

# The role of policy making in the Amazon

– A case study of deforestation in Brazil

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# Abstract

This case study investigates what role the government decisions and policies have for deforestation in the Brazilian Amazon. The decisions and policies are part of the immediate causes of deforestation, which exists in a theoretical framework that I have developed. This theoretical framework constitutes of three levels: underlying causes, immediate causes and sources, which lead to deforestation. And through discussing the different causes there are, I have been able to analyze the role that policies and decisions have for deforestation in the Brazilian Amazon. My results show that the government's decisions and policies have had an important role for deforestation during the time period 1990-2005, and impact through underlying causes, mainly economic development projects, supporting the timber market and population pressure; immediate causes such as insecure property rights, policies for increased share of timber market, and weak institutions; sources, such as agricultural expansion, road building, and infrastructure extension. This analysis has shown that the government's decisions are essential causes for forest clearing, however they have influenced in connection with other causes. That the deforestation has been on high levels through out this time period, has therefore been the consequence of multiple factors contributing.

*Key words:* Deforestation, Case study, Brazilian Amazon, Forest policy, Government decisions and policies.

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# 1 Introduction

In the Brazilian Amazon exists a large part of the world's remaining tropical rainforests, with an abundance of biodiversity, and where thousands of species of mammals, birds, plants and reptiles reside (Fearnside 1999:305*f*). However, what is commonly named the arc of deforestation, stretches also through the Brazilian Amazon, which is where the largest forest clearing presently takes place (Lambin – Geist 2003:210). Tropical rainforests store carbon which has great value for the atmosphere, but in the case of deforestation, carbon dioxide emissions are released which contributes to the greenhouse effect and hence poses a threat to the global environment (Reis – Margulis 1992:335*f*; Fearnside 1997:287). The devastation of tropical rainforests in the Amazon is therefore an important environmental problem, for Brazilian policy making, and for international decision-makers (Laurance 1998:414; Fearnside 1999:316). The late 1980s and 1990s were active years regarding forest policy in Brazil, and initiatives to slow deforestation were made. Still the deforestation rates have increased the last decades rather steadily (Banerjee et al 2009:136*f*; Laurance 1998:414). There have been some years where the rates temporarily declined, which could be attributed to governmental decisions and forest protection policies (Banerjee et al 2009:138,142). But policies that encourage agricultural expansion and development has also been frequent, which support the unsustainable use of forest resources and contributes to deforestation (Benhin 2006:11; Bauch et al 2009:132*f*). In addition to policies, there are a number of other causes that also may affect deforestation in the Brazilian Amazon. These are for instance economic and demographic factors, infrastructure extension and agricultural expansion (Geist -Lambin 2002:144). Since there are different factors that could influence deforestation, the interest and aim of this thesis is to find the role of government decisions and policies in a plethora of causes.

## 1.1 Statement of Purpose

My thesis regard the problem of deforestation in the Brazilian Amazon during 1990-2005. The purpose is to analyze what role decisions, and policies, regarding the forest or land use have when it comes to deforestation. Are the government's initiatives the dominating causes to why the forest clearing increases or declines in Brazil? Or does it rather depend on other factors? This is what I strive to understand, by analyzing the different causes there have been for the forest to be cleared during the chosen time period. My question formulation is the following:

*“What role does government decisions have for deforestation  
in the Brazilian Amazon ?”*

Deforestation is of interest in a political science-study for several reasons. Politically, since I believe the management of natural resources, such as forests, depend on governmental and political decisions. And since most of the forests in tropical countries, Brazil included, are state owned or administrated by the government (Humphreys 2006:12), it matters what views or ideology the political leadership has and what initiatives they make. Deforestation is also of interest from a land use perspective, for instance how the land should be divided between agriculture and forest. And it is one of the largest issues presently in global land use (Encyclopædia Britannica). The rapid clearing of forests is of course interesting in regard to the environment, it is a fundamental problem for the atmosphere, ecology and biodiversity, animal and plants, as well as for communities and cities (Pearce - Brown 1996:3). The forests has a global importance for the society, as well as for the survival of many species, which is why conservation and management remains crucial to prioritize in policy making.

This thesis will not however, focus on the biological or physical aspects of deforestation, since the primary object is to understand the role of policies. By applying the chosen theoretical framework, and making a case-study of Brazil, I will be able to gain a thorough knowledge of the role that government decisions have for deforestation in the Brazilian Amazon, and hope to contribute to the existing research on the area.

## 1.2 Method and Material

The method I am using for the analysis, is a qualitative case study, which falls under the category of intensive research, since I have only one case. It is a theory consuming and mostly descriptive study, because I will use different theories on the case, in order to find causes and describe the role of the government decisions. Descriptive studies have an intrinsic value, since it is impossible to explain something before describing it (Teorell – Svensson 2007:23). And since an actual causal mechanism is impossible to observe (Teorell – Svensson 2007:28), I strive to understand the role of policy making in the Brazilian Amazon rather than explain it. I chose this method to be able to gain a profound understanding of only one case, and from that try to draw well-grounded conclusions, which would have been harder with more cases. I considered a broader approach to analyze all of the countries that have part of the Amazon Rainforest, and thus an extensive research. But this would in the end not give deep understanding of the causes of deforestation. I also thought of making a comparative study with three cases, this would be of interest since I could compare the countries different policies regarding the forests. But since the research of the cases needed to be intensive, it would be to comprising and hence not fit the extent of this thesis.

The case study could be said to have applicable characteristics, since I will apply disparate theories to gain understanding. This type of study is generally used on “heavy cases”, which there are good reasons to choose to analyze (Gustavsson 2010, 19/3). That the Brazilian Amazon is such a case is argued in the chapter of Definitions and Limitations. Within this case study I strive for good validity, the absence of systematical measuring faults, and good reliability, the absence of unsystematic faults. Validity faults are predictable and keep repeating themselves while reliability faults are sometimes overestimating and sometimes underestimating what is intended to be described (Teorell – Svensson 2007:55ff). There is a risk for having a validity and a reliability problem with the deforestation data, since the studies and literature that I use which try to measure this are inadequate, which is further described below. I am therefore careful in claiming causal mechanisms, of what causes deforestation, or of how much forests that have been lost. Instead I strive to have a probabilistic perspective in my findings, content with asserting probable causes (Teorell – Svensson 2007:61).

Regarding the material, I use mostly academic, peer-reviewed articles and some books from 1990-2006, which reveal different causes as dominant for deforestation. They are written recently or from the later years of the 1980s, and consist of those that I would include as more pro-development, such as Lima et al and Banerjee et al, as well as by a majority which are critical towards the government development agenda, such as Fearnside and Laurance. I am aware that this impact the material I use, which is why I try to use many and different sources, and maintain unbiased when describing the material. That I could not review articles or policies written in Portuguese was a problem, since this prohibited me from using first hand information about the policies. I therefore referred to first hand information described in English articles, such as with the government institutions, which I referred to as *INPE/IBAMA/MMA 1998, in Hirakuri 2003:11*. The material that I largely base my developed theoretical framework on, is a logical approach put together by Arild Angelsen, Professor of economics and Associate scientist at Center for International Forest Research (CIFOR) and David Kaimowitz, Ph.D. in agricultural economics and former Director General of CIFOR. Both have studied forest management and causes of deforestation as seen in their publications (“CIFOR”; “Centennial”). I use also material from United Nations Food and Agriculture Organization (FAO) and their Forest Resource Assessments (FRA), to appreciate the forest cover change and deforestation rate. There are however questions about the validity of the deforestation and forest cover data that FAO use, and the FRA 2005 data differ from earlier estimations. It is therefore not clear whether the new estimates are more truthful, or just a model mirage (Wunder 2000:12f). Among the theories regarding the different causes of deforestation, there are many authors who state the problem with deforestation data. The lack of reliable and valid series data that exists, and thereby relatively poor quality of the empirical data (Palo – Letho 1996). Data problem concerning deforestation are also described by Mahapatra – Kant (2005:3-4), and by Kant and Redantz which states that the problem with validity and reliability concern all data (1997:82).

## 1.3 Theoretical Framework

I have chosen to develop a theoretical framework, which is based on a logical approach to analyzing causes of deforestation in the tropical forests. The framework encloses three levels that lead to deforestation: underlying causes, immediate causes, and sources. The underlying causes imply macroeconomic-level factors, and influence the other levels by indirect means. The immediate causes contain government decisions and policies, which in turn affect the third level. Finally, the source level include the actions made by agents, i.e. plantation companies and farmers that make land-use decisions, which directly cause or lead to deforestation (Angelsen – Kaimowitz 1999:74f). The thesis will focus on the immediate causes, and the strive is to understand what role the policies have for deforestation in the Brazilian Amazon.

The logical approach that I have based my framework on, has an adjustment to the significance of the middle level. The approach includes on this level the agents decisions, which are based on their background and resources and then decide what choices they will make regarding the forests (Angelsen – Kaimowitz 1999:74). But since it is not the individuals decision that are of primary interest in this thesis, I will instead concentrate on the governmental decision-making. Because I believe that the decisions that the government make, influence and lead what decisions the agents in turn will make, regarding land use. This is why I decided to change the approach and instead develop a theoretical framework, where the initiatives from the government instead are the immediate causes.

Some models focus on solely underlying causes and some only on direct sources. This approach ranges in its content with causes from the macroeconomic level, which cover the market and economic situation of the state and demographic factors; to the micro-economic level, therein cover the immediate causes and decisions made which effect deforestation; and finally to the more direct sources which are the agents' actions (Angelsen – Kaimowitz 1999:75). The approach is also well-grounded, founded from reviews of more than a hundred models, and comprising since it includes causes from several levels (Angelsen – Kaimowitz 1999:73f). This is why I have chosen to be inspired from, and to base my framework on this approach.

## 1.4 Definitions and Limitations

There is a need to state what one means with theoretical terms, to be able to investigate the term in a material there is a need to make it measurable (Teorell – Svensson 2007:39). One definition that is necessary to make is that of what constitutes the term deforestation. Since I am using the forest cover change data from the FAO, I will adapt their definition of, and hence operationalize the term, deforestation: "the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold"



(FRA 2005 Terms and definitions 25f). This definition is preferred by economists and geographers while a broader definition, which includes forest conversion and different types of degradation that reduces forest quality, is preferred by biologists and ecologists (Wunder 2000:10).

I will limit my thesis in using the forest cover change statistics from FRA from the year 2005. Estimation of the deforestation rate is difficult, according to Wunder is the FRA data the best available knowledge on forest cover change. However, he mean there are uncertainties about the national data since they often do not provide or have all necessary information (Wunder 2000:12). Kant and Redantz also uses the data from FAO and Forest Resource Assessment (1990), which they think should give a fairly good description of forest area and changes in forest area, but the results should be used cautiously since the reliability of even this source is questionable (Kant – Redantz 1997:64). The data from FAO clearly seem to be the most used by researchers on deforestation and forest cover change, used by for example Myers (p.27), Palo (p.47) and Kahn & McDonald (p.61) in *The Causes of Tropical Deforestation*, Brown – Pearce (Eds.) 1996.

The Amazon Rainforest is located in the midst of South America, and stretches over nine different countries: Brazil (with over 60% of the Rainforest), Colombia, Peru, Venezuela, Ecuador, Bolivia, Guyana, Suriname and French Guiana (FRA 2005). The clearing of forests have impact on a larger scale, but an analysis of deforestation on a worldwide level, or enclosing the nine Amazonian states, would be too extensive in this thesis and not allow a deep understanding of the phenomenon. Therefore I focus only one case, namely the Brazilian Amazon.

The reason for choosing only one case, is that it enables me to research thoroughly about that case, since more variables and factors can be included in the analysis. If there were more cases to analyze, there would automatically be less space to focus on each case, and the existing causes for deforestation. By making a case-study of Brazil, and not more countries, it would also further minimize the risk to make wrong judgements, since more material would have been studied and additional sources to support the conclusion. The positive part with having several cases is that one can make comparisons. In the case of Brazil, there will not be other countries to compare with, but still comparative elements since the studied time frame is 15 years, and it become inevitable not to compare earlier years with the more present. Esaiasson et al describes mean that in formal sense, there is not much difference between a comparative case-study and a classic case-study. The difference is if the analytical units are in two disparate contexts (comparative), or in one and the same context (classic) (Esaiasson et al 2007:121).

The reason for choosing Brazil is that it is the country that holds the most land in the Amazon Rainforest, 67% (Benhin 2006:12) and also has accelerated rate of forest clearing (Laurance 1998:411). Brazil contains by far the most extent of tropical forests in the world, and represents about half of South America when it regards both population and area (Wunder 2000:74). At the regional level South America has the highest percentage of forest cover (FRA 2005:17). And there is nowhere in the world that forest destruction occurs faster than in the Amazon, where the Brazilian Amazon encompass 2/3 of this basin (Laurance 1998:411). There are two geographical concepts of the Brazilian Amazon – Legal Amazonia, which includes nine states in a 5 million km<sup>2</sup> area and has been subject to much

deforestation, and Classic Amazonia, which is known as the north region in Brazil (Fearnside – Ferraz 1995:1135; Alves 2001:1). In this thesis the focus is on the Legal Amazonia, and when I refer to Brazilian Amazon it is this area I regard.

I chose to limit my thesis to understanding of the deforestation in the Amazon region of the period 1990-2005. This depends upon the time frame that FAO uses for their Global Forest Resource Assessments, with five or ten year intervals. FAO has made evaluations since 1945 (FRA 2005:1), but the latest ones are from the years 1990, 2000, 2005 and 2010, the last one being released in October 2010 and therefore not available for this study. To be able to gain understanding of the extent of the forest loss in the Amazon area with some time perspective up until today, I chose to include 1990 in my study and the period until the latest available year for statistics from FAO, 2005.

## 1.5 Disposition

In the first introductory chapter, the purpose of the thesis is revealed as well as thoughts about the material and method. The theoretical framework that I will be using is also described along with definitions and limitations in the study. The second chapter involves theory and the empirical material, describing the disparate causes of deforestation. In chapter 3 there is a background over the case, the Brazilian Amazon, before revealing the analysis in chapter 4 and the conclusions in chapter 5.

## 2 Theory

In this chapter will I describe the theoretical framework that I have developed for this thesis, and the different theories and literature available concerning the causes of deforestation. The theoretical framework will then be applied on the Brazilian Amazon to view the impact that government decisions have.

### 2.1 Existing theories

The available literature that regard causes of tropical deforestation consists of many theories which focus on different reasons for deforestation, thus making it hard to summarize the debate. Many of the studies often include multiple-factors and drivers acting synergistically (Kant – Redantz 1997:55; Geist – Lambin 2002:146), and the causes of deforestation vary across regions (Kant – Redantz 1997:82), which is why the most dominating factors will be presented.

Considering the underlying causes, there are many researchers that regard economic factors as causes of deforestation. Kant and Redantz showed that the total GDP (Gross domestic product) influences deforestation through round-wood consumption, and that a growth in GDP causes deforestation through exports, crop land, and pastures (1997:77). Commercialization and market growth, in particular markets for wood, agricultural products and minerals, as well as market failures has shown to be prominent underlying forces. And urban-industrial growth, foreign exchange and low cost conditions (Geist – Lambin 2002:148). A product price increase for timber, along with low cost for land or labour would for instance attract investors and the market would grow. However to the downside for the forests, since foreign investments and trade liberalization tend to accelerate resource-exploitation, for example in oil and natural gas developments, which causes pollution problems and forest destruction (Laurance 1999:113).

”There seems little doubt that human population pressure is the most crucial underlying cause of deforestation.” (Laurance 1999:111)

Population growth is an underlying cause which is supported by many researchers. Rudel found that there is empirical support for the idea that population growth contributes to high rates of deforestation (1994:103). Both Rudel with data from 1960-1970s, Rudel and Roper 1970-1980s, and Southgate 1980s-1990, found positive correlations between a rise in population and deforestation in their studies (Rudel 1994:99; Rudel – Roper 1996:164; Southgate

1994:137ff). They draw inspiration from Thomas Malthus, the proponent for the belief that increasing human population will put severe pressure on natural resources (Rudel 1994:103; Palo 1994:42). As Neo-Malthusians advocate, when there is agricultural growth, a rise in the population will increase deforestation since there is more demand for land and illegal logging for income generation. But there are those with an opposite opinion, and instead support the Boserup hypothesis, which imply that increased population will not increase deforestation, due to labour-intensive agriculture and more people leaving the rural areas for the cities (Mahapatra – Kant 2005:6).

Regarding the immediate causes, the government decisions, such as initiatives, decrees and policies that influence deforestation will be included. Policies on land use and economic development could for example drive deforestation, when related to colonization, transportation or subsidies for land-based activities (Gest – Lambin 2002:146). Fearnside argue that deforestation is encouraged by government subsidies, for agricultural programs and ranching projects, and through incentives, such as income tax exemptions granted on investments regarding development (1989:19). The quality of government departments and institutions may also influence deforestation, since weak institutions may equal less awareness and ability to enforce forest legislation (Laurance 1999:112f). Initiatives and policies, made to protect the tropical forests, also meet problems with enforcement of legislation (Laurance 1998:414), and with applying them consistently across the government departments which has made them ineffective or useless (Laurance 1999:112f). Land tenure arrangements and policy failure are also important drivers of deforestation. It can imply an insecurity when it comes to the owning of land and customary rights, which makes the structure of property rights important (Geist – Lambin 2002:146,148). Insecure property rights might arise from the government's lack of power, stability and support to enforce a certain law of property. When the government lacks control over the use of forests, they tend to be treated as free access resources (Deacon 1994:422).

Concerning the sources of deforestation, there is almost an consensus about agricultural growth. FAO in their assessment state that deforestation is mainly conversion of forests to agricultural land (FRA 2005:14). And according to Southgate, the main source of forest clearing is agriculture. When the domestic demand for agricultural commodities rises because the number of consumers grow, it means increased demand for food and land inputs to crop and livestock production. This has been prevalent in most countries and therefore further increased the deforestation (Southgate 1994:134f). According to Kant and Redantz, the expansion of cropland and pastures are important sources of deforestation (1997:72,75f), and the conversion of forest areas depends upon the different activities of the agriculture sector (1997:62). Angelsen and Kaimowitz also asserts that the main source of deforestation is households or companies clearing for agriculture, or for timber (Angelsen – Kaimowitz 1999:81).

Another source of deforestation, that has been mentioned in the literature, is therefore timber. According to Geist and Lambin the extraction of commercial wood is prevalent in the mainland and insular Asia, whereas to harvest fuel wood and poles for domestic use is more frequent in Africa. It seems to be more common in Latin America with extracting timber for road building and

infrastructure expansion. All in all as a source of deforestation, wood extraction is therefore one of the foremost prevailing (Geist – Lambin 2002:150).

## 2.2 Theoretical Framework

The theoretical framework is developed from a logical approach built to analyze deforestation at three different levels: underlying causes, immediate causes and sources of deforestation (Angelsen – Kaimowitz 1999:74f). I will use this approach but change the middle level, the immediate causes of deforestation. The makers of this approach proposed that this middle level would be useful to explain on a microeconomic level how individuals (agents) allocate their resources, using economic variables such as prices and technology, which then influence the agents decisions regarding the forests (Angelsen – Kaimowitz 1999:78). For the purpose of this thesis it is interesting to look at immediate causes, but to concentrate on the states and how government policies influence the agents actions which may lead to deforestation.

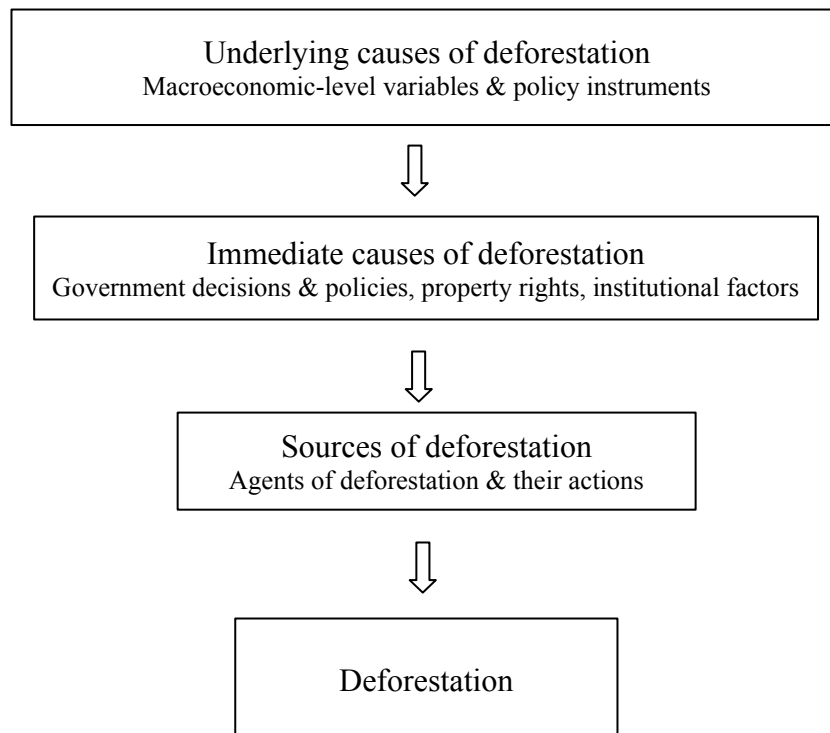
The three levels in the theoretical framework influence each other in a downward direction. The underlying causes are characterized by macroeconomic factors, and effect the immediate level and source level indirectly. They are therefore difficult to say for certain to influence deforestation (Angelsen – Kaimowitz 1999:87). The underlying causes are divided into four categories: Economic, Technological, Cultural/socio-political and Demographic factors. In the economic category you will find factors relating to economic and market growth as well as market failures; those concerning external debt and foreign exchange; as well as urbanization and trade liberalization in general. The technological category include instead agrotechnical change, where e.g. agricultural expansion is dominating, and poor technological applications in the wood sector. Cultural/socio-political factors concern the public's interest in wood and the possible unconcern for preserving forests. Ultimately, the demographic category includes population pressures, migration and population density (Angelsen – Kaimowitz 1999:87; Geist – Lambin 2002:148).

The following level are the immediate causes where I include policy and institutional factors. They can in turn be divided in formal policies, property rights issues and policy failures. The formal policies involve initiatives and decisions concerning e.g. land development, agricultural or infrastructure development which influence economic growth, or credits or subsidies regarding land-based activities (Geist – Lambin 2002:148). All of these policies, in one way or another, influence or support deforestation because they support development or other uses for the forest land (Geist – Lambin 2002:146f). The second category of policy and institutional factors are property rights issues. Or more correctly, lack of structured property rights which implicates insecurity regarding land tenure and the ownership of forest land. Property rights issues can also involve open access conditions and maladjusted customary rights where there are uncertainties of who the owner is of the forest, and there is low empowerment of local user groups.

These issues tend to have ambiguous effects on forest cover but all are said to influence deforestation (Geist – Lambin 2002:146,148). The third category include policy failures, wherein corruption, lawlessness or mismanagement in the forest sector may drive deforestation (*ibid*). Policy failures may be for example when the policies regarding the protection or conservation of forests become ineffective, or not applied consistently over government departments, because of weak enforcement of legislation or in fact weak institutions (Laurance 1999:112).

Sources of deforestation is the third level where agricultural expansion, wood extraction and infrastructure expansion is included. Agricultural expansion can be divided in permanent cultivation, large farms who produce for national or international markets where the crops often are exported; shifting cultivation, often expansion of food-crop for local or regional markets or for the smaller farms livelihood (Kant – Redantz 1997:62); cattle ranching, either large-scale or smallholder; and colonization, resettlement projects or transmigration. These four types of agriculture expansion is associated with nearly all deforestation (Geist – Lambin 2002:144f). The next category is wood extraction, which involve commercial extraction, fuel wood, pole wood and charcoal production. The third category is infrastructure extension which can involve extension for transport, markets, settlements, public service or private companies (*ibid*).

*Theoretical Framework, figure 1. Source: Angelsen – Kaimowitz 1999:75, revised*



## 3 The Brazilian Amazon

In the following chapter will I describe the Brazilian Amazon, the present state of the rainforests and a short historic background to fathom the context. "Understanding the forces that drove policy in the past can inform our expectations of the effectiveness of policy implementation today" (Banerjee et al 2009:130).

### 3.1 Background

#### 3.1.1 Facts and figures

Brazil is the country with the second largest forest area in the world, 478 million hectares (FRA 2005:16). But the Brazilian forest cover has changed noticeable since 1990, when it comprised a total of 520,0 million hectares. From then on it diminished to 493,2 million hectares in 2000, and to the most present estimate of 477,7 million hectares in 2005. This equals an annual change of the total forest area of 2,6 million hectares (-0,5%) between 1990-2000, and 3,1 million hectares (-0,6%) between 2000-2005 (FRA 2005:201; Appendix 1). In the last couple of decades there has therefore been a visible increase in the deforestation rate in Brazil. Deforestation being the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold (FRA 2005 Terms and definitions 25f). Since the year 1990, about 42 million hectares of the Brazilian forest or -8,08% has been lost (Appendix 1). A lot of this forest loss comes from the Brazilian Amazon, i.e. the nine states within Brazil named *Amazônia Legal* (Fernside 1993:540).

#### 3.1.2 Historical background

Settlement projects and exploitation can characterize Brazil during the end of the 1900s and the coming decades, with interests in conservation or protection of the forests being slim. The Atlantic forest area was cleared at a rampant pace, due to a European demand for Brazilian forest products, and to produce energy and crops to sustain a growing population, in which farms and ranches were established by moving settlers (Banerjee et al 2009:131; *Anuário Estatístico do Brasil*). Brazil had predominantly been an agricultural economy, this started to change with the

government pursuing economic development in the 1950s and shift to an industrial economy (Mery et al 2001:245). However the Brazilian Amazon remained relatively intact until the 1960s, since there were no highways or roads built to support a migration to the frontiers (Mahar – Schneider 1994:161).

Between 1960s and 1980s Brazil encountered growth on many levels, the economy grew, the population grew remarkably, and urban areas developed (Macedo 2008:261). A military government was instated in the 1960s (Wunder 2000:76), which initiated a Operation Amazonia to develop, occupy and integrate the Brazilian Amazon with the national economy. This implied building roads and agricultural colonization projects in the area and provide financial incentives for industries in the Amazon (Banerjee et al 2009:133). The military government's projects and decisions for the Amazon development was effective, in that it generated economic growth and promoted forest plantations. But actions relating to sustainable use of forests were limited, and the institutions which was supposed to enforce forest protection laws were weak and underfunded (Banerjee et al 2009:134). Projects such as the Brasilia-Belem highway, extensive road building and converting land to pasture and cattle ranching, increased the deforestation in this period of time (Fujisaka et al 1996:116).

When the oil crisis hit in the 1970s, the road building and focus on settlements were exchanged for export-oriented projects in livestock, forestry and mining in the Brazilian Amazon (Banerjee et al 2009:133f). Such a project was the Polamazonia, in 1974-1987, which began to develop infrastructure and increase investment and foreign exchange earnings, through financial incentives and subsidized credit (Banerjee et al 2009:133f). At the same time Brazil committed to create the Secretariat for the Environment, SEMA, to develop policies for environmental protection and management (Banerjee et al 2009:135). And with a new government in 1974 and President Ernesto Geisel, a process of re-democratization was begun. This prompted the start for an environmental movement with a more open climate and the forming of non-governmental organizations to put pressure on the forest agenda (Banerjee et al 2009:134f).

Through SEMA and other institutions, Brazil achieved to establish environmental protection areas and national parks from the end of the 1970s and the mid 1980s. And the following years were active for the forest policy in Brazil, both domestically and internationally (Banerjee et al 2009:135f). But with the focus of the government to still initiate development projects, the forests were continually threatened. For instance with the programme Polonoroeste, in 1981-1985, which sought to develop and connect Brazil's Amazonian states Mato Grosso and Rondônia through a 1500-kilometre highway (Fearnside 1987:215). From the southern state of Rondônia, this highway now enabled a migration movement during the mid 1980s, into the midst of the Amazon. This growth in in-moving settlers increased the already high pressure on the forests (Mahar 1990:64). The time period from late 1970s and through out the 1980s are characterized with alarmingly high rates of forest loss in the Brazilian Amazon (Laurance et al 2001a:2). With regard to possible discrepancies and a small decline 1987-1990, the deforestation rate hence increased distinctly through out the 1970s and 1980s (Fearnside 1993:538f, Fearnside 1999:307).



## 4 Analysis

In this chapter different causes of deforestation will be discussed, including the role that government policies have for deforestation, and with the adaption of the theoretical framework, I will thereby be able to answer the problem formulation.

### 4.1 Underlying causes - Macroeconomic level

The underlying causes that have been found for deforestation in the Brazilian Amazon have been categorized according to the theoretical framework's division of Economic, Technological, Cultural/socio-political and Demographic factors.

#### 4.1.1 Economic factors

Regarding the economic factors, it is possible to explain some of the changes in the deforestation rate in the beginning of the 1990s, with regard to economic changes and growth. At 1990, the deforestation rate had already begun to decline, a trend seen at the end of the 1980s. The occurrence can be explained by the long period of economic growth coming to a halt in this period. The government and President Fernando Collor froze bank accounts which made the investors unable to gain access to their funds, this in turn constrained the investment and economic activities regarding the forests. Owners of ranches and cattle could not afford expanding their land, and hence clear the forests, therefore there were relatively low rates of deforestation seen in the Brazilian Amazon up until 1994 (Fearnside 1999:307). To help ease the economic climate, the government instated an economic reform in 1994, Plano Real, which made the economy recover along with rising deforestation rates the following year. There were once again opportunities to invest, including in cattle ranches (Fearnside 1999:307f). But since the Plano Real had abruptly cut the inflation rate when initiated, and the land values were falling, there were not that many wanting to invest in Amazonian land, and the high rates therefore diminished from 1996 until the turn of the century (*ibid*). Although the rate diminished, it was still at dauntingly high levels during this period of time (Laurance et al 2001a:2).

After the year 2000, deforestation started to increase much attributed to the increased economical activity (Bugge 2001). The growth in commodities market in Brazil kept the country out of financial crisis, even though Brazil's foreign debts were extensive. This could be depended on that farming and agriculture grew, in an otherwise diminishing economy ("Saving the rainforest" 2004:12).

And Brazil growing into the role as a soya bean cultivator, became a leading supplier of genetically modified-free soya to Europe. A positive thing for their share in the global market and their home economy, but the growing demand for the soya bean cultivation further increased the pressure on the forests in the Brazilian Amazon (Humphreys 2006:19).

When the national and international demand for timber rises, the result is a growing timber market, a prominent underlying force of deforestation (Geist – Lambin 2002:146). In the case of the Brazilian Amazon, the timber extraction increased during the last decades (Verissimo & Amaral 1998, in Lele et al 2000:24), and was done without management due to poor enforcement, low technological availability, and high economic returns (Lele et al 2000:18). That timber extraction is common in the Amazon, depends on the large clearing of the Atlantic forest cover that was made until the 1980s. The high deforestation rate during the 1970-1980s, low rates of reforestation and unsustainable management, resulted in a diminished timber production. And because there were not enough timber to extract from the Atlantic forest, the demand for timber increased for the Brazilian Amazon instead (Lele et al 2000:17f). Most of the timber production goes to the domestic market and only 14 percent exported, still the Amazonian wood from mainly the states Rondônia, Mato Grosso, and Para, accounted in 1997 for almost 40% of the total wood exports (Lele et al 2000:25). The timber industry has therefore grown speedily in the Brazilian Amazon, and according to Mertens et al, the clearing of Brazil's southern forests along with road building and limited environmental oversight, have resulted in large market growth (2002:283).

#### 4.1.2 Technological factors

Towards the turn of this century, Brazil was characterized with modern and high-tech forest industries with a high demand for disparate types of forest products, something that has been developed with the urbanization and a dynamic agricultural sector (Mery et al 2001:245). The promotion of economic growth by the government for a longer time period had led to the establishment of modern industrial plants, e.g. paper and pulp, which could compete on the international market. However the traditional forest sector, such as the sawmill industry, is characterized with poor establishment and organization, consists of many smaller and independent mills and is equipped with low quality technological resources (Mery et al 2001:247). And a majority of the close to 400 legal timber companies in Brazil can be characterized with poor management (Laurance 1998:411).

#### 4.1.3 Cultural/socio-political factors

While awareness is growing in major cities in especially the southern Brazil, the inhabitants of the Amazon, as well as many politicians, are more inclined towards development (Laurance et al 2001a:12). This view could implicate that there is an unconcern for preserving forests. For instance, the implications of the initiative from 2001, Avanca Brasil, which would open up large areas of the Brazilian

Amazon to development, has been poorly discussed and debated (Laurance et al 2001b:439). Likewise has the concern expressed itself in the many other development projects supported in the Amazon, as well as extensive illegal logging which damages the forests (Lima et al 2006:35). Particular in the timber industry has illegal logging been reported, and according to governmental sources was as much as 80% of the logging in the Amazon illegal (Laurance 1998:411). When the public tend to activities such as illegal logging, mining, and hunting, it damages forests and ecosystems, and leads to deforestation in the Amazon (Humphreys 2006:13; Laurance 1998:413f). However, the forest clearing in the Brazilian Amazon has received much press coverage, national as well as international, which have contributed to a public concern regarding the destruction of environment and of Indian cultures (Reis – Margulis 1992:335f). There was also much lobbying and pressure on the government in 1988, when a reforestation programme ended which had contributed to forest plantations since the 1960s. This lobbying influenced the government in focusing more on protection and conservation for the forests during the 1990s (Mery et al 2001:245).

#### 4.1.4 Demographic factors

Brazil accounted for about a third of the high population increase in Latin America between 1950 and 1990, rising from 53 million in 1950, to 150 million in 1990 (Mahar – Schneider 1994:159). And between 1990 and 2005 its population grew to approximately 186 million (Nationmaster). The challenge with population increases in tropical countries, is that it may lead to a visible conversion pressure to change the forests into agricultural land (Laurance 1999:114). When the population grew in Brazil during the 1990s, and the population pressure in the already crowded urban areas became to high, the solution was to implement forest-colonization projects (Laurance 1999:112). Through road building and development of infrastructure, the population growth can therefore constitute a threat to the forests (Rudel 1994:103). Rapid population growth also tend to worsen other existing socio-economic problems, and thus become an important indirect driver of deforestation (Laurance 1999:112). When it regards the Brazilian Amazon there are similar conclusions to be drawn, the region's population increased from 12 million in 1980, to over 21 million in the year 2000. And to an extent did the percentage of deforested land area in the 1990s, reflect the population density during the same period (Perz et al 2005:29).

When there was decline in deforestation rates in the beginning of the 1990s, Mahar and Schneider attribute it to the fall in absolute terms of the rural population in the Brazilian Amazon (1994:171). This fall drastically reduced the pool of potential migrants to the region, and coupled with the economic recession, it limited the resources for road building and infrastructure in forested areas. In the same way can the increase in deforestation during the end of the 1990s, be attributed to the flow of migrants to the centre for development, Manaus, in the midst of the Brazilian Amazon. The highway from Manaus to Rondônia facilitated access to the forests in the region, and thereby further deforestation and

logging (Laurance 1998:412). Hence, there are evidence to say that population and net migration influence deforestation, but mostly in connection with other causes as well (Perz et al 2005:42).

## 4.2 Immediate causes – Policy and institutional factors

The following level are the immediate causes which include policy and institutional factors, they are in turn divided in formal policies, property rights issues and policy failures.

### 4.2.1 Formal policies

There has been many laws regulating the forests in Brazil, but none of them dealt with forest management until the present Forestry Code, which has been revised since it was first enacted in 1965 (Hirakuri 2003:9). The Brazilian government promoted deforestation through a range of financial incentives and colonization programs, settlement schemes and road buildings during the 1970s and 1980s. These initiatives promoted deforestation in the Brazilian Amazon, much because it benefited the cattle ranching that is still prevalent today (Wunder 2000:79f; Laurance 1999:113).

When the government became economically pressured during the end of the 1980s and beginning of the 1990s, the colonization programs shut down and it led to the state retreating from some of the rural areas (Rudel 2007:40). This led to a decline in the deforestation rate, which can be attributed to the government's decisions and the positive effect they had for the forests. The governmental policy changed to restrict the conversion of forest land into agriculture, and there was also a cease of tax concessions on cattle ranching (Hirakuri 2003:11). However, the cuts in promoting Amazonian ranching concerned only new incentives, and not those previously instated from the government (Laurance 1999:113). The existing incentives were hence not removed, and therefore continued to be a driver of deforestation. Mainly since the few new ones to protect forests, could not make up for the range of centuries old projects supporting forest clearing (Fearnside 1997:297).

That the deforestation rate increased again in 1995, was seemingly a response to the government's Plano Real and the containing stabilization measures to ease the economy. The governmental initiative was however met with discontentment from the national, as well as international, environmental movement. To compensate this action, and to improve credibility in the international community, the government passed a provisional measure (Banerjee et al 2009:137f). The provisional measure, earlier called a law-decree, increased the legal reserve requirements to 80% in the Amazon biome. Before this measure, the landowners had right to deforest 50% of their land according to the Forestry Code, the

measure had therefore great significance since they now could only clear 20% (Hirakuri 2003:16). The deforestation rate fell therefore in 1996, much because the provisional measure, the government instating a moratorium on logging of i.a. mahogany, and making strong enforcement measures, such as the Macaúã Operation in 1996-1997 (INPE/IBAMA/MMA 1998, in Hirakuri 2003:11).

Around the turn of the millennium there was a policy shift towards a more sustainable forest management, seen in i.a. the establishment of the National Forest Program (PNF) and the Conservation Area System (SNUC). Both included policies for a sustainable forest, along with incentives for natural forest management (Banerjee et al 2009:139). The PNF aimed also at increasing Brazil's share of the global timber markets, and increase exports from the natural forests from 5-30% by 2010 (MMA, in Macqueen et al 2003:16). Such a development would likely increase the development in the Brazilian Amazon (Banerjee et al 2009:140) and consequently the deforestation as well in that region. The SNUC was a law that entailed guidelines for the establishment of conservation areas, with a mandate to protect biodiversity and promote sustainable development. This resulted in the creation of several protected areas between 2002 and 2004 (Figueiredo 2007:61, 65f).

There were record levels of deforestation in 2002 which were seen as the result of a growing illegal timber market, and hence a need for a law to regulate this illegal logging. The government with President Fernando Henrique Ortega, suggested a proposal the same year to promote sustainable management of public forests for timber and other forest goods and services. This was a decision intended to control the illegal use of the forests. However, with a new government in 2003 this proposal was withdrawn and discussions were once again resumed (Guevara 2003:1). This government, led by President Luiz Inácio Lula da Silva, was more responsive to forest-based development, and a law regulating illegal logging would not come until the year 2006 (Banerjee et al 2009:146,141). Between 2003-2006 there were several covert operations to reveal illegal activity in the forest. This exposed a crisis in the forest sector, where companies and public officials had deeply rooted interests in the illegal activities and where a rural violence was spreading. This resulted in, together with disputes over land, the murder of an American activist in 2005. During the forest sector crisis, and the high levels of deforestation, the government initiated an Action Plan in 2003. This included a step for reduction of deforestation in the Brazilian Amazon with new conservation areas, tenure reforms, improved monitoring, enforcement, and sustainable development. And the diminished deforestation rates in 2004-2006, could mean that this plan had contributed to improved monitoring and enforcement. The government and the police also made strong law enforcement operations against illegal logging between 2003-2006, which resulted in a small decrease of illegal timber harvest (Banerjee et al 2009:142f; Brito – Barreto 2006:2).

## 4.2.2 Property rights issues

Property rights imply ownership, either private or state ownership; leaseholds; regulated access common property or open access common property. Wherein the last stated is the most likely to lead to overuse of natural resources (Benhin 2006:12). In the Brazilian Amazon secure titles on land are relatively rare, only 11% of the land was titled in the 1980s. Since there is plenty of land, but poor property rights, there is a great deal of land that is open access common property, which means the land does not officially belong to anyone. Private companies or buyers can hence obtain the land for a small or no cost, which makes the land economically valueless (Mahar – Schneider 1994:162). Therefore, the incentive for protecting the land or manage it decreases as well which leads to deforestation.

Agrarian conflicts have been prevalent in Brazil since the 1960s, involving landless peasants who struggle to get access to land rights, against the resistance of large landowners who do not want to give up their rights, along with a law that is unclear over who has the rights (Oliveira 2008:305f). These conflicts have continued into the 1990s where the law states that the title holders have right through the statutory law, and settlers through the Constitution. The property rights regime is therefore characterized by confusion, conflicting incentives and welfare losses (Alston et al 2000:183f). Therefore a need for land reform is essential in Brazil (Bryant 1998:186). Distorted governmental policies, laws and regulations in the Brazilian Amazon, generated insecure property rights over land and timber which contributed to conflicts over land and environmental degradation (Oliveira 2008:313). From 1988 to 1994 the government removed much of the income tax treatments, and the financing of credit for the agricultural sector. These changes diminished differences in land prices, but the tenure insecurity would still characterize the remaining 1990s (Bryant 1998:194ff). There was an unbalance between those that obtained land rights in the Brazilian Amazon, often under unclear circumstances of big and unproductive properties, and the millions of landless workers who needed to survive. This led to many landless people moving into the forests to look for unclaimed land, which caused further deforestation (Oliveira 2008:314). However, initiatives from the government during the late 1990s and the beginning of the 2000s, have had positive results in establishing more protection areas (Fearnside 2003:771). And market based initiatives, such as forest certification, are growing which would mean better secured forests and clearer tenure rights (Oliveira 2008:314).

## 4.2.3 Policy failures & institutional factors

Even though there has been improvements in the environmental policy making during the last decades, the deforestation rate continue on high levels, without there being a permanent reduction. One explanation could be the weak enforcement of legislation, the institutions' capabilities lag behind when it comes to controlling that policies and legislation are abided (Laurance et al 2001a:11). Corruption has also been prevalent, and political auction with high positions in

government institutions. This factors has been the drivers of policy failures and the poor governance when it comes to forestry (Lima et al 2006:35).

The relatively strong environmental policy enacted at the end of the 1990s, was made ineffective by the government instating counter solutions, such as executive decrees (Anon, in Laurance 1999:112). And when policies for forest protection have been instated, they were not applied consistently over the government departments (Laurance 1999:112*f*). The government therefore seem to have an ambiguous attitude towards the environment. Comprehensive new conservation initiatives are announced one moment, only to be revoked later on through other decrees or suspended by court orders, a pattern that seemed recurrent in the 1990s (Laurance 1999:113). One fundamental problem, according to Reis and Margulis, is the institutions inside the Brazilian Amazon region that have administrative, as well as juridical, weaknesses when it comes to forest issues. This lead to problems on the local level, regarding the surveillance, and on the state and municipal level, regarding lack of political motivation and economic resources (Reis – Margulis 1992:368).

## 4.3 Sources

The sources of deforestation influence the forest clearing in a direct way, without affecting other indirect factors, and are divided in agricultural expansion, wood extraction and infrastructure expansion.

### 4.3.1 Agricultural expansion

Since agriculture competes with forest for land, the forest acts as a production input in agricultural expansion and hence the agriculture is one of the direct causes of forest loss (Benhin 2006:11). Ranchers and farmers clear forests in preparation for cattle pasture and crops, and tend to activities like clear-cutting and burning patches of forest (Nepstad et al 1999:505). For instance, deforestation rates for the years 1990 and 1991 show that small farmers accounted for about 30% of the deforestation, while 70% were due to ranchers. And the clearing seemed to be most prevalent in the states where ranchers were active, such as in Mato Grosso, where a total of 84% of the land constitutes privately owned, large ranches (Fearnside 1993:544). The head of the Brazilian Institute for the Environment and Renewable Natural Resources, IBAMA, claimed that it was the poor farmers who use shifting cultivation for their livelihood who caused deforestation (Fearnside 1999:307). According to Fearnside this is a justificatory notion, with evidence showing rather that a relatively small amount deforestation are from subsistence agriculture and small farmers. Instead most of the forest clearing is done on large properties for cattle ranching, since the government subsidize established cattle ranching projects in the Brazilian Amazon (Fearnside 1993:543). There is data from Brazil's National Institute for Space Research,

INPE, as well that supports the appreciation that deforestation is unlikely to be mostly caused by small farmers. According to their estimations, only 21% of the area of new clearings in 1995, 18% in 1996, and 10% in 1997 were derived from small farms (INPE, in Fearnside 1999:306,308). The fast development of cities in the Brazilian Amazon together with road building, expanded the cattle market and increased incentives for smallholders to convert forests into pastures (Rudel 2007:37). Deforestation enabled land claims, and cutting forest for cattle pasture, was the cheapest and most effective in this sense (Fearnside 2005:681). Agricultural frontier expansion and land-extensive farming activities are factors that directly has resulted in the clearing of large areas of forests (Lele et al 2000:17). Presently is the most rapid agricultural growth in soy bean plantations, which poses a threat to the forests since it leads to the government investing further in infrastructure development. Also the logging required to build roads, is opening up the forest frontier for investing timber profits in soy bean plantations and cattle ranches (Fearnside 2005:682).

#### 4.3.2 Wood extraction

When it comes to wood extraction as directly contributing to deforestation, logging activity in the Brazilian Amazon is a factor, but substantially smaller than that of agriculture and cattle-raising (Lele et al 2000:17). The indirect contribution of logging is on the other hand larger (ibid), accounted for among the economic underlying causes. Timber extraction increases the forests risk to caught fire which leads to vicious cycle of tree mortality, increasing fuel loads, re-entry of fire, and eventually total destruction of the forest (Fearnside 2005:682). The rapid pace of deforestation can also be attributed to the growing industrial logging and mining, the road networks, and that the logging projects now goes deep into the forests which has severe consequences (Laurance et al 2001b:438). According to Fearnside logging has complex, direct impacts on the forest. In particular the extraction of Mahogany is vulnerable to local extinction, and initiates a process of destruction which leads to losses in the entire ecosystem (Fearnside 1999:308). Although logging and fires usually do not kill the trees, it damages the forests for a long period of time through the harvest process of timber. Nepstad et al appreciates that about 10.000-15.000 km<sup>2</sup> of undisturbed forest were logged per year in 1996 and 1997 in the Brazilian Amazon, this equals an area of about 50-90% the size of the area that was completely deforested in 1996 (1999:505). The logging may therefore impact and be a direct cause of the deforestation, however the indirect impacts are greater and influence deforestation through underlying causes (Fearnside 1999:308).

#### 4.3.3 Infrastructure extension

Alves found that most of the deforestation between 1991-1997 took place in proximity to roads and highways. Nearly 90% of the deforestation during this time was concentrated within 100 km from major roads. Most of this deforestation



was located in the Brazilian Amazon States of Maranhão, Mato Grosso, eastern Pará and Rondônia, and then in connection to major roads and development zones from the 1970s programmes strive to expand the country and connect the states. However the correlated deforestation was not found in the more remote regions along the Tranzamazon or Northwest roads (Alves 2002:2905f). The rapid agricultural expansion during the 1990s was highly driven by the government's road building projects, since the economic development and settlement programmes were dependent on infrastructure and road network (Reis – Margulis 1992:350). Verissimo et al also show that most logging activities takes place around major highways and river systems (1998:129). On the whole, this would imply that deforestation is due to land use intensification, since most deforestation has occurred near roads and close to the already developed regions, instead of expansion into the distant areas (Alves 2002:2907).

## 5 Conclusions

This chapter is a summary of what I found in the analysis, which was made to understand the role of government policies through 1990-2005 in relation to other underlying and immediate causes, and sources of deforestation.

The government's decisions and policies have an important role for deforestation in the Brazilian Amazon. The high levels of deforestation during the time period 1990-2005 have been influenced by the policies supporting economic development and converting forest land to agricultural land. The long promotion of development and infrastructure investments in the Brazilian Amazon up until the 1970s and 1980s, is also visible that it affected the deforestation prevalent from then on until the year 2005. The agricultural expansion during the 1990s, which for a great part was a cause of the deforestation, would not have been that extensive had it not been for the government's policies regarding road building, incentives for cattle ranches, settlement schemes and other financial incentives to support the forest land conversion. In this way that the government indirectly supported the agriculture and cattle ranching, through different incentives and credit mechanisms, could serve as important causes for the deforestation. Even if the government decided to remove some of these incentives to support agriculture during the 1990s, it only regarded new initiatives. The governmental contribution to deforestation hence continued, but that the deforestation rate fell in 1996 was much because of the provisional measure the government had initiated and the instating of a moratorium on logging of i.a. mahogany, and making strong enforcement measures. After the year 2000 there was a policy shift to more sustainable forest development, and even if it implied more protected forest areas, the focus was still on increasing the timber market and thereby promoting the development in the Amazon. The deforestation did therefore not decline, and the record levels in 2002 was contributed by the illegal logging, which the government discussed for several years before a law regulating it would come. In 2003 there was another Action Plan, a result of a forest sector in disarray, which had positive effects with new conservation areas, tenure reforms, improved monitoring, enforcement, and diminishing deforestation rates in 2004-2006.

The governmental decisions during 1990-2005, was of course dependent on the underlying factors, where the changes in deforestation rates related to the shifts in the economy during this time. In particular the stabilization reform plan in 1994 would not have been instated, were it not for the severe state of the economy. The decrease in deforestation rates that followed in the coming years, were not however a consequence of the plan, but more from market events such as falling land values which made the investors disappear, and that the plan had cut the inflation rate when instated. That the plan did not affect that the rates diminished, depended in my opinion, on the aim of the plan which was to increase the economic activity and the development of the forests. And this was exactly

what happened after the year 2000, economic activity grew along with deforestation rates. In relation to economic factors, government decisions did affect that the deforestation rates grew, but did not influence the diminished rates during the 1990s. When it regards the growth in timber and commodities market that there has been, the indirect cause of logging, it has been promoted by the government economic development and urbanization projects in the Brazilian Amazon. Technological factors had not been that significant for deforestation, but when the demand for forest products grew and consequently the timber sector, the government contributed with more resources and high technology to those industries. The cultural factors and the unconcern from Amazonian inhabitants for forest protection, has been supported by politicians and the policies for development. And would likely be different if the government had instead focused on conservation policies earlier than was seen. Regarding demographic factors and the rapid increase of population in Brazil, it has resulted in more pressure on the forests, but mostly through other factors such as road building and forest-colonization projects, initiated by the government to assist the over-crowded urban areas.

Regarding immediate causes, the property rights issues has led to problems and confusion over land rights, increased by the government's ambiguous laws over land tenure. This has resulted in conflicts over land and large areas that are untitled or occupied, with a low incentive for the owners to protect their forests. The government has contributed to this disorder by not making the property rights secure, the system has however had changes recently with positive effects. There has also been institutional weaknesses and failure to enforce many of the policies, which has contributed to high deforestation rates. Even if there were improvements in the policy making the last decades, they could have had more effect if other factors such as corruption, poor enforcement capabilities and policy failures had not influenced. Some policies were even made ineffective, because of the government instating counter solutions that support development instead.

Government decisions has affected the sources of deforestation, in particular agricultural expansion. Much of the deforestation in the Brazilian Amazon was attributed to the activities of large-scale ranchers and done on large properties for cattle ranching. This depends on the government subsidizing established cattle ranching projects and focusing on developing cities which expanded the cattle market, and gave smallholders incentives for converting their forests to pastures. Wood extraction was also a contributing source of deforestation, but less so than agriculture and cattle-raising. Logging damages the forest for a long period of time, through the way the harvest of timber is done, and since timber extraction increases the risks for fires, which can destroy whole forests and ecosystems. Concerning infrastructure expansion, most of the deforestation in the Brazilian Amazon took place in proximity to roads and highways. The infrastructure serves as a necessity for road building and the prevalent development programmes which was supported by the government, and contributed to agriculture expansion during the 1990s. This would imply that deforestation was due to land use intensification, since most of the clearing occurred close to already developed areas.

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# 7 Appendix

## 7.1 Appendix 1

Interpretation of the "Table 4, Change in extent of forest and other wooded land 1990-2005" in the Global Forest Resource Assessment, FRA, from 2005.

Author has interpreted the numbers for the Amazonian states, from Table 4 and extent of the forest change, to be able to see the percental change for the chosen period 1990-2005. Numbers were therefore calculated to percent for the whole period to be able to see which countries that had forest loss and which that had been able to preserve their forests. These numbers deviate from the earlier FRA 1990, 1997 and 2000 on forest cover change, however, I choose to use the most present statistics which have been revised with new information (FRA 2005:xvi).

FRA 2005 . TABLE 4. p.201.

"Change in extent of forest and other wooded land 1990–2005"

Total 1990	Total 2005	Forest change	Percental change 1990-2005
<b>Brazil:</b> 520million ha(90), 478million ha(05).		<b>Forest change 90-05:</b> -42million ha.	<b>-8,08%</b>
- difference:90-00: -2,6million ha/yr (-0,5%); <b>00-05:</b> -3,1millionha/yr <b>(-0,6%/år)</b> .			
<b>Peru:</b> 70,2million ha(90), 68,7million ha(05).		<b>Forest change 90-05:</b> -1,4million ha.	<b>-2,14%</b>
- difference:90-00: -94000 ha/yr (-0,1); <b>00-05:</b> -94000 ha/yr <b>(-0,1)</b> .			
<b>Colombia:</b> 61,4million ha(90), 60,7million ha(05).		<b>Forest change 90-05:</b> -711000 ha.	<b>-1,14%</b>
- difference:90-00: -48000 ha/yr (-0,1); <b>00-05:</b> -47000 ha/yr <b>(-0,1)</b> .			
<b>Venezuela:</b> 52,0million ha(90), 47,7million ha(05).		<b>Forest change 90-05:</b> -4,3million ha	
- difference: 90-00: -288000 ha/yr (-0,6); <b>00-05:</b> -288000 ha/yr <b>(-0,6)</b> .			<b>-8,27%</b>
<b>Ecuador:</b> 13,8million ha(90), 10,9million ha(05).		<b>Forest change 90-05:</b> -2,9million ha	
- difference: 90-00: -198000 ha/yr (1,5); <b>00-05:</b> -198000 ha/yr <b>(-1,7)</b> .			<b>-21,01%</b>
<b>Bolivia:</b> 62,8million ha(90), 58,7million ha(05).		<b>Forest change 90-05:</b> -4,0million ha	
- difference: 90-00: -270000 ha/yr (-0,4); <b>00-05:</b> -270000 ha/yr <b>(-0,5)</b> .			<b>-6,53%</b>
<b>Guyana:</b> 15million ha(90), 15million ha(05).		<b>Forest change 90-05:</b> 0.	<b>0%</b>
<b>Suriname:</b> 14,8million ha(90), 14,8million ha(05).		<b>Forest change 90-05:</b> 0.	<b>0%</b>
<b>Fr.Guiana:</b> 8,1million ha(90), 8,0million ha(05).		<b>Forest change 90-05:</b> -28000ha.	<b>-1,23%</b>
<b>Largest reduction of forest:</b> Ecuador (21,01%); Venezuela (8,27%); Brazil (8,08%); Bolivia(6,53%)			

Source: FAO, FRA 2005:201 (Annex 3: Global tables)