

2. Destruction of tropical forest ecosystems due to logging and slash-and-burn activities

The tropical rain forests of Amazonia are not the “lungs of the world” and they do not produce 20% of the oxygen needed by mankind, as parts of the press, news channels and politicians repeat like a prayer wheel.

The Amazon rain forest is not a big source of oxygen since the trees consume almost all the oxygen they produce through photosynthesis. Amazonian rain forests produce only about 6% of the planet’s oxygen⁴²⁰ and the forest ecosystems have hardly any effect on the oxygen content in the atmosphere.

But the extremely important function of intact rain forests is the storage of large amounts of carbon with their biomass. 150–200 billion tons of carbon are stored in vegetation and soils. Production of woody biomass accounts for 8–13% of the photosynthetic carbon uptake. “The ability of ecosystems to capture, process, and store carbon and other nutrients is determined by climatic, edaphic, hydrological, and biological factors” (Nobre *et al.* 2021, Message 4). Tropical forest ecosystems are a huge CO₂ reservoir that binds greenhouse gases that are responsible for climate change, among other trace gases. In 2022, global CO₂ emissions amounted to about 37 billion tons. The Amazonian ecosystems absorb 2 billion tons of CO₂ per year or 5% of global annual emissions (Nobre *et al.* 2016).⁴²¹

In 2021, total Brazilian CO₂ emissions amounted to 1.48 billion tons, i.e., a share of 3.6% on global CO₂ emissions. CO₂ emissions from land-use change in Brazil reached 993 million tons, i.e., 67% of Brazil’s total emissions or a share of 25.2% on global CO₂ emissions from land-use change.⁴²²

The tropical forests are biodiversity hotspots. Slash-and-burn not only releases enormous amounts of CO₂ but also destroys the high biodiversity, reduces evaporation and regional precipitation, and damages the water balance. Increased forest fragmentation leaves areas of the remaining rain forests more vulnerable (Laurance *et al.* 2001).

Data of deforestation, based on satellite image evaluations and published by the internationally renowned INPE, show, that in the Brazilian Amazon region from 1975 (only 0.6%) to 2021 19.9% of the original rain forest area (4.1 million km²: nearly the total area of the European Union) were devastated. This means that smaller fires close

419 Cf. chapters I.3.3; I.4.5.1; II.2.2.2; II.6.3.1.

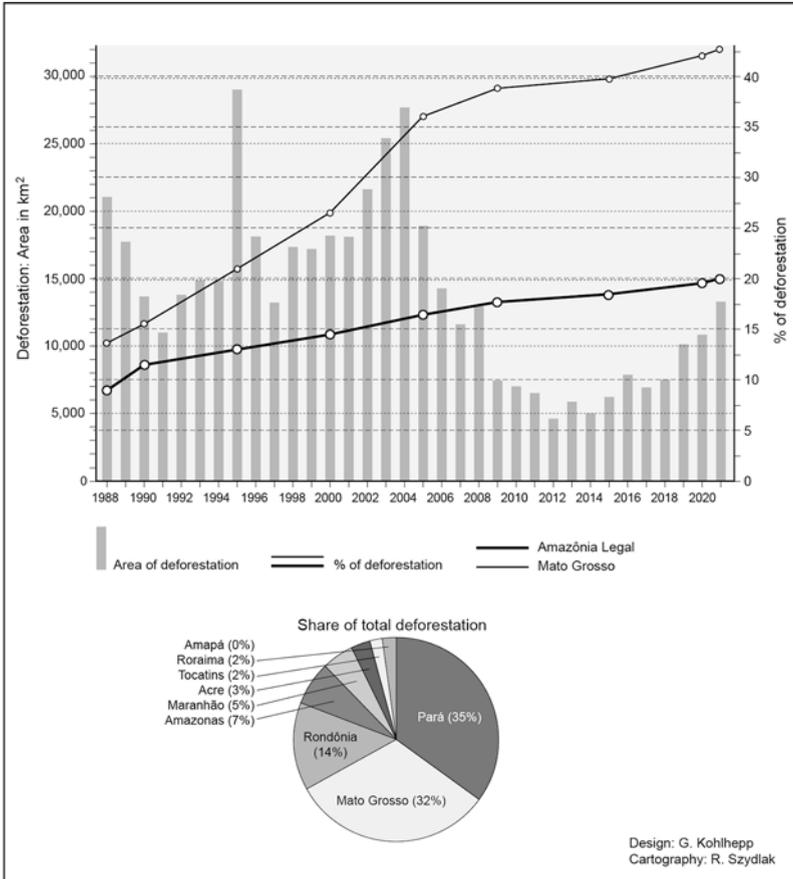
420 According to Jonathan Foley, Climate and environmental scientist, Executive Director of Project Drawdown (Zimmer 2019).

421 Emissions are measured in CO₂ equivalents (CO₂ eq).

422 Source: <https://ourworldindata.org/carbon-deforestation-trade> (accessed April 22, 2023).

to the ground, which lead to dehydration and greatly promote the subsequent risk of fire, are not yet covered. All the data were disputed by Bolsonaro and led to the unjust dismissal of INPE’s director.

Figure 38. Deforestation in Amazônia Legal (1988–2021) (by area and share of states)⁴²³



Source: Data INPE/PRODES. Design: G. Kohlhepp.

In some years, deforestation had reached extremely high levels, corresponding to the extent of some countries. For example, 29 059 km² (about the size of Belgium) of rain forest was cleared in 1995 and 27 772 km² (about the size of Haiti) in 2004. Slash-and-burn, having decreased from 2004 to 2012 by more than 84 % – caused by the soybean moratorium, blacklists, and CAR registry – during the phases I and II of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm), launched in 2004, increased again in recent years but has continued to increase very quickly since 2019 (Fig. 38).

This was also due to illegal clearing in Indigenous territories and protected areas, which amounted to 14 % of total deforestation in the last two decades. The total area de-

423 Annual deforestation is calculated from August 1 to July 31 of the following year.

forested in Indigenous territories during Bolsonaro's first three years was 138 % higher than in the previous three years (2016–2018), according to the Socio-Environmental Institute (ISA). Under Bolsonaro, deforestation in the Amazon region increased by 73 % between 2019 and 2021, reaching its highest level in 15 years. More than 13 000 km² of rain forest were destroyed in 2021, the highest figure reported since 2006. The area deforested in the first half of 2022 (nearly 4000 km²) was 80 % larger than in the same period in 2018, the year before Bolsonaro took office. This shows that even in the main rainy season (until April) more clearing was done than usual, especially as the passability of unpaved paths and roads is very limited during this time.

Table 18. Deforestation in Amazônia Legal 1975–2021 (in % of the original rain forest area and total deforestation area)

Federal states	Original rain forest area (in 1000 km ²)	% of state area	Deforestation 1975–2021			
			1975–1987 in %	1988–2021 in %	Total in km ²	Total in %
Acre	163.7	99.4	4.9	10.2	24 652	15.1
Amapá	113.3	79.5	1.3	1.5	3 155	2.8
Amazonas	1449.7	93.0	1.0	2.1	44 910	3.1
Maranhão	97.4	37.3	55.1	22.8	75 924	77.9
Mato Grosso	473.9	52.5	10.8	31.7	201 649	42.5
Pará	1112.2	89.3	10.7	14.6	281 011	25.3
Rondônia	212.7	89.5	14.9	30.4	96 282	45.3
Roraima	182.8	81.8	1.6	4.9	11 886	6.5
Tocantins	23.5	8.5	52.8	37.3	21 183	90.1
Amazônia Legal	3829.2	76.3	7.6	12.3	760 652	19.9

Source: Own elaboration, based on deforestation data INPE/PRODES; IMAZON (2021, Table 5, original rain forest area); Percentages: own calculations.

In a detailed overview between 1975 and 2021, the dynamism of deforestation in the various phases is becoming abundantly clear. From 1975 to 1987, in the initial phase of modern exploitation of Amazonia, only 7.6 % of the Brazilian Amazon rain forest area were cleared, from 1988 to 2021 12.3 % more, so that in 2021 a total area of 760 652 km² or 19.9 % of the rain forest area of Amazônia Legal were devastated (Fig. 38). This corresponds to the size of Turkey. It is important to remember that at least the same area, but probably almost one million km² of rain forest, has been additionally degraded. This means that about 45 % of the original tropical rain forest area has already been affected to various degrees by deforestation and its side effects.

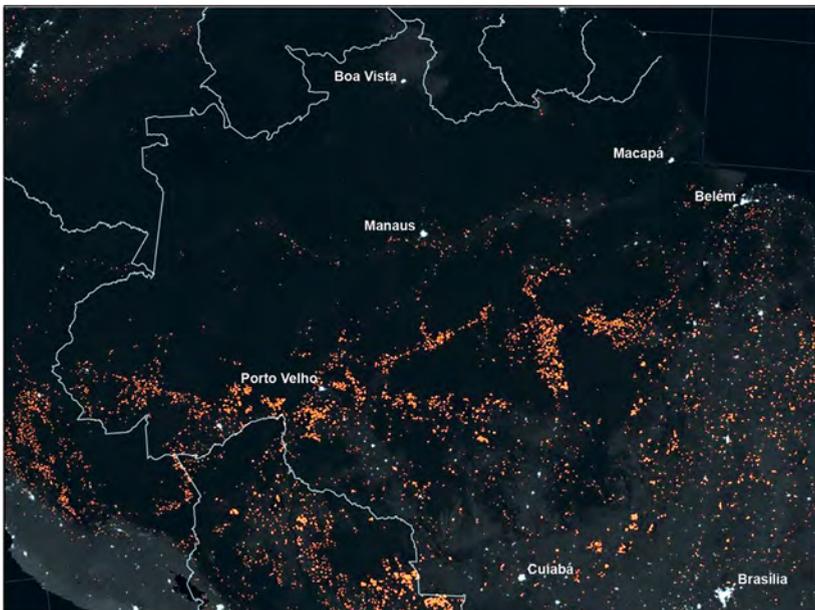
In the individual federal states of Amazônia Legal, deforestation developed very differently. In the states of Maranhão and Tocantins, which have a considerable share

of *campos cerrados*, a high proportion of the existing forest area was cleared very quickly with over 50%. In Rondônia, Pará and Mato Grosso large areas were cleared by agrarian colonisation projects, cattle ranching, and timber industry. Only during the second phase of exploitation, soybean cultivation expanded especially in Mato Grosso.

While in Amazonas, Amapá and Roraima only relatively low percentages of deforestation have been recorded so far, this nevertheless affects relatively large areas. Apart from Tocantins and Maranhão, having only a relatively small original rain forest area in Amazonian relations, which were already deforested by 90 respectively 78%, the states of Rondônia (45.3%) and Mato Grosso (42.5%) account for the largest proportion of deforestation with significantly over 40%. In these states, the increase in the period between 1988 and today was particularly large (Table 18). In Fig. 38, in addition to the curve for the whole area of Amazônia Legal, the curve for the state of Mato Grosso is shown, which had a very rapid rise until 2005 and has since flattened out somewhat but rose sharply again in the last four years. In terms of the share of total deforestation area, Pará (35%) and Mato Grosso (32%) are in the leading position. The area deforested in both states in four and a half decades is almost the size of Spain.

About 80% of the deforestation in Amazonia, accounting for two-thirds of the Brazilian CO₂-emissions, were due to large-scale cattle farms. Only 6% of the area deforested is used by farming, among others for soybean cultivation, which has so far penetrated mainly into the southern and eastern areas due to the generally low soil fertility of Amazonia. Despite of obscure conspiracy theories of the Bolsonaro government relating to probable arsonists – the government even accused NGOs – cattle farmers were also responsible for the majority of the 2019 large-scale fires. A “day of fire” had been proclaimed by ranchers in the state of Pará on August 10, 2019 (Fig. 39).

Figure 39. Forest fires in Amazônia Legal, August 12–25, 2019



Source: MODIS/NASA Earth Observatory/ Joshua Stevens.

It is obvious that the larger forest fires occurred along the main axes of the road connections BR-163 (northern section in Pará) (Klingler 2022), BR-230 (central section of the Transamazônica in Pará and Amazonas), and BR-364 (in Rondônia and especially in Acre). Furthermore, forest fires raged in North Mato Grosso and in the Terra do Meio,⁴²⁴ a region located in the central portion of southern Pará, in the interflaves of the Xingu and Iriri rivers.

Frequently, land speculation was and still is the background of deforestation because deforesting for cattle pasture is the practical way to secure land holdings. Money from drug trafficking, corruption and fiscally undisclosed income sources can be converted by “money laundering” to “legal” money and invested in Amazonian deforestation with minimal risk (Fearnside 2017c).⁴²⁵ Especially in the 1970s and 1980s, the first phase of large-scale exploitation of Amazonia, land speculation often was one of the main factors. In these cases, officially approved cattle grazing projects after a few years were abandoned.⁴²⁶ In some regions, the increase in land prices and land speculation made more profit than raising cattle (Kohlhepp 1979; Hecht 1985 and 1993; Hecht *et al.* 1988).⁴²⁷

The cattle herd in Amazônia Legal has increased from 8 million in the early 1960s to 93 million animals in 2021, i.e., 43 % of Brazil's cattle (224.6 million) graze in Amazonia. The largest cattle population per state in Brazil is in Mato Grosso (32.7 million = 14.4 % of Brazil's total) (InfoAmazonia, 09.11.2021; Greenpeace 2009a). Cattle ranching is expanding in Amazônia Legal despite all attempts to tackle this major problem of deforestation. The “success” of cattle farming in Amazonia with low stocking density (1–1.3 animals/ha) is only ensured by the expansion of clearing new pastures with a very low average productivity at 70–80 kg meat/ha/year. Pasture expansion for cattle production is the main driver of deforestation with about 80% of clearing (Skidmore *et al.* 2021; Global Forest Atlas 2019; Fatheuer 2017).⁴²⁸ The substitution of ranching by more profitable agricultural land use (soybean, sugarcane, etc.) in South and South-

424 Terra do Meio is a region with a rich biodiversity, formed by a mosaic of natural conservation units, including state and federal units, and Indigenous territories. It is a vast area, which is approximately twice the size of the state of Rio de Janeiro. The region is suffering from three major fronts of anthropic pressure: the Altamira-Itaituba section of the Transamazônica to the north, the BR-163 to the west and the most exposed agricultural frontier of the Amazon biome, to the southeast. The mosaic is part of a territory of contiguous protected areas, which covers 28 million ha, and which makes the region the second largest biodiversity corridor in Brazil (<https://www.funbio.org.br> [accessed February 12, 2023]) (Schmink *et al.* 2019). Terra do Meio, especially the region of São Félix do Xingu and Tucumã, was one of the most deforested regions in the Amazon in recent years. The Apyterewa Indigenous Territory (Parakanã people) has lost nearly 30% of its forest cover, with some 5 % cleared in 2019 alone (<https://news.mongabay.com/2023/02/in-brazil-criminals-dismantle-one-of-the-best-preserved-swaths-of-the-amazon/> [accessed September 23, 2023]).

425 The Terra do Meio in Pará, for many years has been dominated by drug traffickers (cf. Schöenberg 2002a, 2002b; Machado 2002; 2009), *grileiros* and other illegal actors.

426 Cf. chapter 1.1.1.2, Fig. 1.

427 In the late 1950s and 1960s, along the Belém–Brasília highway, first settlers were squatters who were later expelled, often violently, and replaced by large ranchers (Fearnside 2017c; cf. Valverde and Dias 1967; Glaser, 1971; Schmink and Wood 1992).

428 Almost 20 % of the land that had been cleared for new pastureland was abandoned and not put to any other productive use (Hirota *et al.* 2022).

east Brazil, and the cheap land prices in Amazonia contributed to a progressive transference of cattle herds to the North (Smeraldi and May 2008).⁴²⁹

Deforestation for cattle pastures even occur in Indigenous territories, conservation units and extractive reserves. Sown pasture with *Brachiaria brizantha* – allowing a reasonable forage production during the dry season – has become the major forage species in Amazônia Legal today, in contrast to *Panicum maximum* in the beginning of cattle breeding in the 1960s and 1970s (Veiga *et al.* 2002),⁴³⁰ which has a higher nutritive value. The main ecological consequences of deforestation are chemical and physical soil depletion as well as weed encroachment. The main technological reasons of pasture degradation are insufficient pasture establishment, neglected management, lack of investments, technology and know-how (P and N fertiliser) (Hohnwald *et al.* 2010; Serrão and Nepstad 1996).

After beef exports had been barred from international markets for some time due to the foot-and-mouth disease, since 2015 no cases of this disease were stated in all states of Brazilian Amazonia. In 2015 and 2016, negotiations with Russia and China have opened these markets to Brazilian beef. The Chinese market is extremely important since its potential scale is infinite from the perspective of Brazilian producers (Fearnside 2017c). Brazil is also China's main supplier of leather.

The cattle industry in Amazônia Legal is dominated by large exporting meat-packing companies that supply the domestic and the international markets. In 2009, Greenpeace (2009b) published a report linking the cattle industry to the deforestation of Amazonia, which caused uproar of the international press. Because this was threatening their export strategies, major meatpackers signed a “cattle agreement” with Greenpeace to block deforestation from their supply chains (Skidmore *et al.* 2021).

Four of the world's largest cattle producers and traders⁴³¹ have agreed to stop buying cattle from newly deforested areas in the Amazon rain forest. In this “cattle moratorium,” they will implement certification and monitoring systems to ensure that beef and leather in their supply chains is not a result of new forest clearings. Cattle and by-products shall only be supplied by farms who have formally committed to adopting a verifiable tracking system. However, some years later, many still have no monitoring systems.

Besides meat processing, JBS also operates in the leather segment and has 15 tannery units, with the capacity to process nearly 50 000 hides per day in Brazil. As the world's largest leather processor, it produces for the automotive, furniture, footwear and leather goods sectors. The non-transparent leather supply chain in Amazonia runs from the cattle ranches via JBS slaughterhouses and tanneries, frequently to the Lear Corporation in Atlanta/USA, one of the world's leading automotive technology companies in the seating sector with its high-quality leather production for car seats for the most important European manufacturers of high-priced cars.

429 In 2007, the number of cattle slaughtered in Amazônia Legal exceeded 10 million, which represented 41 % of the total slaughtered in Brazil that year.

430 Cf. chapter I.1.1.2; Kohlhepp (1979).

431 JBS-Friboi is the world's largest beef producer and global exporter of processed beef. JBS produces and sells beef through two business units: Friboi, in Brazil, and JBS USA Beef, present in the United States, Canada and Australia.

There were actually two agreements: in July 2009 a “term of adjustment of conduct” was signed, and in October 2009 a “zero deforestation agreement” (Fearnside 2017c). The companies also agreed not to buy cattle from ranches using slave labour or illegally occupying protected areas and Indigenous reserves. Land grabbing and land conflicts had to be rejected by the participants.

The agreements had a positive effect, despite problems with “laundering” cattle. “Laundering” cattle occurs when a non-participating ranch moves its cattle to a participating ranch, from which the cattle are sold to one of the signatory slaughterhouses” (Gibbs *et al.* 2016, 39).

Under the “cattle agreement,” “progress has been made on monitoring direct suppliers for deforestation, but broader impacts on forest conservation have lagged behind” (Skidmore *et al.* 2021, n. p.).

With less than one head per ha, cattle ranching has low productivity and, overall, a small local benefit. However, very low production costs and low variability in prices seems to guarantee safe returns in cattle ranching for smallholders to large farmers and agribusiness companies (Skidmore *et al.* 2021).⁴³² Success of cattle farming in Amazonia is only ensured by the expansion of forest clearing for pastures. This makes it difficult to convince cattle ranchers of zero-deforestation, especially those who do not comply with the cattle moratorium and engage in “cattle laundering.”

There were significant shortcomings to the existing cattle agreements. Hundreds of thousands of cattle continue grazing on areas which should have been excluded from the cattle supply chain in Amazônia Legal. This demonstrated the importance of organising new systems for monitoring cattle supply chains in remote areas of the Amazon region (Klingler *et al.* 2018).

The failure of the “cattle agreement” motivated Greenpeace to withdraw from the agreement in 2017 and to renew its campaign to boycott Brazilian beef. This was a challenge for the three largest packaging companies to move their self-imposed deadline for eliminating illegal deforestation back from 2035 to 2025.

Nearly 90% of the timber industry in the Amazon region had been illegal already under previous governments. Questionable statements by top Bolsonaro government officials on environmental issues, budget and job cuts at IBAMA leading to a decrease in regulatory inspections and reduced or no longer imposed penalties for environmental crimes characterised the situation. Thus, IBAMA, which had previously struggled with a shortage of funds, was almost completely deprived of its function. For example, the forest law that stipulates the preservation of 80% of the forest area per plot in Amazonia was on the brink of collapse because it could not be implemented.

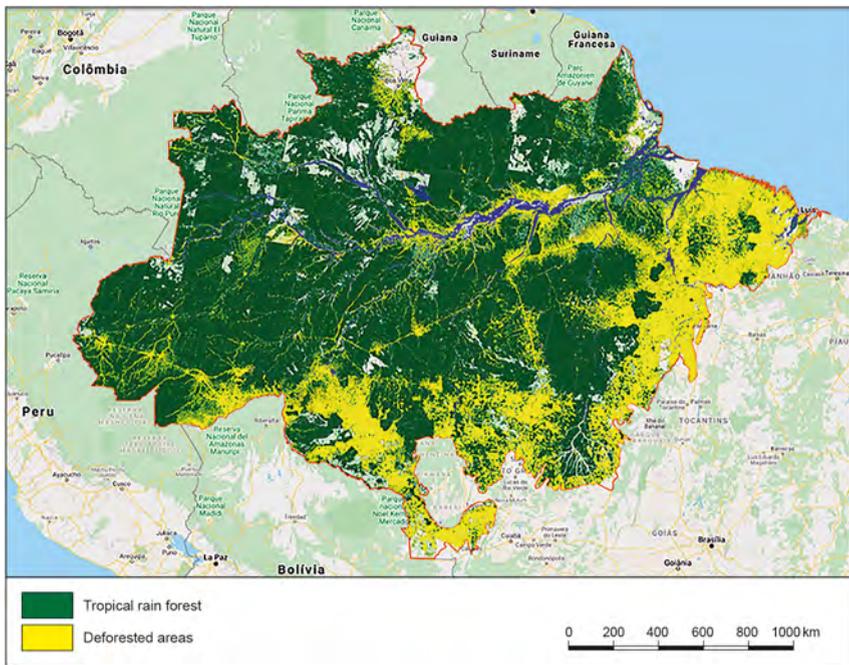
The state of Mato Grosso, where agribusiness with soybean cultivation and huge cattle ranches dominate the economy, wanted to escape the Forest Code, which requires a “legal reserve” of native forests of 80% for any private property with forest in Amazônia Legal. A bill introduced in the National Congress in 2022 provided that Mato Grosso would leave the Amazônia Legal planning region and thus only need to

432 Small farmers are increasingly opting for livestock farming. This is profitable due to the low-interest loans granted for dairy farming and the transfer payments from the bolsa-família programme (Pereira, R. *et al.* 2016). In areas with rising land prices, smallholders often sell their land to land speculators or larger landowners and move to new forest frontiers, where they acquire larger plots and restart the land rotation system.

maintain a legal reserve of 20% as is fixed in forest and *cerrado* areas outside Amazônia Legal (Ribeiro *et al.* 2022). This would then allow huge areas to be legally cleared. The bill prepared under the Bolsonaro government will certainly also cause problems for the government of its successor.

The very well-located mafia-like criminal networks that dominate illegal logging and timber trade could violently secure their influence with their own militias almost undisturbed. Cattle ranchers realised illegal deforestation to a very high degree. Violence and death threats prevented complaints from civil society or posed a very high risk. Even state employees were often openly threatened. The selective logging of hardwood, very sought after on the international markets, is not only lucrative (1 m³: about US\$ 500 in 2019) but a very small, sometimes punctual clearing is unfortunately hardly visible and detectable even by satellite images.

Figure 40. Total deforestation in the Brazilian Amazônia Legal until 2021



Source: Terra Brasilis/PRODES/INPE.

By bribery and falsification of documents, logging and slash-and-burn activities for cattle ranches were “legalised” as well as – unfortunately almost traditionally – land titles illegally acquired (*grilagem*) (Torres *et al.* 2017). These crimes, which lead to social tensions and violent conflicts over land and natural resources, and which had recently increased considerably, can only be combated with improved governance and legal presence on the ground. However, this was hardly or only inadmissibly taking place during the Bolsonaro government. Affected residents even spoke of a *carte blanche* for forest destruction. Uncontrolled activities of several hundred thousand gold and diamond prospectors (*garimpeiros*) contributed in large parts of Amazônia Legal to

environmental damage and violation of legally defined boundaries of Indigenous territories, of ecological corridors or other protected areas. All this led to the fact that earlier positive results under the Pilot Programme (PPG7)⁴³³ were not continued accordingly. Since the 1990s, very many so-called sustainable experiments could not be implemented for the benefit of the local population and their vision of a sustainable regional development of Amazonia. However, in the 2010s, Mato Grosso was a pioneer in testing innovative governance models to promote an integrated model characterised by a better balance between environmental protection and social and economic considerations (Mello-Théry 2016; Arvor *et al.* 2018).

The overall picture of deforestation in Amazônia Legal highlights the problem of the destruction of large parts of the Amazon ecosystems. The eastern areas of the planning region, especially in Maranhão and Pará, are largely deforested. Very clearly, the deforested areas along the eastern section of the Transamazônica and in the Terra do Meio stand out. Forest destruction in North Mato Grosso is very advanced and the development axis of BR-163 shows a strong expansion of economic activities.⁴³⁴

The central section of the Transamazônica is not yet strongly integrated into the economic process of large-scale deforestation. On the other hand, the huge deforestation in Rondônia shows economic activities of agrarian colonisation and expanding ranching that increasingly affect the state of Acre.

The tropical rain forest areas west of the Rio Madeira must be preserved at all costs. This will be a task for future governments. So far, north of the Rio Solimões/Amazonas mainly mining companies have acted selectively but the massively occurring *garimpeiros* are responsible in the state of Roraima for widespread deforestation and destruction of the habitat of the Yanomami.

433 Cf. chapter II.2.

434 See chapters II.4.2; II.4.4; II.5.2. Scholz *et al.* (2003); Scholz (2005); IAG (2004a); UNEP (2006); Fearnside (2007); Passos (2007; 2019; 2022); Coy and Neuburger (2008); Kohlhepp and Coy (2010); Coy and Klingler (2014); Klingler and Mack (2020); Klingler (2022).

