from the people living in or near the forest. Chico Mendes still is the most recognized victim, but many more people have been killed for their efforts to protect and preserve the Amazon rain forest. The report *Deadly Environment* by Global Witness (2014) showed that worldwide, 900 environmental protector people were killed during the last decade; 448 of them occurred in Brazil and many in the Brazilian Amazon, with two Brazilian states (Pará and Mato Grosso) standing out as being particularly violent. Hence, much Amazonian deforestation is illegal and strongly associated with violent crimes.

This essay gives an overview of deforestation in the Brazilian Amazon. What are the trends, geographical patterns, and driving forces behind Amazonian deforestation? Why is this deforestation so strongly associated with violence and

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1. One football field of Amazon rain forest disappearing per minute means that 60 disappear every hour and 1440 every day (of 24 h). On a yearly basis this comes down to 525,600 football fields. Considering that a standard football pitch of many professional teams measures 7140 m<sup>2</sup> (105 by 68 m) 525,600 pitches equals 3753 km<sup>2</sup>. Over the last few years, deforestation in the Brazil Amazon was larger: respectively 4571 km<sup>2</sup> in 2012 (1.2 pitch per minute), 5891 km<sup>2</sup> in 2013 (1.6 pitch per minute), and 4.848 km<sup>2</sup> in 2014 (1.3 pitch per minute). In previous decades, however, the destruction of Amazonian rain forest occurred several times faster (see further). It should be noted that some football pitches are smaller. Nobre (2014) 23, for example, uses a smaller pitch of 4136 m<sup>2</sup> as a basis for calculating Amazonian deforestation in number of football fields, which logically leads to a higher number of “deforested (football) fields.”

who are the (main) victims and perpetrators? Also addressed is the perception or framing of the Amazonian deforestation question. What is being done—or not—to limit Amazonian deforestation and its associated crimes and damages, and which arguments are used? In this essay, the Amazonian deforestation of the late 1980s, when it came on the political agenda, will be juxtaposed with today's situation. What has changed and what has remained unchanged?

### 12.3.2 THEORETICAL PERSPECTIVES AND METHODS

Deforestation can be studied from several academic perspectives. An uncommon perspective is from criminology, although one could argue that this is logical, considering that most tropical deforestation is not only illegal, but is also related to other deforestation-related crimes such as violence and corruption (Boekhout van Solinge, 2014a). Still, one can count on one hand the number of criminologists studying illegal deforestation.

Criminology can be simply defined as the study of crime, but a more common approach among practitioners—mostly social scientists—is that it looks at crime as a social phenomena. According to a much used definition by Edwin Sutherland (1883–1950), it includes the process of making law, of breaking laws, and the social reaction toward the breaking of law (Sutherland et al., 1992, 3).

Criminology's young and small branch, green criminology, which has existed as such for a decade or so, has expanded the study area in two ways. First, green criminology distances itself from the traditional anthropocentric demarcation of the domain of conventional criminology. Whereas most criminologists are preoccupied with acts against humans, green criminologists have included acts of harm and violence against animals and ecosystems as well. A second way in which green criminology has expanded the terrain of criminology is by not only considering acts that are criminalized—as conventional criminology does—but also by taking harm as a point of departure (Beirne and South, 2007). Although (expected or perceived) harm is generally the basis for criminalizing certain behavior, no direct relationship exists between the extent of harm and the extent to which something is criminalized (in terms of punishment or other sanctions). Also morals, power, and the level of knowledge or ignorance about certain activities influence whether they are considered harmful and consequently declared illegal. Put differently, there is not always a congruent relationship between the extent of harm and the extent of criminalization. Some acts that are (severely) criminalized<sup>2</sup> are in reality not so harmful, whereas some harmful acts are not criminalized—or they are criminalized but not enforced.

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2. Here one could think, for example, of certain psychoactive substances. Several medical studies (published, for example, in *The Lancet* or *British Medical Journal*) have shown that there is no direct or logical relationship between the criminalization of certain illicit drugs and the harm or danger they pose to consumers. The way societies and the “international community” (such as the UN) deals with psychoactive substances is the author's former area of specialization (see for example Boekhout van Solinge (2004)).

Tropical deforestation is a good example of something that is clearly harmful, but which is not correspondingly criminalized and enforced. The different human and nonhuman harms that are related to tropical deforestation, such as in the planet's largest rain forest, Amazonia, are the subject of discussion in this essay. These damages and risks, including crimes, are addressed by using data from various disciplines.

Different research methods were used for this essay. Scientific literature was consulted, as well as reports from NGOs and news sources. Some Web sites were also used to gather information about forest cover in the Amazon, in particular, the recent and valuable Web site of Global Forest Watch.<sup>3</sup>

Anthropological methods were also used, as the author lived halftime in the Brazilian Amazon between 2009 and 2012; first in Amazonas state, later in Pará state (Boekhout van Solinge, 2014b).<sup>4</sup> Amazonas and Pará are Brazil's largest states—each measuring more than twice continental (metropolitan) France.<sup>5</sup> They are located in northern Brazil, around the Amazon River. Pará is located in the lower Amazon, where the Amazon River flows into the Atlantic Ocean, and Amazonas is located upstream, west of Pará. The difference in forest cover between these two states is enormous. Although Amazonas is still mostly forested, Pará is known for its high deforestation rates. The author's stays in the two states, and traveling back and forth, mostly by boat and sometimes by plane,<sup>6</sup> helped to understand the dynamics of Amazonian deforestation and the forest's vulnerability to deforestation.<sup>7</sup>

One explanation for the contrasting forest cover between Amazonas and Pará is economical. Amazonas' economy is more industrial, with the capital Manaus being Brazil's industrial center in the north; an urban and industrial enclave in Amazonia, mostly accessed by rivers. The economy of downstream Pará is dominated by natural resource exploitation: forestry, mining, and agriculture. These sectors directly imply deforestation.

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3. See [www.globalforestwatch.org](http://www.globalforestwatch.org)

4. These stays were partly facilitated by a project that he coordinates: Lands and Rights in Troubled Water (LAR), funded by the Dutch Organisation of Scientific Research (NWO). See the blog of this project, [landsandrights.blog.com](http://landsandrights.blog.com). This project is part of an NWO programme on Conflicts and Cooperation over Natural Resources (CoCooN), (see Bavinck et al., 2014).

5. The size of continental or metropolitan France is 551,695 km<sup>2</sup>. The size of Pará state (capital Belém) is 1,248,000 km<sup>2</sup>, which is more than twice France. The size of Amazonas (capital Manaus) is 1,559,000 km<sup>2</sup>, which is almost three times France's size.

6. The most common public transport in the Amazon is by riverboat where the travelers sit or lie in their hammock. From the river, one can notice that Amazonas state has more trees along the riverbanks than Pará state. An aerial view, such as from the airplane from Manaus to Belém, makes the difference in forest cover more obvious. Web sites such as from Global Forest Watch also show the difference.

7. The author lived for some time in the small town of Presidente Figueiredo (Amazonas state) that is surrounded by rain forest. Some of the forest there grows on sand or solid rock. When trees grow on rocks, the tree roots form a horizontal patchwork, or tree root tapestry. If such an area is deforested, it will take many human generations before a forest can come back, if it comes back.

Besides this economic explanation, a criminological or criminal justice explanation is also possible. Whereas the rule of law in Amazonas state is relatively adequate, Pará state is known as the “conflict state” where the rule of law does not function properly (Greenpeace International, 2003).<sup>8</sup> In Pará, a powerful agricultural lobby is present and large landholders traditionally have had much power in the rural and forested areas, which may also mean that in some parts they do, in fact, monopolize the violence.

As Max Weber formulated a century ago, the monopoly on the use of violence is a key characteristic of a (functioning) state. When this monopoly is not in the hand of the state, this undermines the state’s power. The factual power relations in rural and forested Pará are indeed such—more than in Amazonas—that large landholders have much power. State institutions and state actors are not very common, which provides opportunities for other actors, such as large landholders and their henchmen. This also explains why (illegal) deforestation is much more prevalent in Pará than in Amazonas.

The author’s stays in the Brazilian Amazon and work with NGOs influenced the perspective that is taken in this essay.<sup>9</sup> When deforestation is discussed in the western world, the—threatened—nonhuman inhabitants of Amazonia are often emphasized: the flora and especially the fauna. International NGOs commonly emphasize the nonhuman inhabitants of tropical rain forests such as Amazonia. Their public campaigns aimed at raising awareness and money often emphasize the natural beauty. The media have played their part too, familiarizing the public fairly well with Amazonia and its unparalleled biodiversity (Goulding et al. 2003:229).

Staff members of local NGOs in the Brazilian Amazon regularly express being bothered by the fact that international NGOs tend to emphasize the nonhuman victimization of deforestation (Boekhout van Solinge, 2014b). By contrast, local NGOs usually emphasize the human victimization of (illegal) deforestation and the deforestation-related violence.

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8. This difference in the rule of law is something that is widely known among locals, especially among those who are familiar with both states (Pará and Amazonas), such as people from Pará who have moved to Amazonas, for example, to find work in Manaus. Traveling by riverboat between the two states, when one spends one, two, or three days and nights in a hammock, the difference in rule of law between the two states was a subject that the author discussed several times with fellow travelers. Also at other occasions this issue was discussed. In 2012, when the author lived in Pará and visited Amazonas State University in Manaus, he had a conversation with three guards at the reception, one of whom was from Pará. This guard spontaneously started telling his two colleagues from Amazonas about the lawlessness in Pará. “In Pará, there is no law,” he told them. Although his statement was clear, it is more accurate to say that the problem in Pará is the lack of law enforcement.

9. A requirement of the before-mentioned NWO-funded project that the author coordinates is that academic researchers not only work with other academics, but also with NGOs. In the case of Brazil, academics work with two NGOs in the Brazilian Amazon: the Pastoral Land Commission (CPT) and *Terra de Direito*, an NGO with mostly lawyers specializing in land right issues.

Living in Amazonia—following the news, reading, meeting people, and visiting communities—makes one realize that millions of people are living there, in the cities and towns and along rivers and lakes. In line with the dominant, local perspective, the emphasis in this essay is put on the human victimization.

### 12.3.3 THE CONTEXT OF CHICO MENDES' MURDER

As explained at the start of this essay, the international uproar about Amazonian deforestation started after the murder of Chico Mendes in 1988. Who was he and why was he killed?

Chico Mendes was a third-generation rubber tapper. His grandfather had migrated in the early twentieth century from Brazil's northeast to work in the rubber industry (Shoumatoff, 1990). Since the mid-nineteenth century, rubber extraction had been the mainstay of the Amazonian economy. Until the beginning of the twentieth century, the Brazilian Amazon supplied almost all of the world's rubber—in increasing demand since the industrial age—and Amazonian latex made up 40% of Brazil's total exports (Grandin, 2010, 26). This rubber boom attracted national and international migrants; many poor from Brazil's northeast—still the country's poorest region—and merchants from other continents, such as Arab and Jewish merchants from North Africa and the Middle East (Grandin, 2010).<sup>10</sup> Chico Mendes' grandfather was among the poor national migrants who found work in Acre state, in the southwestern Amazon near Bolivia.

As a child during the 1950s, Chico Mendes (1944–1988) started tapping rubber. As Mendes (1989) explained in a book published after his death (based on interviews), ranchers had arrived in Acre during the 1960s and 1970s, turning rain forest into pastureland. This brought them in almost immediate conflict with the already present and often-impoorished rubber tappers, for whom the forest is the main source of livelihood. This land conversion, transforming Amazon rain forest into pastureland, substantially increased much during the 1980s and the conflicts of interest between rubber tappers and ranchers grew sharply.

These conflicts also became more violent, especially from the side of the ranchers. Shoumatoff (1990) described that there were at the time 130 ranchers in Acre. In a period of 20 years they had, supported by their henchmen, *pistoleiros*, driven tens of thousands of rubber tappers out of the forest. Shoumatoff further mentioned that many dozens of union leaders had been killed and that, during the 1980s, over one thousand people had been killed in the struggle over land use in the Brazilian Amazon, but this had only led to two

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10. The rubber boom also attracted people attempting to take seeds from the precious rubber tree, in order to commercialize them elsewhere. It led to the historical case of eco-piracy when in 1876 the Briton, Henry Wickham, smuggled some 70,000 rubber seeds out of the Brazilian Amazon to England. They were later shipped to British tropical Asia to help start rubber plantations. Eventually this would lead to the demise of the Amazonian economy until far into the twentieth century (see Jackson, 2008).

condemnations. Also, local policemen had either been paid off or they were afraid, as most murders did not lead to court cases.

The charismatic and articulate rubber tapper Chico Mendes started organizing rubber tappers in unions. Mendes also increasingly gave speeches, in and outside Brazil, promoting preservation of the Amazon rain forest. In 1987, he went to the United States, where he was invited for the annual meeting of the Inter-American Development Bank. He also met members of the U.S. Senate in Washington. In 1987, he was awarded international prizes from the UN's Environmental Programme and from the Better World Society.

The ranchers increasingly considered him as a troublemaker and threat, which made him a target. As [Shoumatoff \(1990\)](#) described in detail, Mendes had been in danger since the early 1980s, but in 1988, when he received the *anunciado*, the announcing death threat, he knew his last days were counted. He also knew which rancher family was going to kill him, as they had openly announced it—a sign of the climate of impunity that was and still is prevalent in many places in the Brazilian Amazon.

#### 12.3.4 AMAZONIAN DEFORESTATION ON THE INTERNATIONAL AGENDA

An interesting question is why the murder of a rubber tapper, committed in a remote, southwestern corner of the Amazon rain forest, far from any city, made international headlines. Why did this murder lead to so much international uproar?

One reason is that there already was a certain level of international concern about deforestation in the Amazon since the 1970s, related to the construction of Trans-Amazon Highway of the early 1970s. *Time* and *Newsweek* articles pointed at the possible negative effect of this highway on the Amazon's flora and fauna, which were still largely unknown to the scientific community ([Shoumatoff, 1990](#)).

Second, deforestation in the Amazon was increasing rapidly. [Fearnside \(1982\)](#) noted that deforestation in the Brazilian Amazon grew exponentially in the late 1970s and early 1980s. By the late 1980s, annual forest loss in the Amazon increased to several tens of thousands of square kilometers. This forest loss was mainly caused through burning. Usually it is only at the end of the dry season, in September, that the rain forest is dry enough to successfully burn it.

In 1987, a considerably dry year, at least 80,000 km<sup>2</sup> of Amazon rain forest were destroyed ([Stoddard, 1992, 527](#)), an area almost twice the Netherlands or Switzerland. Some sources even put the forest loss at 200,000 km<sup>2</sup> ([Shoumatoff, 1990](#); [Setzer and Pereira, 1991, 19](#)). Satellites detected over 350,000 fires during the dry season, from June to October ([Simons, 1988](#)). The consequent giant smoke and haze clouds extended over millions of square kilometers. The fires produced so much different emissions—of carbon monoxide, methane, ozone, nitrogen oxides, and others—that it was

comparable to the outburst of a very large volcano. These emissions caused severe atmospheric pollution effects, with possible global implications.<sup>11</sup> Scientists and journalists consequently reported about it in a worrisome manner (Simons, 1988; Setzer and Pereira, 1991, 19).

The year 1988 was another dry one in the Amazon, and large areas of Amazonia went up in smoke again. Smoke clouds rose to 12,000 feet (3.6 km), and as gases and particles, including methane and nitrogen oxides, were lifted up into the jet streams and blown south toward Antarctica, scientists believed that this could affect the stratosphere by directly or indirectly depleting ozone (Simons, 1988). That Amazonian deforestation could negatively affect the ozone layer made Amazonian deforestation a pressing global issue.<sup>12</sup>

Third, next to these possible stratospheric consequences and risks, what was really gaining attention in 1988 were the potential atmospheric consequences of Amazonian deforestation, particularly, global warming. Scientists' warnings started appearing in the media: the releasing into the air of large quantities of carbon, such as from the rain forest's biomass, might be warming up the atmosphere (London and Kelly, 2007, 40).

An important reason as to why this came on the agenda was that 1988 was globally the hottest year on record. Not only the Amazon was hot and dry; North America experienced a heat wave, the so-called North American Drought of 1988. Thus, while the Amazon rain forest in South America suffered from fires, North America experienced a heat wave. The two were easily combined and causally related: the South American Amazon was burning and North Americans were feeling the heat (see London and Kelly, 2007, 40).

Amidst of all these global concerns, Chico Mendes, a rain forest protector from the interior of the Amazon rain forest was killed, which gave the Amazon deforestation disaster a human face. "For the first time, an issue emerged from the jungle with a human element. Not only were trees dying, but people were dying, too. (...) His death reminded the world that there were millions of people living in the Amazon (London and Kelly, 2007, 44)."

### 12.3.5 DEFORESTATION DRIVERS AND MECHANISMS

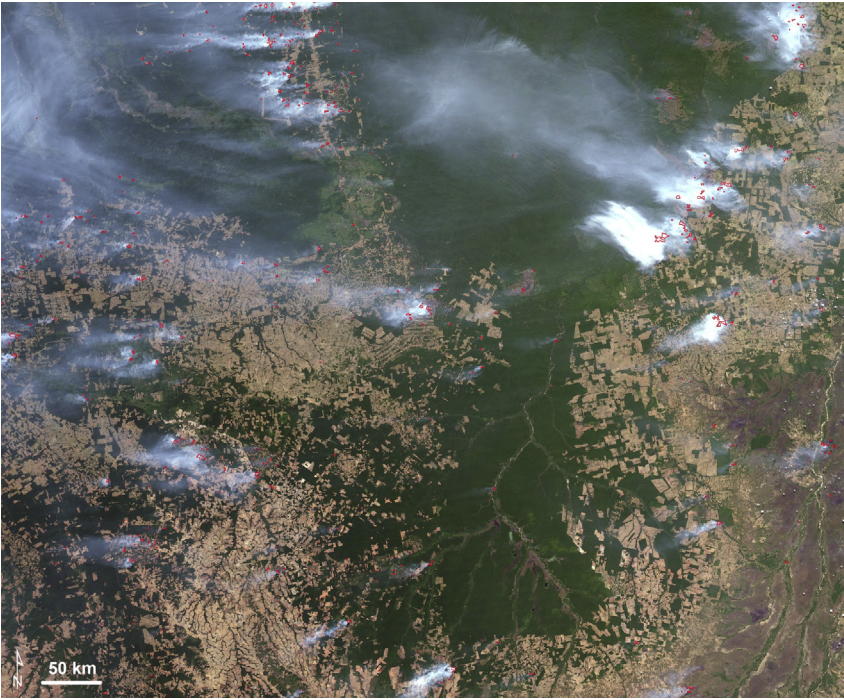
Large-scale deforestation in the Amazon is relatively recent. In 1970, only 2% of the Amazon had been deforested (Loureiro, 2011, 102). Deforestation on a larger scale started in the 1970s, first driven and facilitated by the construction of two roads that would cut through the rain forest.

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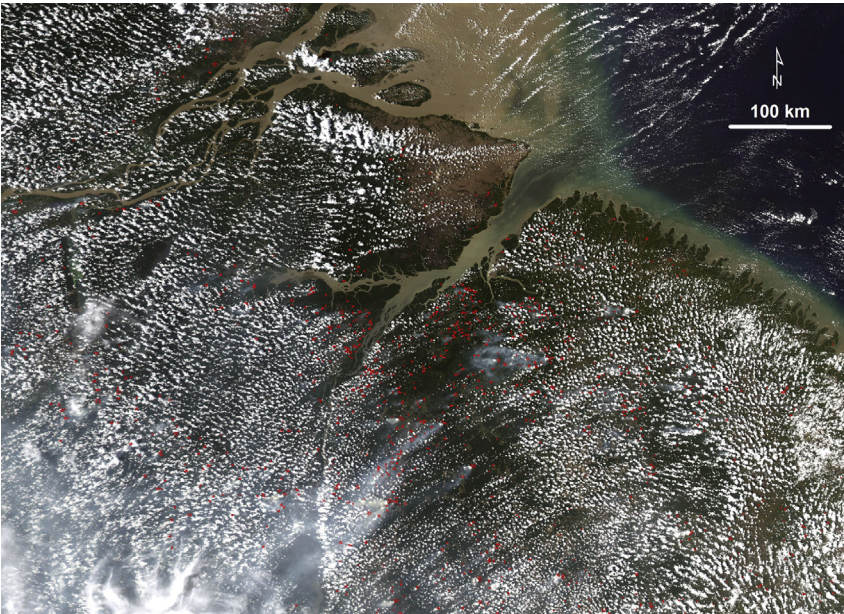
11. In a later article, Setzer and Pereira (1991: 19) made the following estimates of the emissions of the 1987 fires in the Brazilian Amazon, in millions of tonnes: 1700 for CO<sub>2</sub>, 94 for CO, 6 for particulates, 9 for ozone (secondary reactions), 10 for CH<sub>4</sub>, 1 for NO<sub>x</sub>, and 0.1 for CH<sub>3</sub>Cl.

12. At the time, the depleting ozone layer was high on the political agenda. In 1985, the Antarctic ozone hole had been discovered and in 1987 an agreement was reached over an international treaty, the Montreal Protocol, which took effect in 1989.





**PICTURE 12.3.1** Fires in the Brazilian Amazon (Mato Grosso state, August 12, 2007) [http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=18862&eocn=image&eoci=related\\_image](http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=18862&eocn=image&eoci=related_image) Text: Deforestation and fires in Mato Grosso state are marked in red (August 12, 2007).



**PICTURE 12.3.2** Fires at the Amazon River mouth (Pará state, November 22, 2004) [http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=14225&eocn=image&eoci=related\\_image](http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=14225&eocn=image&eoci=related_image) Text: Numerous fires burning (in red) near the Amazon River mouth in Brazil's Pará state.

In 1970, the Brazilian military government made a commitment to integrate the relatively “disconnected” Amazon basin with the rest of the economy (Goulding et al., 2003, 56). Roads were a key first step. Military and geopolitical reasons also existed for them, to be able to better control the Brazilian Amazon, which represents 40% of Brazil’s territory and which is immensely rich in natural resources. Not only does this refer to well-known resources such as gold and iron—for example, the world’s largest iron mine is located in the lower Amazon—but water as well. After all, the Amazon basin is by far the world’s largest river basin. And Brazil is heavily dependent on water for its national energy supplies; today 80% of all energy comes from hydroelectric sources.

Trans-Amazonian roads would also enable settlers to colonize the Amazon. In order to reduce poverty, Brazil started a colonization program, aimed at transferring Brazilians from the poor northeast to the Amazon. Initially, most Brazilian colonists migrated to the southwestern part of the Brazilian Amazon (Vosti et al., 2002, 18). Using the road (BR-364) built in 1968, they could easily access the states of Rondônia and Acre, respectively near Bolivia and Peru.

Loggers and ranchers were the first who started clearing forests on a large scale. They would often work together; before a rancher lights a forest, he would commonly allow a timber trader to extract valuable trees. The presence of a road obviously facilitates log transports. In this economic context, the tensions grew between the already present rubber tappers and the later arrival of ranchers, which eventually also led to Mendes’ murder in Acre.

During the late 1980s and 1990s, most large-scale deforestation took place on the other side of the Brazilian Amazon, on the eastern and southeastern side, in the states of Maranhão, Mato Grosso, and Pará. More than half of the forest cleared between 1988 and 1994 occurred in Mato Grosso and Pará (Faminow and Vosti, n.d.). The principal driver during this period was pastureland expansion for livestock grazing.

Since the early twentieth century, most deforestation still occurred in the east and southeastern Amazon, but now a second additional agricultural activity has been expanding and driving Amazonian deforestation: the mechanized cultivation of soybeans that are mostly destined for exports to Asia and Europe, where they are mainly used as animal feed (Boekhout van Solinge and Kuijpers, 2013, 209). Brazil’s soy production has grown impressively and Brazil has become, after the US, the second largest soy producer and exporter.<sup>13</sup>

Large-scale soybean cultivation started in southern Brazil in the 1960s and its cultivation has gradually moved northward toward Central Brazil, such as to today’s Brazil’s “soy heartland,” Mato Grosso state. The southern half of Mato Grosso has a dry savannah climate whereas the northern humid half is part of the Amazon biome. After Brazilian scientists developed a new soybean variety that could grow in humid climates, the soybean frontier moved farther

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13. See e.g., the Web site [soystats.com](http://soystats.com), or see [www.fao.org](http://www.fao.org).

north into the Amazon. This started in the northern part of Mato Grosso, and later moved to Pará state as well, stimulated by the Pará state government which saw much economic potential in soy cultivation (Steward, 2007).

Since 2004, soy has been cultivated near the Amazon River and in the lower or eastern Amazon, particularly near the town Santarém, situated at the confluence of the clearwater Tapajós River and the Amazon River. Local businessmen from the town Santarém, together with Pará state officials had traveled to Mato Grosso in order to stimulate soy producers to invest in the Santarém region (Steward, 2007, 113). But what really prompted soy farmers from central and southern Brazil to go there, was the—initially illegal (Santana 2010)—Cargill-led construction of a soy export harbor in Santarém (Boekhout van Solinge and Kuijpers, 2013).<sup>14</sup> This soy export harbor in the west of Pará state, at some 700 km from the river mouth, was built for logistical reasons: to export soy from Central Brazil. An indirect effect of the harbor, however, was that it attracted soy farmers from south and central Brazil to the lower Amazon, which led to much (illegal) deforestation in the Santarém region (see also Boekhout van Solinge, 2014b).

In the process of Amazonian deforestation, logging, and land conversion often go hand-in-hand. The conversion of rain forest to agriculture is the main driver of Amazonian deforestation. As mentioned before, much of this happens illegally, as many farmers deforest (much) more than is allowed (Lawson, 2014, 35–36). Both ranchers and soy farmers often work together with loggers, who generally take out commercially attractive trees before the forest is burned and cleared in the dry season. Logging thus has remained an economic driver for deforestation as well and the Brazilian Amazon continues to export much illegal timber, especially from notorious “conflict state” Pará.

Environmental inspectors (e.g., IBAMA) do exist, but their presence and enforcement is quite weak in Pará state. Considering that environmental inspectors in the Amazon may face threats from farmers and loggers, they may prefer to be bribed (see also London and Kelly, 2007). Brazil’s Forest Code states that if a farmer controls a piece of forestland, a maximum of 20% can be cleared. However, landholders commonly remove more, as this law is not well enforced, especially in “conflict state” Pará. It also regularly happens that inspectors are corrupt. In 2014, the Federal Police shut down the IBAMA office in Santarém, Pará. This closure was related to a huge quantity of illegal timber (500,000 m<sup>3</sup>) that was “legalized” by hackers who obtained access to the governmental timber monitoring system (Boekhout van Solinge, 2014b).

When the state intervenes and gives fines to timber traders or loggers, it is generally known that most of the fines are not paid (Lawson and MacFaul, 2010, 15). In practice, a general lack of law enforcement and monitoring occurs.

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14. The harbor construction was allegedly illegal because the legally required Environmental Impact Assessment was not executed.

The problem is acknowledged at the Federal level in Brazil, where corruption is lower than the state or local level, and improvements are being made, but there still is a long way to go.<sup>15</sup> The state and its institutions need to perform better in order to limit illegal deforestation and deforestation-related crimes.

As [Acemogul and Robinson \(2012\)](#) argued in their noted book *Why Nations Fail*, well-functioning institutions make the difference whether countries perform well economically or not. The problem of Amazonian deforestation and deforestation-related crimes, however, is not only the weak functioning of the state and some of its institutions. Responsible behavior of private actors and the monitoring or governance of private actors' promises—such as codes of conduct and corporate social responsibility—also need improvements. For example, the soy moratorium, a promise of private actors to no longer buy soy that is grown on recently deforested land, has resulted in less soy-led deforestation (see [Gibbs et al., 2015](#)). However, in the region of Santarém in western Pará, deforestation for soy continues. Some of the claims, such as by soy-giant Cargill, that deforestation has stopped since 2006 in the Santarém area, do not correspond with what locals say and what satellites show ([Boekhout van Solinge, 2014b](#)).

Beef and soy, in combination with timber extraction, are the chief proximate agricultural drivers of Amazonian deforestation. However, as a substantial part of the beef, leather, soy and timber are for export markets, global demand for meat and timber indirectly influences deforestation in Brazil. This shows that it is thus too simple to solely blame “the Brazilians” for this deforestation, as this would only highlight the supply side of the problem, and ignore the demand side or destination markets of timber, cattle, and soy.

### 12.3.6 AMAZONIAN (DEFORESTATION) SCALES AND TRENDS

At the time of Chico Mendes's murder in the late 1980s, around 10% of the Amazon had been deforested. Today this has doubled to around 19%; 80% of which occurred in Brazil. The area of the Amazon that has been deforested to date is generally estimated to be around 762,979 km<sup>2</sup> ([Nobre, 2014](#)). This is an area larger than the size of two Germanys or two Japans. It should be noted, however, that an even larger part of Amazonia is considered degraded: an estimated 1,225,100 km<sup>2</sup> ([Nobre, 2014](#): 24). The latter figure is commonly not taken into account when Amazonian deforestation is discussed. What is also often underestimated and not observed by most satellite systems that only detect large-scale deforestation is the effect of selective

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15. An example of a recent improvement is a special anti-logging security force that was created early 2015. However, although enforcement may improve with regard to illegal logging, illegal deforestation for land conversion (for agriculture) seems to get less attention. It is known that at state level (such as in Pará and Mato Grosso) as well as Federal level the agricultural lobby is powerful.



logging on deforestation. When selective logging is factored in, deforestation in the Amazon might actually be twice as high as the conventional (governmental) satellite surveys reveal (Asner et al., 2005). Ecologists think that if 30–40% of the forest cover were to be removed, the Amazon would be pushed into a permanently drier climate (Verweij et al., 2009: 7, 32, Nobre, 2014).

A relative positive trend is that the general level of deforestation today is much lower than in the late 1980s. Between 1988 and 2006, the annual deforestation rate in the Brazilian Amazon averaged 18,100 km<sup>2</sup> (Malhi et al., 2008, 169). This is comparable to forest areas being destroyed almost half the size of the Netherlands or Switzerland. A deforestation peak occurred in the mid-1990s (such as 1995 with 29,000 km<sup>2</sup>) and also in 2003 and 2004 (respectively 25,000 and 27,000 km<sup>2</sup>), but since 2004 a clear downward deforestation trend has occurred.

Since 2009, annual deforestation in the Brazilian Amazon has been under 10,000 km<sup>2</sup> and since 2012 it has been around 5000 km<sup>2</sup> per year.<sup>16</sup> This is the equivalent of 80 football pitches per hour, or 1.3 pitch per minute of Amazon rain forest that is destroyed in Brazil.<sup>17</sup> The general downward trend since 2004 was broken in 2013, when deforestation suddenly increased by 29% as compared to 2012 (from 4571 km<sup>2</sup> in 2012 to 5891 km<sup>2</sup> in 2013), but in 2014 deforestation decreased again to 4848 km<sup>2</sup>, which is still higher than in 2012.

On an aggregate level, cattle ranching has been responsible for some 70% of deforestation of the Brazilian Amazon (Malhi et al., 2008, 169). Brazil's cattle herd has grown rapidly and especially in the Amazon. Brazil now has, after India, the largest cattle herd, and has become a main producer and exporter of beef and leather. The numbers of cows and steers are now comparable to the number of humans: both are around 200 million. In the Brazilian Amazon, the cattle number is three times higher than the number of people (of 25 million people). The continued expansion of cattle ranches in the Brazilian Amazon has led to a new term, “cattelization” (Verweij et al., 2009), next to the earlier expression “Africanization of the Amazon,” as African grasses for grazing animals replace the rain forest and its rich arboreal fauna (Goulding et al., 2003, 56).

Cattle numbers have grown much particularly in the states Mato Grosso and Pará (Greenpeace Brazil, 2009). Over the last few years, these two states have been responsible for over half of all deforestation in the Brazilian

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16. See the Web site of Brazil's Federal Ministry of the Environment that monitors deforestation with satellites: <http://www.obt.inpe.br/prodes/index/>. Sources such as Wikipedia also use this database. See [http://en.wikipedia.org/wiki/Deforestation\\_of\\_the\\_Amazon\\_Rainforest](http://en.wikipedia.org/wiki/Deforestation_of_the_Amazon_Rainforest).

17. As explained in the first footnote of this contribution, this number is based on a football field size of 7140 m<sup>2</sup> (105 by 68 m). Nobre (2014), 23 takes a smaller football field as a basis for his calculations, which would increase the number of pitches of Amazon rain forest that has disappeared.

Amazon. In 2013 and 2014, 59% of all deforestation occurred in these two states.<sup>18</sup> Cattle ranching has been driving most deforestation in these two states, but some deforestation is attributed to soy cultivation. Soy is, after cattle, the second agricultural driver of Amazonian deforestation.

The dynamics of deforestation in the Amazon are complex. A debate occurs as to whether the more recent mechanized soy cultivation has become a more important driver of Amazonian deforestation than cattle. Barona et al. (2010) studied this question for the period 2000–2006 in Mato Grosso state. Their study showed that deforestation was mainly the result of pasture expansion. However, the study also found evidence for the hypothesis that the growth of the soy industry was indirectly contributing to deforestation, as soybean expansion sometimes replaced pastures, and displaced them into forest areas. The term is used in this context is the soy–beef complex (Verweij et al., 2009, 40). Although common, this does not happen everywhere. In the Santarém area in western Pará, rain forest areas have been transformed directly into soy fields, without the intermediary step of cattle farms (Boekhout van Solinge and Kuijpers, 2013).

A clear geographical trend can be observed with regard to deforestation in the Brazilian Amazon. In the 1970s, it started in the west and southwest of the Brazilian Amazon. In the 1990s, it jumped to the east and southeast of the Brazilian Amazon. Since the early twentieth century the deforestation frontier is moving northward, from Mato Grosso state into Pará State. Hence, besides the major shift from deforestation in the western Amazon to the eastern Amazon, this more recent deforestation frontier in the east is moving from the southeastern Amazon to the northeastern Amazon.

This geographical dimension of deforestation is important in order to understand some of the risks this may entail (Monbiot, 1991). It was already mentioned that the Amazon basin is by far the planet's largest river basin. It occupies more than 6.8 million km<sup>2</sup> and is nearly twice the size of the second largest river basin of the world, the Congo (Goulding et al., 2003, 18). The Amazon River, the largest and main river in the Amazon basin, is by far the planet's largest river in terms of water discharge,<sup>19</sup> discharging 15–16% of all freshwater that is delivered to oceans (Goulding et al., 2003, 26–27).

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18. In Brazil, nine states occur in the Amazon region. See (again) the following Web site where Brazilian deforestation data are located for each state: <http://www.obt.inpe.br/prodes/index.php>. For example, they show that in 2014 in total 4848 km<sup>2</sup> was deforested. 1829 km<sup>2</sup> of it occurred in Pará and 1048 km<sup>2</sup> in Mato Grosso, which together accounts for 59% of the total. In 2013, these two states also accounted for 59% of the total: 2346 km<sup>2</sup> in Pará and 1139 km<sup>2</sup> in Mato Grosso, of a total of 5891 km<sup>2</sup>. If one looks back a few more years, more than half of all deforestation in the Brazilian Amazon occurred in these two states.

19. The Amazon basin contains 14 large rivers, including the largest and best known, the Amazon River. The names of some of the other large rivers in the Amazon River are generally not very known, except among locals. For example, it is not much known that two of the Amazon's transnational tributaries—the Madeira and the Negro—are among the 10 largest rivers of the world (Goulding et al., 2003: 10).

Interestingly, of all the rain that falls in the Amazon basin, only 41% makes it to the sea. Some 59% of the rainwater is recycled back into the atmosphere through evapotranspiration (Goulding et al., 2003, 24). The original source of all this rainwater is the Atlantic Ocean. In South America, eastern winds dominate, bringing evaporated Atlantic Ocean water formed into clouds. Much rain from these clouds first falls in the eastern Amazon and is then recycled back through evapotranspiration several times before reaching the western Amazon and other parts of the continent. In other words, the eastern Amazon can be considered as the first water recycling area; it represents the first phase of a series of water cycles of the Amazonian water pump (Nobre, 2014).<sup>20</sup>

This process is referred to as the theory of the biotic pump of Makarieva and Gorshkov (2007). They argued that land with extended natural forests attracts much more moisture from the sea than land without these forest areas. As natural forests with high leaf indexes maintain high evaporation fluxes, this water evaporation supports the ascending air motion over the forest, which attracts or “sucks in” moist air from the ocean. According to this theory, when a substantial part of the (eastern) Amazon is deforested, less water can be contained in the eastern Amazon that can later be pumped to the western Amazon and elsewhere on the South American continent. Several studies indicate that the Amazon is drier than it used to be as a result of less rain (see Hilker et al., 2014).

### 12.3.6.1 Perpetrators and Victims

That Chico Mendes was murdered by the son of a rancher was not coincidental. The roads of the 1960s and 1970s that cut the Amazon rain forest open brought settlers and farmers, but not all was planned. Unplanned colonization through squatting, the traditional means of settlement, “engendered many bloody fights throughout Amazonia between squatters and either landowners holding documents for legal ownership or the more feared *grileiros*,

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20. See Chapter 1 of Monbiot (1991). That the Amazon rain forest contains so much water can be experienced when living there (but not in the large urban enclave Manaus, which as Monbiot already pointed out, has a climate on its own). The author lived for some time in Presidente Figueiredo (Amazonas state), a small town that is surrounded by rain forest. In the wet season, the humidity is so high that it can take days before clothes are dry, if the days are cloudy. Often, and not only in the rainy season, (heavy) rain falls during the night. During the morning hours the forest (floor) stays wet. During the day, it heats up and water evaporates. Near Santarém in Pará state, the Tapajós National Park has a 45-m high tower with monitoring instruments. In 2014, the author stood on top of the tower at midday when it started to rain. Immediately after the rain stopped, the humidity (clouds) could be observed rising up from the forest. Rainfall is abundant near the Amazon’s river mouth, such as in Pará’s capital Belém, where it rains every early afternoon. The local expression “after the rain,” is much used, such as for setting appointments.

speculators making their living by contracting thugs (*jagunços* or *pistoleiros*) to drive small farmers off the land they occupy (Fearnside, 1984, 50).”

All along the deforestation frontier or deforestation arc in Amazonia, there are land conflicts between recent arrivals, mainly farmers who are often large landholders or land-grabbers (*grileiros*), and the people who already lived there. This includes rubber tappers (Mendes, 1989) and traditional communities: indigenous (who today form a small minority in the Amazon), *quilombos* (descendants of runaway slaves), and *caboclos* (people of mixed Indian and white or Indian and black ancestry). Many traditional forest communities have existed for generations, but the inhabitants never registered officially at a governmental institution. As a result, they do not always have legal papers that show or confirm that they are formally living where they live. Considering that land grabbing is a “way of life” in the Amazon (London and Kelly, 2007, 151), a farmer, large landholder or speculator may turn up one day claiming the land in or around where these communities live. This claim may be supported by documents, that are maybe authentic, and the claim may be strengthened by the presence of some armed men.

In South America and its history of latifundia, the Weberian ideal type of nation-states having the monopoly on violence, does not exist in all territories of states (Koonings and Kruijt, 2004). In other words, the state and its institutions that are supposed to be responsible for public order, control of (non-state) violence, and justice, are not always around. In many parts of Amazonia, large landowners traditionally have had much power; not only political power, but sometimes also in control of the monopoly on violence, through henchmen. It still is a quite common practice that large landholders such as ranchers and soy farmers, in collusion with loggers, use *pistoleiros* to threaten or kill opposition (Monbiot, 1991; Brooks, 2011; Boekhout van Solinge, 2010b, 2014a). Opposition more commonly comes from forest inhabitants or from environmental activists.

Timber traders and farmers can log and deforest illegally and threaten and kill opposition, because in most cases they get away with it. Much of this violence goes unpunished, as there is a climate of impunity. As Amazonian deforestation often goes hand-in-hand with violence and corruption of public officials, it actually fits within the common definitions of organized crime (Boekhout van Solinge, 2014a,b). Boekhout van Solinge (2014b) coined the term violent business subcultures, as agribusinesses and timber traders are often involved as perpetrators.<sup>21</sup>

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21. In Europe, farmers and timber traders are generally considered normal professions without any negative stigma attached to them. In the Brazilian Amazon, this is very different. Large landowners and timber traders often have a bad name among a large part of the population. They have the reputation for being violent, to easily give orders to violence, and for being involved in other illegal activities as well, deforesting or illegal logging, or falsifying paper work. In the Amazon, most parents are not happy if their daughter would date a timber trader.



Violence used against people trying to protect and preserve Amazonia generally does not reach international media. It only seems to reach those media when westerners with access to western media witness the violence (Boekhout van Solinge, 2010a), when the victim is western, or when the victim is an internationally known local. This was the case in 2005 with the murder, in Pará, of Dorothy Stang, a 73-old woman, originally from the USA, defending the Amazon and its inhabitants. It also was the case with the murder of Chico Mendes in 1988, as well as in 2011, when the Da Silvas, a well-known Amazonian activist couple were killed in Pará (Boekhout van Solinge, 2010b).

Since the murder of Chico Mendes, over 1150 people have been killed in the Brazilian Amazon in the context of these types of land disputes over deforestation (Brooks, 2011). The Brazilian NGOs, CPT, and CIMI monitor the violence over land conflicts, but their annual reports rarely reach international media.<sup>22</sup>

The direct human victims of deforestation-related land conflicts are forest inhabitants. Most of them are not indigenous.<sup>23</sup> Indigenous people now form a clear minority in the region of around half a million,<sup>24</sup> out of a total of around 25 million Brazilians who live in the Amazon. However, indigenous populations are clearly overrepresented among the human victims of deforestation, which is partly caused by their lower socioeconomic status.<sup>25</sup> They do have rights, but these rights are often not respected in practice. One subcategory of indigenous tribes is particularly vulnerable: the strongly decreasing (estimated) numbers of tribal groups that (deliberately) live without contact with

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22. CPT (Comissão Pastoral da Terra, Pastoral Land Commission) is a well-known and well respected (by both rural and forest communities, as well as by governmental institutions) NGO that is affiliated to the Catholic Church. CIMI is the Brazilian Missionary Indigenous Council, which also publishes annual reports detailing violence against indigenous people in Brazil.

23. The population that is dominant in quantitative numbers in Amazonia are the so-called *caboclos* (literally copper colored), people who are of mixed Indian/white or Indian/black ancestry. Waves of migration brought different groups: escaped African slaves fleeing into the forest, Europeans, traders from the Middle East, Japanese, Confederates from the United States, and adventurers from different corners.

24. Estimates are that in pre-Colombian times, hence before the Europeans arrived, the human population—obviously exclusively indigenous—in the Amazon region counted several million.

25. In a book by pop artists Sting and Jean-Pierre Dutilleul (1989), the latter writes that a cattle farmer told him that he does not make any difference between Indians and wild pigs. If they come on my land, I shoot them without hesitation, the cattle farmer explains. A similar picture emerges from the book by Dutch journalist and former Brazil correspondent Ineke Holtwijk (2006). For her book about uncontacted tribes, she also met large landholders who basically explain her to not see any problem in killing Indians. Actually, this sometimes is a strategy. The law says that when uncontacted Indians are found to be living in a part of a forest, that piece of forestland will get protected status. This same law can also endanger the Indians. When a farmer interested in that piece of land knows there are Indians living, he might decide to have them killed, as this will mean there is no-one living, which makes exploitation (starting with deforestation) easier. From Holtwijk's book the picture emerges that this is a quite common attitude of ranchers and large landholders.

modern society. The numbers of these sometimes very small tribal groups are dwindling and are now estimated at several dozens. These groups of often seminomadic hunters-gatherers represent the oldest form of human societies and the Amazon is the world's main location where they occur (Boekhout van Solinge, 2010b).

Forest inhabitants are, however, not the only (potential) human victims of Amazonian deforestation. A substantial portion of modern medicines is derived from traditional botanical medicine, in particular, from species-rich tropical rain forests. This botanical knowledge of medicinal usages of plants is especially prevalent among forest inhabitants. Further destroying (Amazonian) rain forest could, in the long run, have repercussions for humanity, as it might mean that potential medicinal plants are being destroyed. Hence, besides the direct human victims, in the long term if future generations are included, indirect victims occur as well. From this perspective, the human victimization of Amazonian deforestation is much larger.

The disappearance of species as a result of Amazon rain forest destruction is especially plausible when one takes into account that biodiversity has geographical dimensions, as Darwin's friend and colleague Alfred R. Wallace already discovered during his mid-nineteenth century research in Amazonia and later Southeast Asia (Boekhout van Solinge, 2008). Wallace developed the river or riverine barrier hypothesis. Amazonia's many waterways, which really form a water labyrinth, seem to have formed barriers that have, in evolutionary terms, led to a differentiation of species.

Tropical rain forests, in general, are the "headquarters of biodiversity," covering 6% of the land surface and containing more than half of the known species (Wilson, 2003, 59). Amazonia represents 40% of the remaining tropical rain forest and is considered the most biodiverse region on the planet, even though large parts are still unexplored by scientists and many specimens that were collected have not been studied yet. Maybe over 50,000 plants still remain to be discovered by science (Verweij et al., 2009, 12). Ten square kilometers of Amazon rain forest contain more plant and animal species than in all of Europe (Wilson, 2003, 62). Destroying (large) parts of Amazonia logically implies that animal and plants species are being lost.

Considering their high biodiversity, tropical rain forests today are in general the "leading abattoir" of species extinction (Wilson, 2003, 59).<sup>26</sup> The destruction of species-rich rain forests such as Amazonia, therefore, contributes to the already ongoing extinction crisis (Leakey and Lewin, 1996). Besides the human victimization, one could argue that many nonhuman victims

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26. One beautiful book that deserves being mentioned here is *The Tree* by Tudge (2006). One of the things that Tudge explains well (pp. 323 and 343–344) is how animals (including insects) are vital for the dispersal of seeds and thus the reproduction of plants and trees. Whereas in temperate climates trees reproduce by using the wind and gravity, in tropical rain forests many trees are dependant on animals for their successful reproduction.

of Amazonian destruction also occur. As much of this destruction is illegal, one could label this as flora and fauna crime.

### 12.3.6.2 Discussion: Deforestation on the Agenda

Deforestation in Brazil is a sensitive political issue to discuss as a foreigner. Ranked fifth in size and population, in combination with its emerging economy, Brazil is increasingly self-confident. Brazil's (educated) middle and upper classes easily perceive criticism on Amazon deforestation as an intermingling into internal Brazilian affairs. Why should Brazil not be allowed to develop itself and use its natural resources for that purpose? A Brazilian viewpoint is that in order to compete with the subsidized agricultural sectors in the Europe and North America, Brazil has to use its relatively unused land in the Amazon.

What seems a quite widespread viewpoint in urban Brazil, such as Brazil's south, is that Brazil is developing and has many issues with which to deal. Amazonian deforestation is a problem, but it does not have priority. What seems a quite common viewpoint in forested Brazil, the Amazon, is that there still remains so much forest and that it is hard to imagine that it will disappear.

The year 1988 spurred international interest in global warming and brought Amazonian deforestation to the forefront with Chico Mendes' murder. Deforestation has been back on the international agenda for a few years. The main reason is global warming. Since 1988, the global average temperatures have increased. The year 1988 was warm at the time, but today 1988 does not even feature in the top 20 warmest years.<sup>27</sup> What has increased as well since 1988, is scientific knowledge about global warming, including knowledge about the share that deforestation causes, which the IPCC (2007) estimates at 18%. Although an influential corporate lobby has attempted to raise doubt about global warming, as Oreskes and Conway (2010) showed in their important book, international agreements aim to limit global warming to 2 °C by 2100.

In September 2014, during a UN Climate Summit in New York, the New York Declaration on Forests was announced. Brazil was not among the signatory countries because it had not been consulted beforehand.<sup>28</sup> Also in September 2014, news reports started appearing in Brazilian media about a drought in central and especially southern Brazil. These reports only increased during the

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27. As remarked James Renwick, of the School of Geography, Environment and Earth Sciences, Victoria University in Wellington, New Zealand. Taken from <http://www.sciencemediacentre.co.nz/2015/01/20/2014-hottest-year-on-record-experts-respond/>. Consulted on March 23, 2015.

28. Brazil's position about climate policies is not entirely clear. Although President Rousseff made statements that suggest she takes global warming seriously, in January 2015 she appointed a new government minister of Science, Technology and Innovation, Aldo Rebelo, who doubts the existence of global warming. See: <http://blogs.edf.org/climatetalks/2015/01/05/climate-change-denier-named-brazils-science-minister/#more-4299>.

following months. Particularly São Paulo, Brazil's economic center and South America's largest city with a population of 20 million, suffered a severe drought and water crisis. As so many Brazilians and also (hydroelectric) energy sources were effected, Brazil's water crisis led to discussions about the cause.

One scientist was getting much attention in Brazil's (social) media: Antonio Nobre, who argued that deforestation in Brazil was a major contributor of the drought. Nobre, a scientist at the Brazil's Centre for Earth Systems Science, had been pointing at the relationship between deforestation and droughts before, but due to Brazil's serious drought, media and public opinion seemed more receptive to his arguments. Nobre (2014) has argued that Amazonia acts like a giant water pump, delivering precipitation across a considerable portion of South America.

Brazil's strong agricultural lobby denied the connection between deforestation and the drought, but it seems that Brazil's drought of 2014/2105 was a wake-up call for the Brazilians, making clear that it is in the general interest and in Brazil's interest to preserve Amazonia. Interestingly, the risk of drought for Brazil's south is one of the potential risks that Mendes (1989) explicitly mentioned in interviews not long before being murdered. This intelligent man from the rain forest, from poor descent, and mostly self-educated, explained that southern Brazil receives rain clouds from the north, the Amazon. The humid Amazon guarantees a constant supply of rain clouds for the south. Amazonian deforestation, he explained, could lead to a drier climate in the south.

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