Cover photo Diaz-Chavez. (2015). Eucalyptus plantation in Santa Catarina, Brazil

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Socio-economic assessment of forestry production for a developing pellet sector

The case of Santa Catarina in Brazil

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Content

CONTENT 1

SUMMARY 5

1. INTRODUCTION 7

2. SOCIO-ECONOMIC IMPACTS 8

3. METHODOLOGY AND INDICATORS SELECTED 9

4. THE CASE OF SANTA CATARINA IN BRAZIL 13

4.1 Background information 13

4.2 Production and contribution to local economy 15

4.3 Wood prices 19

4.4 Pellets production 22

4.5 Logistics 41

4.6 Stakeholders 24

5. INDICATORS 25

5.1 Local economy and Employment 25

5.2 Income and Gini index 28

5.3 Gender 34

5.4 Human Development Index 36

5.5 Land Security and land price 38

5.6 Working conditions 39

5.7 Certification 42

5.8 Forest sector and development 44

6. DISCUSSION 45

7. CONCLUSIONS AND RECOMMENDATIONS 48

8. REFERENCES **50**

APPENDIX 1 – INTERVIEWS IN BRAZIL (SUMMARY OF TRANSCRIPTS) **53**

APPENDIX 2 – CALENDAR OF INTERVIEWS **58**

APPENDIX 3 – ADDITIONAL PELLET PRODUCERS IN BRAZIL **59**

List of figures

Figure 1 Dimensions of the Human Development Index (after UNDP, 2016) 12
Figure 2 Growth of planted trees in Brazil, from 2006 to 2014 (Source: SNIF, 2015) 13
Figure 3 Location of planted forests in Brazil, by 2014 (Source: IBA, 2015) 14
Figure 4 Location of planted forests in Santa Catarina (Source: ACR, 2014. The studied area in this project is the one marked by the red square.)..... 15
Figure 5 Profile of the total income of the forest industry in 2013 (Source: SNIF, 2015)..... 16
Figure 6 Average prices of round wood in Santa Catarina, from June 2010 to July 2016 (Higher values = round wood at the industry; lower values = round wood at the forest, before harvesting) (Source: EPAGRI-CEPA, 2016)..... 21
Figure 7. Energia Futura plant..... 23
Figure 8 a) Itajai port; b) Infrastructure at port; c) Transport companies; d) Percentage of imports and exports in 2014 (Itajai Port) 42
Figure 9 Stakeholders identified in Santa Catarina..... 24
Figure 10: Santa Catarina in Brazil, Lages in Santa Catarina (municipality in red) and the Serrana region (the region marked with an arrow) (Wikipedia, 2015)..... 26
Figure 11. Evolution of numbers of direct jobs in Santa Catarina (ACR, 2014)..... 27
Figure 12: Gini index evolution for Santa Catarina State (IBGE, 2016)..... 32
Figure 13: Income distribution in 2014 (based on salaries earned), in the wood and forest sector in Lages. (IBGE, 2016)..... 34
Figure 14. Human Development Index changes (IBGE, 2015) 37
Figure 15. Pellet company in Benedito Novo..... 41
Figure 16. Area certified under FSC (A) by type of forest and state and by CERFLOR (B) total certified area by state (SNIF, 2015)..... 43
Figure 17. Plantations and log companies in Lages 57

List of Tables

Table 1 Indicators of the Global-Bio-Pact Project (2015) 10
Table 2 Selected socio-economic indicators 11
Table 3 Exports of forest products (national wide) and share of Santa Catarina by 2013 (Source: SNIF, 2015) 16
Table 4 Profile of the forest sector in Santa Catarina by 2012 (Source: ACR, 2014) 17
Table 5 Importance of the wood and forest sector (W+F) regarding employment and average income in Santa Catarina and in specific municipalities (IBGE, 2016) 18
Table 6 Average prices in Santa Catarina of biomass products and prices growth along a specific period (Source: EPAGRI-CEPA, 2016) 19
Table 7 Average market prices in Santa Catarina of inputs and costs and their growth in a specific period of time (Source: EPAGRI-CEPA, 2016) 20
Table 8 Average market prices in Santa Catarina of round wood (pine) and their growth in specific period of time (Source: EPAGRI-CEPA, 2016) 21
Table 9 Exports of pellets in recent years (SNIF, 2015) 22
Table 10: Estimates of pellets production in Brazil (tonnes) (Garcia, 2016; and Escobar, 2016 for the alternative information regarding 2014)) 23
Table 11: Profile of local economy in Lages, in the Serrana Region and in Benedito Novo in 2014 (IBGE, 2016). 25
Table 12: Population and employed people (in 2014) by the wood and forest sector in Santa Catarina, and in Lages and Benedito Novo (IBGE, 2016). 27
Table 13: Change in selected economic indicators between 2006 and 2014, in Lages, in the Serrana Region and in Benedito Novo (IBGE, 2016) 28
Table 14 – Employment and Income for Santa Catarina state and selected municipalities in 2000, 2010 and 2014 (ACR, 2014) 29
Table 15: Average income in Santa Catarina and in specific municipalities (IBGE, 2016) 31
Table 16 – Gini index for Santa Catarina state and selected municipalities for 1991, 2000 and 2010 (IBGE, 2016) 31
Table 17: Gini index (based on salaries) in Santa Catarina and in specific municipalities; estimates for 2014 (IBGE, 1016). 32
Table 18: Average income (number of minimum salaries per month) in Santa Catarina and in specific municipalities: median and most frequent case (IBGE, 2016) 33
Table 19 –Women's share of income for Santa Catarina state and selected municipalities in 2000, 2010 and 2014 35
Table 20: Share of women among workers and average workers' age in Santa Catarina and in specific municipalities; figures for 2014 (IBGE, 2016). 36
Table 21: Municipal Human Development Index (IBGE, 2016) 37
Table 22: Land prices and price's growth in Municipalities in Santa Catarina (EPAGRI-CEPA, 2016) 38
Table 23. ILO Conventions and state in Brazil (ILO) 39
Table 24 – Forestry production in Santa Catarina state for 1991, 2000, 2010 and 2014 and total correlation between forestry production and selected indicators. 44

Summary

Improvement of socio-economic conditions is a relevant goal for the further development of biomass and bioenergy production and trade. Several factors, including geographical location and local economic conditions, influence local quality of life as well as society's development. To spread and effectively bring socio-economic development to a region or a whole country, public policies directly focused on areas with reduced opportunities in terms of jobs, public health and education are necessary. In particular in rural areas, the conditions cannot be generalised considering that there is a remarkable heterogeneity in the development trajectories of rural regions that go far beyond the traditional, generalized image of rural disadvantage.

Woody biomass use for modern bioenergy production (e.g. electricity production or residential heating) is a form of renewable energy, which is often promoted in rural areas. One example is the production of wood pellets from feedstocks such as sawdust, thinnings and pulp-quality logs. The production of woody biomass depends mostly on forestry related sectors. The woody biomass feedstock should be sourced while minimizing negative impacts on society, and ideally prevent or help mitigate negative trajectories, the forestry sector may be in to continue guaranteeing the mitigation of impacts on vulnerable communities in rural areas. This report aims at understanding some impacts of forestry production and the emerging wood pellets sector on the local society using well-established indicators to reveal the dynamics between local development and forestry activities. Indicators to measure these impacts are selected based on four basic rules, namely measurability (even if qualitative), easiness to gather data, usefulness of assessing socio-economic impacts and temporality. Eight issues were chosen for the analysis: (1) Local economy and Employment, (2) Income and Gini index, (3) Gender, (4) Human Development Index, (5) Land security and land price, (6) Working conditions, (7) Logistics, and (8) Certification for exports.

Wood pellet production has already been taking off in a number of countries in the EU, British Columbia (Canada) and especially the South-East states of the USA. However, it is also of interest to assess what the potential impact of wood pellet production could be in other world regions with a significant forestry sector where wood pellet production is still developing. In Brazil, the forestry sector grew strongly due to a very low starting point and shows positive results in its development, which could be explained by the close relationship between the forestry industry and the local communities. Selected criteria, index and indicators were applied in a selected region in Santa Catarina, Brazil. The secondary data was gathered from industry and government sources and combined with primary data gathered from in-depth interviews and visits to the region. In Santa Catarina there is availability of resources from the forestry production but the pellet production sector is yet incipient and mainly for regional use. Santa Catarina represents 8.5% of the country's total planted forests, having 82% of that area covered with pine. Wood production mainly supplies the pulp and paper industry, as well as the timber industry. More specifically, the area studied in this report (Lages) represents 60% of the wood production in the state.

There still exist methodological challenges for socio-economic assessments, particularly regarding the lack of specific data about the recently emerged bioenergy sector on pellets production. It is difficult to disaggregate data of the overall forestry sector and the wood pellet industry, especially due to the still very limited volume of pellet production in Brazil. Therefore, there is yet research needed for improving this type of monitoring especially as the pellet production in Brazil is starting to grow.

1. Introduction

Due to the EU objectives to reduce emissions under the Renewable Energy Directive (RED, 2009) and the objectives of pushing forward the green economy in the EU, biomass exports for electricity, heat and biomaterials are expected to increase in the next 20 years.

Several studies have been conducted to evaluate the main supply chains regarding environmental issues such as GHG emissions, land use, and indirect land use. Nevertheless, there are few studies to understand the socio-economic implications of this biomass production (e.g. Wear and Greis, 2013, Garcia, 2016) in developed and emerging economies. Several factors, including geographical location and local economic conditions, influence local quality of life as well as the society's development. Distance to regional urban centres, local population density, local market size and even infrastructure issues as electricity and highway networks are just samples of locational variables used to capture the effect of local development (Jonasson and Helfand, 2010).

The Overseas Development Institute (Locke and Henley, 2014) indicated that a starting point for assessing socio-economic impacts would be to use a different analytical framework to assess the balance and distribution of different impacts on (socio-economic) issues with comparison points. It also recommended using more data from baseline surveys and longitudinal studies that allow comparison before-and-after impacts and comparison over time and across target populations.

To spread and effectively bring development to a country or a region, public policies directly focused to improve conditions on areas with reduced opportunities in terms of jobs, public health and education are necessary. In general, in rural municipalities income is inferior, infrastructure is reduced and non-farm jobs are not abundant, leading to high levels or emigration to urban centres. The connection between rurality and backwardness, however, cannot be generalized, considering that there is a remarkable heterogeneity in the development trajectories of rural regions that go far beyond the traditional, generalized image of rural disadvantage. In this sense, many well profitable crops have brought development into municipalities when other activities were not feasible in remote areas (European Commission 2008).

Socio-economic impacts have been investigated mainly on the use of biomass for traditional uses such as cooking stoves, or for the production of liquid biofuels. This report focuses on socio-economic impacts from the production of forestry that is associated as a proxy to the production of pellets used the framework developed by the Global-Bio-Pact project (Rutz and Janssen, 2014) and assessed a selected number of socio-economic indicators related to the biomass production and conversion supply chain in particular of pellets for the EU biomass market. For this report, Brazil was selected as a case study, being a potential supplier of solid biomass (pellets) but not yet fully developed. Brazil is one of the world's leading countries in consumption of bioenergy from solid biomass (IEA, 2011). Biomass makes at least 25% of the overall final energy consumption: ethanol 5.1%; biodiesel 1.3%; wood 6.3%; bagasse 10.8% and charcoal 1.5% (EPE/MME, 2015). Besides sugarcane bagasse wood and forestry residues are the main solid bioenergy feedstocks used in the country. Around 41 million tonnes of forestry biomass residues are produced in Brazil each year, which can contribute with around 1.7 GW of electricity generation (ABRAF, 2013). However, wood pellets as such are barely produced and none or only negligible amounts are exported (FAO, 2016).

The overall aim of the project is to use the socio-economic framework to identify and analyse selected socio-economic indicators to the forest sector of Santa Catarina in Brazil and discuss implications for a developing pellet sector in the region.

2. Socio-economic impacts

Human activities cause impacts. Activities in biomass supply chains have impacts, same as the input and output resources, products or activities associated to them. The impacts may occur at different levels (local, regional, national). Furthermore, in environmental management there are different types of impacts including physical or socio-economic, direct or indirect, cumulative, long or short term, reversible or irreversible, qualitative or quantitative, among others (Glasson et al, 2012).

The classic approach is to identify, assess and monitor environmental impacts but these impacts should not only refer to the biophysical environment. The environment is structured in different forms with different components, scales and time (Glasson et al, 2012). Therefore it also has economic and socio-cultural dimensions, mostly approached as socio-economic. They include for example labour markets, demography, lifestyles and values.

In the context of bioenergy, different impacts have been assessed in supply chains such as working conditions, land use rights, child labour, health and safety, forced labour, wages, working hours; contracts and subcontractors (Diaz-Chavez, 2011). Nevertheless, social impacts tend to be more difficult to monitor and quantify as they require more in-depth studies and sometimes time consuming and costly household surveys (Diaz-Chavez, 2014).

The impacts can be assessed, predicted or monitored through different environmental management tools such as Environmental and social impact assessment (ESIA), sustainability assessment (SIA) or strategic environmental assessment (SEA) (Vis et al, 2014; Diaz-Chavez, 2011). Some standards were developed in order to asses through audits some productive supply chains mainly in the production of liquid biofuels (EC, 2016; ISO, 2015). Thus, the implementation of standards might provide an effective means of bringing together organizations that are already monitoring impacts and certifying activities but considering this monitoring refers more to the compliance of the standards rather than the actual impacts.

What most of the frameworks in sustainability assessment and standards have in common is the use of indicators. Indicators are employed to inform about a system's performance and evolution towards a certain goal, as well as to express tendencies that are not straight-forward (Bellen 2004). In other words, an indicator serves the purpose of identifying how a system works. Socio-economic indicators are used to analyse a particular social phenomenon or society as whole. They are useful for monitoring developments over a period of time; they are appropriate for including within a standard or certification scheme; they may be derived from qualitative and quantitative data (Diaz-Chavez, 2014).

Socioeconomic indicators encompass several aspects of human life, which are connected directly with welfare and life satisfaction, and have gone from simple monetary measures to multidimensional aspect of the indicators seen today (Matarrita-Cascante 2010).

Objective socioeconomic indicators are societal measures, which reflect people's objective circumstances in a certain cultural, geographical or economic unit. The concept of socioeconomic indicator embraces several measurements of variables representing a wide range of societal domains. On one hand, areas such as human rights, welfare and education had frequently been used in the sphere of social indicators, and, on the other hand, wealth and monetary measurements had been used in the economic sphere of indicators, although wealth factors are key to social development. Diener & Suh (1997) point out several strengths when choosing social (objective) indicators, as objectiveness, the fact they reflect normative ideals of a society and the opportunity of learning from the information provided. One limitation, nonetheless, is the subjective decision in selecting and measuring variables.

Selected socio-economic indicators have been applied in the bioenergy sector in Brazil mainly for the biofuel production supply chains (e.g. Macedo in BNDES 2008, Azanha et al, 2015). These papers have shown socio-economic improvements in the supply chains using data of 30 years on for example on the Human Development Index. The use of new indicators or index that demonstrate more positive socio-economic impacts that go beyond job creation and workers conditions as in traditional assessments in bioenergy may contribute to a better understanding particularly in developed countries and emerging economies such as Brazil.

3. Methodology and indicators selected

The state of Santa Catarina was selected for the case study as it is a region with tradition on eucalyptus and pine production and recently developed small-scale pellets production for national/regional use. In Santa Catarina the planted area in 2014 corresponded to 8.5% of the total forest planted area in Brazil. The wood and forest sector is the third most important in Santa Catarina, considering jobs, and the second considering its contribution to the Gross Domestic Product (GDP). Although there is little experience with large-scale production of pellets in Brazil, it has started to demonstrate potential with local production.

The proposed methodology followed the socio-economic assessment framework developed for the EU FP7 funded project Global-Bio-Project[1] which aimed to assess the impacts of biofuels supply chains in different countries across the world. The set of indicators developed with partners and other stakeholders was applied to two supply-chains of sugarcane, in Brazil, and of soy-bean, in Argentina. A number of socioeconomic sustainability criteria and indicators were selected to be included in the Global-Bio-Pact project (Diaz-Chavez, 2014). These indicators aimed to measure socioeconomic impacts of biomass production and cover a wide range of aspects related to macro and micro socioeconomic sustainability, including contribution to local economy, working rights and working conditions, health and safety, gender, land rights and conflicts, food security and a range of environmental impacts that could affect local communities (Table 1).

In the Global-Bio-Project field tests were conducted where the operation industries were asked to fill in a questionnaire that covered different aspects of the indicators. This was followed up with a visit to the facilities and production areas. The original framework conducted interviews with main stakeholders and employees.

[1] http://www.globalbiopact.eu/

Table 1 Indicators of the Global-Bio-Pact Project (2015)

Impact	Examples of indicators
Basic information	
Framework conditions	Location, average yield
Socio-Economic	
Contribution to local economy	Value added, employment
Working conditions and rights	Employment benefits
Health and Safety	Work related accidents
Gender	Benefits
Land rights	Land rights and conflicts
Food security	Land converted from staple crops
Environmental	
Air	Open burning
Soil	Soil erosion
Water	Availability of water
Biodiversity	Conservation measures
Ecosystem Services	Access to ecosystem services

In this project, the criteria selected from the set of indicators of the Global Bio-Pact was adapted to this assessment as the EU project focused on liquid biofuels production. The criteria used for this assessment is presented in Table 2. The indicators are both qualitative and quantitative in nature but the qualitative indicators are also presented in a narrative form.

In an attempt to understand the impacts on local society of a future production of pellets, this report deals with well-established indicators that can reveal the dynamics between local development and forestry activities. Based on four basic rules for indicators including measurability, easiness to gather data, usefulness of assessing socio-economic impacts and temporality, as proposed by Diaz-Chavez (2014), eight issues were chosen for the analysis: (1) Local economy and Employment, (2) Income and Gini index, (3) Gender, (4) Human Development Index, (5) Land security and land price, (6) Working conditions, (7) Logistics, and (8) Certification for exports.

The background information (first criterion in the framework) was conducted as well as the identification of stakeholders, field visits and in-depth interviews.

Table 2 Selected socio-economic indicators

Impact	Examples of indicators	Applied to the case study
Basic information		
Framework conditions	Location, average yield	
Socio-Economic		
Contribution to local economy	Value added, employment	HDI, Gini, Number of workers/producers
Working conditions and rights	Employment benefits	Sustainable reports
Gender	Benefits	Equity issues
Land rights/property	Land rights and conflicts	Land tenure
Certification	Compliance	Indication of certification schemes used

Among the criteria considered to include for the socio-economic assessment was the Human Development Index (HDI). According to the United Nations Development Programme (UNDP, 2016), the HDI was created as the main criteria for assessing the development of a country or region based more on people and their capabilities and not just on economic growth. It is an average of key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions (Figure 1). The Index includes three relevant dimensions which are the decent standard living, health and knowledge.

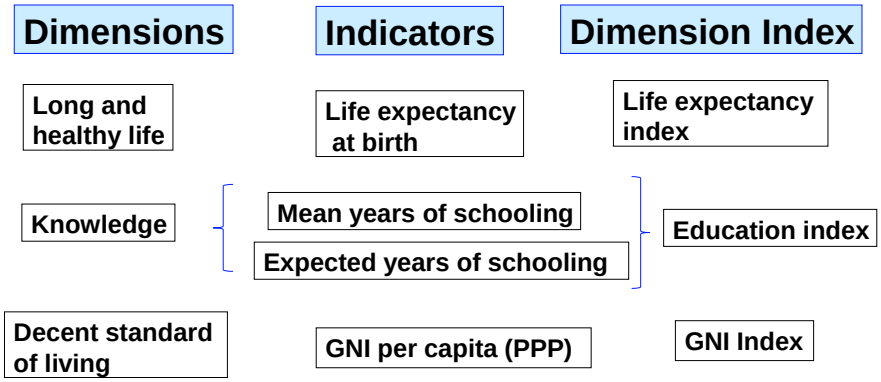


Figure 1 Dimensions of the Human Development Index (after UNDP, 2016)

Although there are difficulties attributing some socio-economic indicators to the bioenergy sector in general (as they include different sectors such as agriculture, forestry, and industry), this research highlights some of these links and how the activities within the bioenergy sector may impact both positively and negatively in local and regional communities.

Data

Secondary data was mainly used completed with in-depth interviews. Income data was obtained from the Annual Social Information List (RAIS), provided by the Work and Employment Ministry (MTE) (MTE, 2016), and was presented for the whole economy, for the forestry sector (wood production sector) and for the wood and paper sector (transformation sectors). This database includes only the formal jobs, and data was available for 2000, 2010 and 2014. The Human Development Atlas (PNUD, 2016) provided data for HDI-M (Municipal Human Development Index) and Gini index.

After the field trip to Santa Catarina, as agreed during the visits, questionnaires were sent to the companies and organizations aiming at complementing the information gathered. Despite repeated efforts it was not possible to get additional data. Thus, the indicators presented in this report are based on secondary data (national surveys) and are aggregated to the municipal level.

4. The case of Santa Catarina in Brazil

4.1 BACKGROUND INFORMATION

Worldwide, Brazil has the second largest forest area (Russia has the largest). More than 60% of the Brazilian territory is covered by forests (estimated at 524 million hectares in 2008, or 61.5% of the total area, according to Brazil, 2009). The Brazilian share of the Amazon tropical forest corresponds to the bulk of the national natural forests – 69%. Planted forests correspond to less than 2% of the total forests in Brazil (SNIF, 2015).

The total planted area grew from about 6.1 million hectares in 2006 to more than 7.7 million hectares in 2014, i.e., a continuous growth with an annual average growth rate of 3.06% along the period (Figure 2). The planted area with pine decreased in these eight years (from approximately 1.9 to 1.6 Mha, figures from 2006 and 2014, respectively), while the planted area with eucalyptus (from 3.9 to 5.6 Mha) and other species (from 0.33 to 0.59 Mha) grew in the same period (SNIF, 2015).

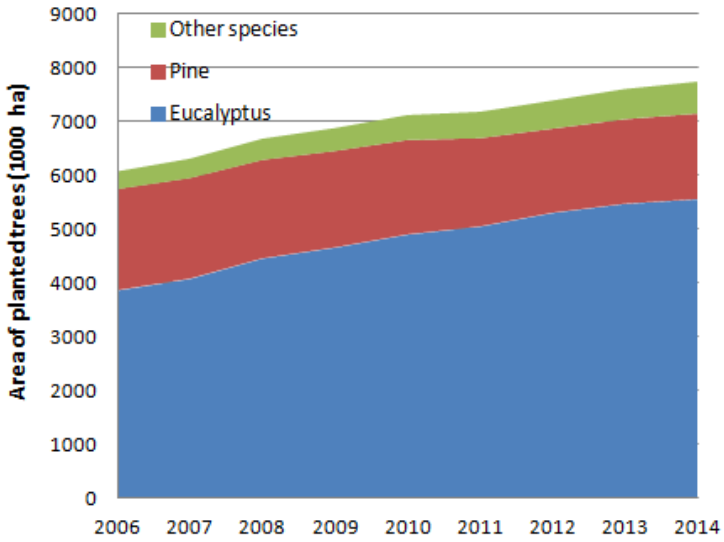


Figure 2 Growth of planted trees in Brazil, from 2006 to 2014 (Source: SNIF, 2015)

Planted forests are distributed in different Brazilian states (Figure 3). Santa Catarina (SC), in the south, is the state where the case study was developed in this project. In Santa Catarina the planted area in 2014 corresponded to 8.5% of the total planted area in Brazil and in this state the bulk of plantations is with pine (82%) (Estimated at 540 thousand hectares), followed by eucalyptus (17%) (about 112 thousand hectares). In Brazil, according to the National Association of Entrepreneurs acting in the planted tree sector (IBA, 2015), 34% of the planted area (in 2014) belonged to companies of the pulp and paper segment, while 28.6% belonged to out growers (independent operators) who are, in general, small and medium-sized producers (IBA, 2015). Financial investors hold 10% of the planted trees in Brazil.

As of the total planted area in Brazil, 63% (almost 4.9 Mha) are certified by organizations such as the Forest Stewardship Council (FSC) (2.6 Mha exclusively by FSC) and/or the Programme for the Endorsement of Forest Certification Schemes (PEFC) (0.6 Mha exclusively by PEFC) (1.7 Mha by both) (IBA, 2015).

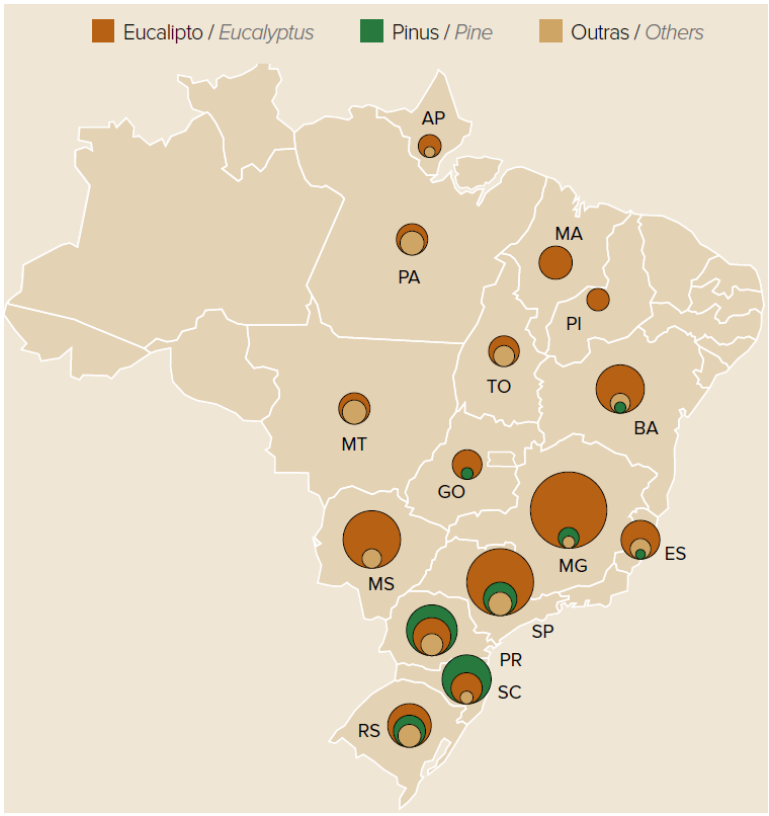


Figure 3 Location of planted forests in Brazil, by 2014 (Source: IBA, 2015)

Figure 4 shows the planted forests in the main regions of Santa Catarina. The purple areas represent where the planted areas are mostly concentrated (planted areas higher than 20,000 hectares). The studied area in this project is the one marked by the red square, where Lages – in the south – is the main city. In the studied region (called "Serrana") most of the pine production aims at pulp and paper industry and timber.

Araucaria (*Araucaria angustifolia*) is the natural pine in the Brazilian south. In Santa Catarina, deforestation started in the 1910s in the whole State, while around Lages, deforestation started later in the 1940s, mainly due to the topography and accessibility. In less than three decades the natural vegetation in the Serrana region was almost completely removed. In the 1960s, due to the lack of wood, the Federal Government started programs aiming at reforestation for timber and for the pulp and paper industry; in Santa Catarina the investment was for planting *Pinus elliottii*, originally from North America (Silveira, 2005).

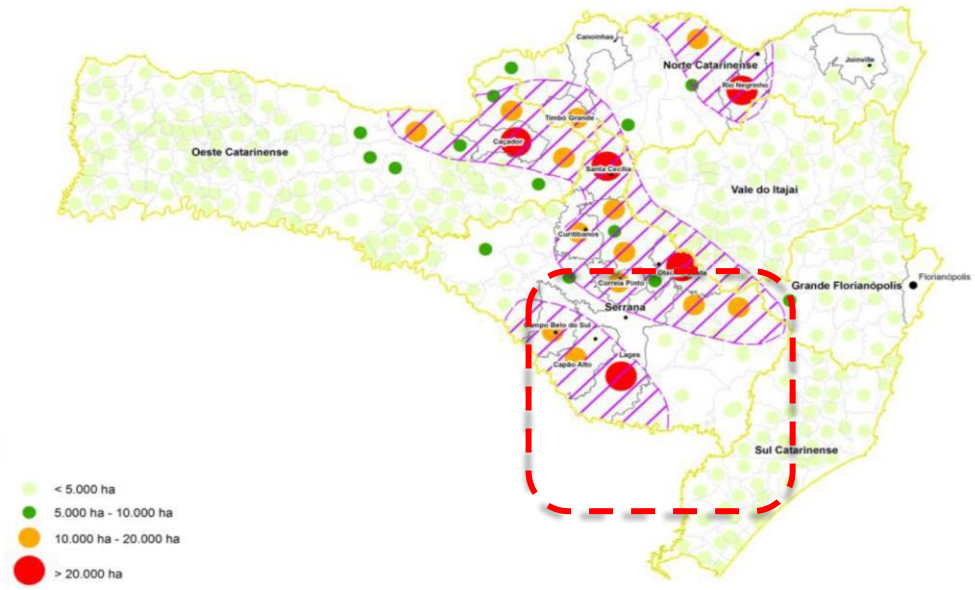


Figure 4 Location of planted forests in Santa Catarina (Source: ACR, 2014. The studied area in this project is the one marked by the red square.)

More recently, another program (conducted by the State government) was based on subsidies from the government and put priority on pine trees. The program failed because of the low demand and also because in the last 10 years the preference moved to plantations of eucalyptus (*pers comm*. Joseli Stradioto, 2015). Although the market for wood in the region is still ongoing, it moves at a lower pace.

Around Lages there are 3,300 rural properties involved with wood production. A very small producer is the one who has up to 10 hectares of forests and this represents about 10% of the total. About 2 thousand units are classified as small (up to 80 hectares of forests) and medium (up to 300 hectares) producers (*pers comm*. Joseli Stradioto, 2015). Small wood producers have difficulties for selling as the main buyer in the region is a large pulp and paper industry (Klabin) that has its own production and imposes low prices. More recently (the last 3-4 years) no one is interested to start wood production (*pers comm.* Carlos Peron, 2015).

Large wood producers are those who have planted areas surpassing 30 thousand hectares, but there are few of them; in general, they are suppliers of the pulp and paper industry. Wood producers can both harvest or let the harvest to be done by sawmills (*pers comm.* Giovani Arruda).

In Santa Catarina the most recent tendency is a reduction of the forest area due to the expansion of soy (farmers are also cropping wheat during the off-harvesting). Considering land availability, the enlargement of planted forests in Santa Catarina is currently limited by the attractiveness of agriculture and by environmental constrains (e.g., requirements for preserving areas with natural vegetation). It would be necessary to enlarge forest productiveness and there is room for that taken into account the results achieved by investors on eucalyptus (*pers comm*. Mauro Murara).

4.2 PRODUCTION AND CONTRIBUTION TO LOCAL ECONOMY

According to the SNIF (2015), in 2013 the value of the total production of forest products in Brazil was estimated at 34.2 billion US$ (24.8 billion Euro) (considering the exchange rate in

December 2013), or about 1.5% of the national GDP at that year. Considering the total income in the forest industry in 2013, the share of the different products was mainly represented by the pulp and paper industry followed by panels, secondary wood (category that includes pellets) and lumber industries (Figure 5).

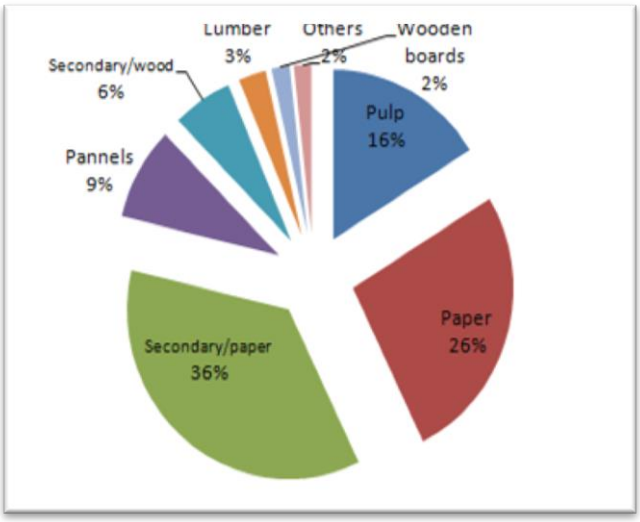


Figure 5 Profile of the total income of the forest industry in 2013 (Source: SNIF, 2015)

In the same year, the exports of forest products summed up 9.7 billion US$ (10.4 billion US$ in 2015), or about 28.5% of the income of this economic sector, being the largest shares by pulp exports (53.3%), paper (17.9%) and secondary wood products (14.6%) (SNIF, 2015). The share of Santa Catarina in the national exports of some forest products by 2013 is presented in Table 3.

Table 3 Exports of forest products (national wide) and share of Santa Catarina by 2013 (Source: SNIF, 2015)

Product	Value of Exports (million US$)	Share of Santa Catarina (%)
Paper	1,970.0	10
Furniture	468.9	37
Wooden boards	398.1	27
Wooden doors	174.0	75
Timber	168.7	38

Product	Value of Exports (million US$)	Share of Santa Catarina (%)
Panels	132.5	6

Santa Catarina's total population is around 6 million inhabitants and has 295 municipalities. Regarding formal jobs in the forest sector, in Brazil, 668 thousand were reported in 2013 (666.4 thousand in 2014), being 31% in the furniture industry, 27.2% in the pulp and paper industry, 11.7% in sawmills and 9.7% in planted forests. From 2006 to 2014 the number of jobs increased almost 20% in the pulp and paper industry, while the number of jobs in sawmills decreased 27% in the same period (steady tendencies); the number of jobs in planted forests increased almost 30% from 2006 to 2011, but decreased 11% from 2011 to 2014 (SNIF, 2015). In Santa Catarina, the number of jobs in the forest sector in 2012 was estimated at 90.6 thousand, i.e., 13% of the national total jobs in this sector in that year (ACR, 2014).

Table 4 Profile of the forest sector in Santa Catarina by 2012 (Source: ACR, 2014)

	Companies/Share at the state	Jobs/Share at the state
Number	4,980	90,551
Sawmills	47%	43%
Furniture	37%	28%
Pine plantations	12%	7%

In 2014, the number of jobs in Santa Catarina in the wood and forest sectors was 96.5 thousand, slightly more than 4% of the total formal jobs in the whole state in that year (estimated at 2,273.9 thousand) (IBGE, 2016). In the State, about 8.5% of the jobs in the forest and wood sector were in Lages, the municipality that was chosen for the case study in this project. Comparatively, considering number of jobs, the importance of the wood and forest sector is larger in Lages than in the state as a whole, as can be seen Table 5. This table also presents the average income per capita, per month, in the municipality and the income related to the wood and forest sector; it can be seen that the average income in the wood and forest sector is 17% larger than the average in Lages, but 23% lower than the average in the state (IBGE, 2016). Table 5 presents information about two other municipalities: Benedito Novo, where a pellet mill is located, and this

unit was also visited during the project; Rio Negrinho is the centre of another wood and forest pole in Santa Catarina, and where another pellet mill is located. Currently there are three pellet mills in the state.

Table 5 Importance of the wood and forest sector (W+F) regarding employment and average income in Santa Catarina and in specific municipalities (IBGE, 2016)

	Population [1]	**Number of employees (thousand)** [2]		**(W+F) /T**	**Income (Euro/capita/month)** [2]	
		Total (T)	Wood & Forest (W+F)	Share (%)	Total	Wood & Forest (W+F)
Santa Catarina	6,919,553	2,273.9	96.5	4.2	566	435
Lages	158,620	68.9	8.2	11.8	444	522
Benedito Novo	11,297	3.3	1.0	31.5	432	430
Rio Negrinho	41,817	11.8	3.7	31.3	424	409

[1] estimated in 2016

[2] in 2014, assuming 3.619 Euro/Real, the exchange rate at the end of 2014

Although it is reported that more than 95 thousand direct jobs related with the wood and forest sector exist, it is estimated that the economic activity contributes with more 300 thousand indirect jobs (*pers comm*. Mauro Murara, 2015).

4.3 WOOD PRICES

The last information of average prices in Santa Catarina, for wood shavings, sawdust and logs is for July 2016 and the series available is for prices since August 2007 (Table 6). Thus, it is possible to compare the evolution of prices with the inflation in the period, and the results are presented in the table. It can be seen that for wood shavings and sawdust prices change according to the inflation, but in case of logs the prices show the devaluation.

Table 6 Average prices in Santa Catarina of biomass products and prices growth along a specific period (Source: EPAGRI-CEPA, 2016)

Product	Price in July 2016	Growth	Period	Inflation in the period
Wood shavings	26.20 R$/m3	81.3%	Aug 2007-July 2016	84.3%
Sawdust	19.60 R$/m3	81.7%	Aug 2007-July 2016	84.3%
Log of pine for construction	20.42 R$/m3	41.0%	Aug 2007-July 2016	84.3%

The prices shown on the table above are average figures for the State of Santa Catarina and not for a specific locality. As for all goods in the economy, prices are defined by the interaction of demand and supply. Due to the economic recession in Brazil, there is low demand for materials used in the construction of buildings. The most remarkable change on prices, or costs, of some inputs of wood production was related with the payments for rural workers – in case of hiring people for short-term and for specific tasks – that grew much more than the inflation from 2007 to 2016 (Table 7). The minimum salary at national level grew 131.6% in the period August 2007 to July 2016 (from 380 R$/month to 880 R$/month; the value have been corrected once a year, at the beginning of a calendar year). The policy in Brazil has been correcting the minimum salary above the inflation. Regarding road freighting, in recent years, the costs in real terms decreased for large distances (e.g., 1,000 km) but increased for short distances (e.g. 50 km).

Table 7 Average market prices in Santa Catarina of inputs and costs and their growth in a specific period of time (Source: EPAGRI-CEPA, 2016)

Product	Price in July 2016	Growth	Period	Inflation in the period
Sapling (pine)	0.30 R$/unit	49.2%	Aug 2007-July 2016	84.3%
Payment to rural workers	99.83 R$/day	183.1%	Aug 2007-July 2016	84.3%
Road freight (50 km)	36.77 R$/t	71.8%	Aug 2011-July 2016	41.2%
Road freight (100 km)	46.17 R$/t	89.0%	Aug 2007-July 2016	84.3%
Road freight (1,000 km)	175.80 R$/t	43.6%	Aug 2007-July 2016	84.3%

In 2015, there was a deep reduction of the prices paid in Santa Catarina for round wood, both for the wood at the forest (before harvesting) as for the wood at the industry (Table 8). Nominal prices in the period June 2010 to July 2016 declined 11% to 19% respectively, when the inflation at national level was about 54%. Figure 6 shows details of the price trends in the period: it can be seen that for round wood at the industry the nominal prices dropped throughout the period, while for standing trees (wood at the forest site) the nominal prices declined just at the end of 2014 (EPAGRI-CEPA, 2016)

Table 8 Average market prices in Santa Catarina of round wood (pine) and their growth in specific period of time (Source: EPAGRI-CEPA, 2016)

Product	Price in July 2016	Growth	Period	Inflation in the period
Round wood at the forest[1]	58.63 R$/m3	- 18.58%	Jun 2010-July 2016	54.4%
Round wood at the industry	108.98 R$/m3	- 11.30%	Jun 2010-July 2016	54.4%

[1]Standing trees, i.e., before harvesting

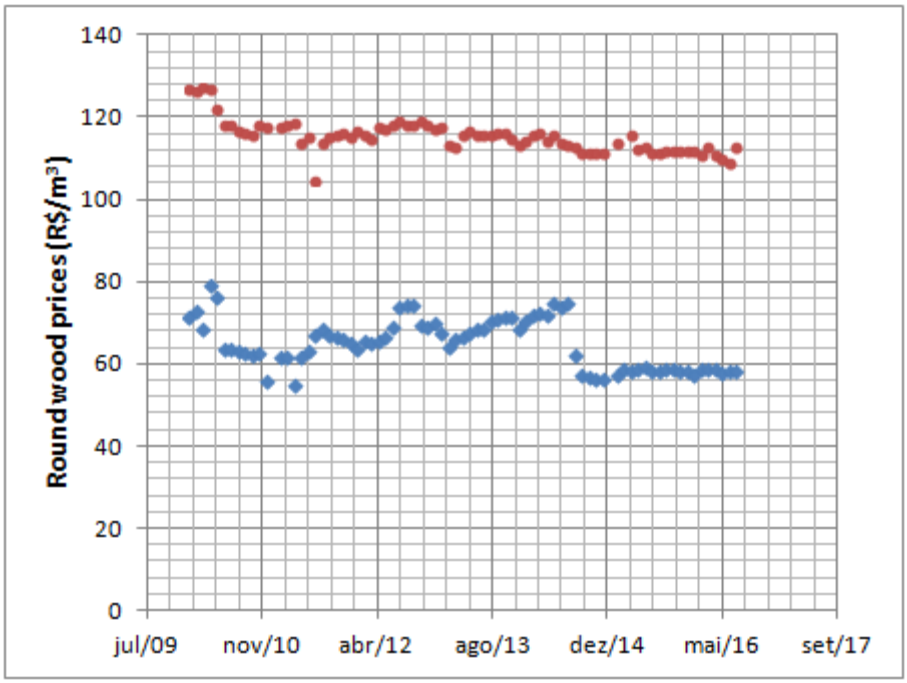


Figure 6 Average prices of round wood in Santa Catarina, from June 2010 to July 2016 (Higher values = round wood at the industry; lower values = round wood at the forest, before harvesting) (Source: EPAGRI-CEPA, 2016)

Currently, there are about 260 sawmills in Lages and in the region around. In the past (e.g. 1980s) there were more sawmills in the region, but the tendency has been the concentration, with few units of more capacity (a medium-size sawmill processes 10 thousand tonnes/month). Standard requirements and scale effects explain this tendency (*pers comm.* Giovani Arruda, 2015). Considering the production of panels and Medium density fireboard (MDF) plates, 60 to 70% of the production is exported and the bulk is for the USA. Also in the region there are two

pulp and paper industrial plants (they belong to the same company – Klabin) which are the largest consumers of wood (the total demand is estimated at 230,000 tonnes per month).

In 2001, Tractbel decided to build a 28 MW cogeneration plant in Lages (the commercial operation started in 2013), fuelled with biomass, and at that time there was no constrain regarding the biomass supply and the prices were relatively low. This was not the case in 2015. Different industries (including a pulp and paper plant), the thermal power plant and also pig and chicken farmers (they use residual biomass to cover the soil) demand residual biomass from industries and the demand heated up (*pers comm.* Martha Brand, 2015).

4.4 PELLETS PRODUCTION

The information about the production of pellets in Brazil is not accurate but, on the other hand, the figures about exports of pellets seem to be precise. The reason is that the Brazilian Government monitors trade flows and exports of pellets have been specifically registered, while the production of pellets is presented diluted in the category "secondary wood products". Officially, exports of pellets started in 2012 and continuously grew since them, as can be seen in Table 9.

Table 9 Exports of pellets in recent years (SNIF, 2015)

	2012	2013	2014	2015
Tonnes	6	194	6,660	24,368
1,000 US$	9.7	47.9	1,409.3	4,360.6
US$/t (average)[a]	1,619.3	246.8	211.6	178.9

Note: [a] Values calculated by the authors.

In 2015, the bulk of the production for exports was in Santa Catarina state (about 93%), with a small contribution of Rio Grande do Sul (about 5%) and Paraná. In the same year, in practice, Italy was the only destination of Brazilian exports (99.4%).

According to the pellets association (ABIPEL[2]), in 2014 there were 13 industries producing pellets – or able to produce – with a total installed capacity of 176 thousand tonnes per year; about 80% of this producing capacity is located in Brazilian south (43 thousand tonnes in Santa Catarina). Table 10 shows the estimates of pellets production in Brazil from 2011 to 2014; in 2014, according to Garcia (2016), there was a reduction of about 20% on the production capacity (it seems that three plants closed down) compared to previous years.

[2] http://www.abipel.com.br/

According to Escobar (2016) there were 13 operating plants in 2014 (the same number presented by ABIPEL) with a total production of 74,200 tonnes of pellets. Almost 50% of the production in 2014 was in Santa Catarina (three mills). Additional information about the production in 2014 is presented in Appendix 3.

Table 10: Estimates of pellets production in Brazil (tonnes) (Garcia, 2016; and Escobar, 2016 for the alternative information regarding 2014))

2011	2012	2013	2014	2014
50,080	56,580	61,550	49,390	74,200

The publication World of Pellets 2016, by Bioenergy International (2016), lists four pellets industrial plants in Brazil, summing up a producing capacity of 630 thousand tonnes. The largest unit is Tanac, in Rio Grande south of Brazil that seems to be ready to produce. Based on its capacity, this unit is going to be among the ten largest pellets mill worldwide. More information about the project is presented in Appendix 3.

In general, the pellets plants installed in Brazil are small (less than 4 tonnes/hour) and are barely able to match the technical standards required in Europe. For instance, in some cases the machines used for producing wood pellets are those used for producing animal feed although this was the form several plants started in the EU (Figure 7. Energia Futura plant). According to Nones (2014), in Santa Catarina there is only one supplier of pellets machines (Lippel, located in Agrolândia[3]) and its machines are able to produce up to 750 kg/h. The consumer market of pellets is mainly restaurants, hotels, clubs, large laundries and small industries. The retail price was estimated by Spanhol (2015) at 430-550 R$/t (FOB) in 2014-2015 (133-170 Euro/t, assuming the exchange rate at the end of 2014). This is considered a very high alternative price for motivating actions aiming at exporting.

Figure 7. Energia Futura plant

[3] http://www.lippel.com.br/en#

Although the plants are currently small and the number of employees is quite reduced, the social and economic benefits of the supply chains are provided by the generation of indirect jobs and suppliers, for instance with the additional services provided through transportation of the forest products or the mills' residues and other services (pers comm Giovanni Pereira, 2015).

4.5 STAKEHOLDERS

The research team did a field trip in Santa Catarina, Brazil, from September 21 to September 25, 2015. The focus of the activities was Lages, at the south of Santa Catarina, municipality that is a pole of the wood and forest sector. Different stakeholders were identified related to the supply chain. Some were more focused to the transport and export of wood products to the EU, while others were related to the production of the feedstock, or the production of the pellets, and some others were related to social issues related to it, such as the Worker's Association (Figure 8).

In Lages, people interviewed included (1) an academic at the local university (UDESC), (2) a member of the State Association of Wood and Forest companies (ACR), (3) a representative of the union of timber industries (Sindimadeiras), (4) a member of the union of rural workers, (5) a representative of the main pulp and paper industry in the municipality (Klabin), and (6) a representative of the state organization that gives support to the producers (EPAGRI).

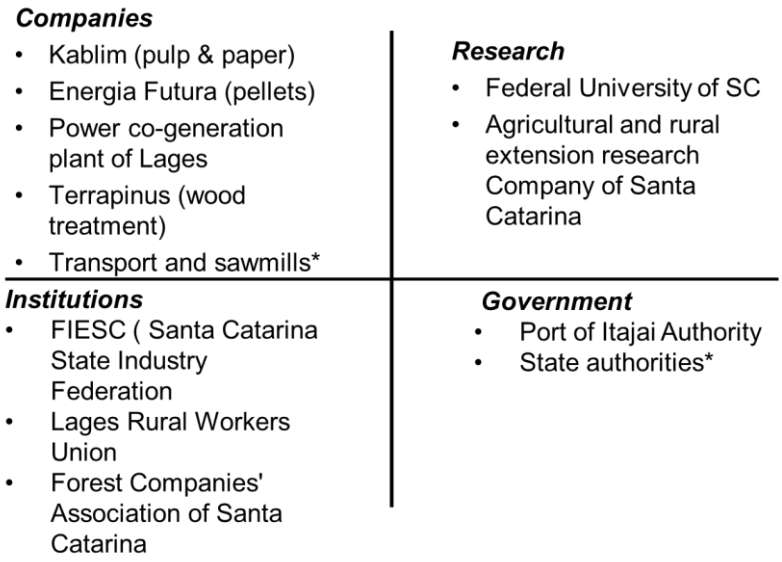


Figure 8 Stakeholders identified in Santa Catarina

Two other stakeholders were interviewed related to logistics, the main authority at the Port of Itajai and a pellet producer Energia Futura in Benedito Novo, Santa Catarina. The summary of the interviews conducted with them during the visits is presented in Annex 1. Relevant information has been incorporated throughout the report through statements provided by the interviewees.

5. Issues and indicators

5.1 LOCAL ECONOMY AND EMPLOYMENT

Santa Catarina is divided in six administrative (Figure 9). Serrana is one of the six administrative regions of Santa Catarina and in total has 23 municipalities, being Lages the most important from an economic point of view and the one with the largest population (estimated at 46.3% of the regional population in 2016). In this region, twelve municipalities have population lower than 5,000 thousand people and in six of them the share of people working (regarding the total population) is between 10% and 15% (in 13 municipalities is 20% or lower). In the region there is a concentration of planted forests (see Figure 2) and three of the five municipalities in Santa Catarina with the largest areas of planted forests are there (ACR, 2014).

Compared with the whole region, Lages has about 50% of the working force and concentrates more than 50% of the income (considering it is also the main city and therefore has a larger population size). However, the average wage in Lages is not much larger than in the whole State. In Lages the average is 2.2 minimum wage while the average in the region was of 2.0 minimum wages (standard deviation 0.4). The minimum wage is a legal reference in Brazil, and is the lowest salary a worker can earn per month; in 2014 it was equivalent to 200 Euro/month, considering the exchange rate at the end of the year of 3.619 Euro/Real$ (Table 11) (IBGE, 2016).

Table 11: Profile of local economy in Lages, in the Serrana Region and in Benedito Novo in 2014 (IBGE, 2016).

Parameter	Lages	Serrana region	Lages/Region	Benedito Novo
Number of registered commercial units	6,124	12,211	50.2%	500
Number of commercial units under operation	5,839	11,783	49.6%	491
Estimated population in 2014	157,989	341,317	46.3%	10,977
People working	50,059	89,992	55.6%	3,895
People working receiving salary	42,172	75,781	55.6%	3,359
Income due to salary (Euro)	250,593	455,572	55.1%	18,902

Salaries over municipal GDP	24.3%			38.0%
Average salary (in number of minimum wages)	2.2	2.0		2.1

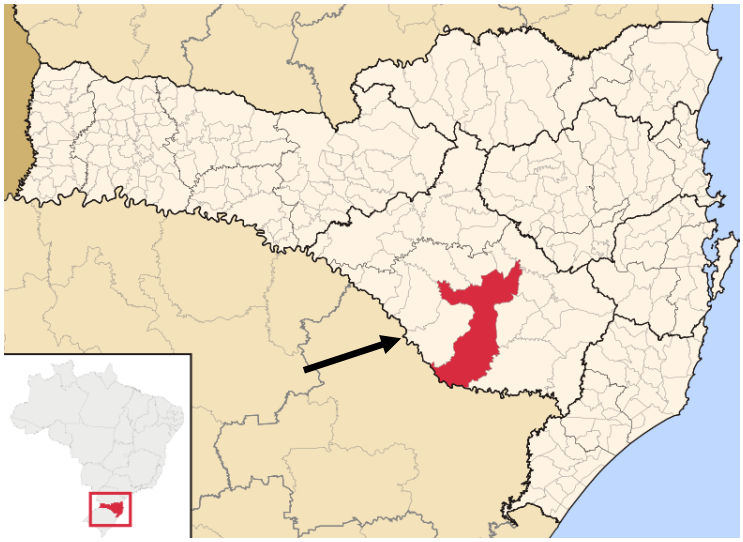


Figure 9: Santa Catarina in Brazil, Lages in Santa Catarina (municipality in red) and the Serrana region (the region marked with an arrow) (Wikipedia, 2015)

Table 14**Error! Reference source not found.** presents data on the total number of employed people (formal jobs) and the number of employed people by the wood and forest sector in 2014, for Santa Catarina State (and the municipalities of Lages and Benedito Novo, both visited during the field trip). Lages is the largest and the main city (from an economic point of view) in the Serrana region that is a pole of wood production and wood processing. Benedito Novo, on the other hand, is a small city with tradition on wood producing and processing, and where there is a producer of pellets. Figure 10 shows the evolution of direct jobs in the last 10 years in Santa Catarina. Despite a reduction in 2009 it showed a recovery and the importance of the sector in the region.

Considering the number of jobs, it can be seen the importance of the wood and forest sector in Lages and Benedito Novo. Lages is a larger city and has a more diversified economy, but in a small city, like Benedito Novo, people depend much more on the wood and forest sector. Compared with the figures of the whole state, the share of population with formal jobs is much lower in Benedito Novo (13% less) and employed people depend much on the wood and forest sector. It is worthy to mention that the existing pellets industry in Benedito Novo (Energia Futura) is quite small and is currently not relevant for jobs creation.

Table 12: Population and employed people (in 2014) by the wood and forest sector in Santa Catarina, and in Lages and Benedito Novo (IBGE, 2016).

	Population	Employed people	Share of employed people (%)	Employees by the wood & forest sector	Share of employed people by the sector (%)
Santa Catarina	6,727,000	2,737,933	33.8	96,458	4.2
Lages	157,989	68,896	43.6	8,150	11.8
Benedito Novo	10,977	3,275	29.8	1,033	31.5

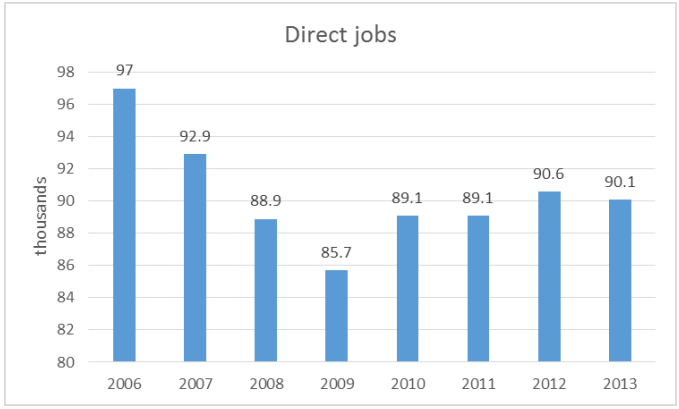


Figure 10. Evolution of numbers of direct jobs in Santa Catarina (ACR, 2014).

In the case of Benedito Novo, the share of people working is higher than that for any other municipality in the Serrana region (34.5% of the population is actively working) and over 86% of workers are employees. The share of salaries on local GDP is high with 38% (IBGE, 2016).

As regards the number of commercial units, a comparison of data for 2006, and data for 2014 (shown in Table 11) indicates that there has been a reduction in six of the 23 municipalities of the Serrana region, while the economic growth was very low (

Table 13).

Table 13: Change in selected economic indicators between 2006 and 2014, in Lages, in the Serrana Region and in Benedito Novo (IBGE, 2016)

Parameter	Lages	Serrana region	Benedito Novo
Registered commercial units	19.7%	18.2%	25.3%
Working share of the population	33.1%	31.1%	2.0%
Workers receiving salary	34.7%	31.6%	-3.4%
Salaries received per month (minimum salaries)	-0,20	-0,05	0,20

Taken as a whole, all municipalities (23 in the Serrana region, and also Benedito Novo), in only one case there was a decrease in the number of people in work between 2006 and 2014. In Lages, for instance, there was a considerable growth in the number of workers, including waged workers, although the actual number of minimum wages earned dropped (this does not necessarily indicates a decrease in total income earned but reflects the fact that the National Minimum Wage is used as measure of economic performance). On the other hand, in Benedito Novo the number of people in work grew only slightly, whereas the number of people earning wages declined. This may be due to the fact that there may be more people running their own business, as suggested by the growth in commercial units. In Benedito Novo, the volume of wages increased (i.e. the actual number of individual National Minimum Wage earned) (IBGE, 2016).

5.2 INCOME AND GINI INDEX

Between 2000 and 2014 employment has increased by 111% in the state of Santa Catarina (

Table 14) and in the selected municipalities, although lower percentages, the increase in job positions was also noticeable. For the wood and forest sector, information is also presented in Table 14. The number of jobs in the forestry sector grew between 2000 and 2010, but declined from 2000 to 2014. The behaviour was the same comparing the figure for Santa Catarina and for Lages and Rio Negrinho (in practice, Benedito Novo had no forestry activities in 2000). Considering the industrial branch of transforming wood, along the period there was growth of jobs in the State but a reduction in regions like Lages and Rio Negrinho, mostly probably as (

Table 14) result of continuous increase of efficiency and productivity of the sector (ACR, 2014).

Table 14 – Employment and Income for Santa Catarina state and selected municipalities in 2000, 2010 and 2014 (ACR, 2014)

Indicator	Sector	Year	State/Municipalities			
			Santa Catarina	Lages	Bened ito Novo	Rio Negrin ho
Employees (number of people)	Whole economy	2000	1,077,929	24,386	2,075	9,608
		2010	1,969,654	37,921	3,209	10,905
		2014	2,273,933	43,562	3,275	11,801
	Forestry	2000	3,761	112	-	484
		2010	7,585	580	15	523
		2014	6,043	451	30	295
	Transformation	2000	74,334	4,029	743	4,005
		2010	83,998	3,513	959	3,622
		2014	89,946	3,365	1,003	3,492
Income (euro/month/person)*	Whole economy	2000	535.1	437.4	390.8	482.5
		2010	526.9	487.8	482.4	479.4

		2014	726.0	577.9	554.7	544.0
	Forestry	2000	337.9	234.1	0.0	337.9
		2010	583.2	459.3	325.5	624.9
		2014	549.7	648.0	564.0	867.6
	Transform ation	2000	366.2	347.3	241.0	415.4
		2010	476.4	474.3	460.0	443.4
		2014	709.8	647.1	705.8	649.5

*In Euros of 2010.

Table 14 also presents figures for the income (wage) per month and per worker (in 2010 values, converted to Euro). In Santa Catarina, income has increased 35% from 2000 to 2014, but the results for the forestry sector and for the industrial branch of transforming wood were even better. The same can be observed in the three municipalities considered in this analysis. These results indicate that in Santa Catarina the wood and forest sector expanded, and payments improved

Estimates of the average income per capita (not just wages) per month in 2016 and in the wood and forest sector are presented in

Table 15. Data is presented for Santa Catarina, Lages, Benedito Novo and Rio Negrinho. It can be seen that just in Lages the income in the wood and forest sector is very close to the average income in the state, but even in this case is lower (3% lower). The income in the wood and forest sector is larger in Lages than the average income in the State, while in Benedito Novo and Rio Negrinho the average income due to the sector is quite similar to the average state figure (also because of the importance of the wood and forest sector vis-à-vis the whole economy) (IBGE, 2016).

Table 15: Average income in Santa Catarina and in specific municipalities (IBGE, 2016)

	Income (Euro/capita/month)[1]		(W+F)/Total
	Total	Wood & Forest Sector	
Santa Catarina	566	435	76.9%
Lages	444	522	117.6%
Benedito Novo	432	430	99.5%
Rio Negrinho	424	409	96.5%

[1] in 2014, assuming 3.619 Euro/Real, the exchange rate at the end of 2014

The Gini index is an indicator of wealth concentration. The higher the indicator, the more concentrated is the wealth distribution. The indicator varies between 0 and 1; 0 means an absolutely equal distribution and 1 a hypothetical situation in which just one person would have all income (IBGE, 2016).

The estimates for the Gini Index in a time series is presented in Table 16 and Figure 11, for Santa Catarina as a whole and for the three municipalities considered.

Table 16 – Gini index for Santa Catarina state and selected municipalities for 1991, 2000 and 2010 (IBGE, 2016)

Indicator	Year	State/Municipalities			
		Santa Catarina	Lages	Benedito Novo	Rio Negrinho
GINI	1991	0.55	0.56	0.43	0.48
	2000	0.56	0.6	0.37	0.48
	2010	0.49	0.54	0.36	0.44

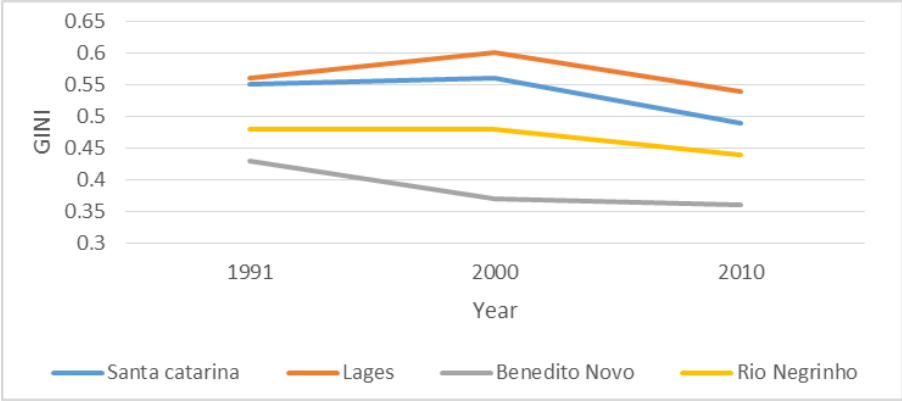


Figure 11: Gini index evolution for Santa Catarina State (IBGE, 2016)

The estimates of the Gini index for 2014, based on wages paid, are presented in Table 17. The results allow a comparison between the wood and forest sector and the whole economy. For Santa Catarina, income is even more concentrated in the wood and forest sector than in the other economic sectors. On the contrary, in Lages wealth concentration is lower in the wood and forest sector, but the index is higher than the general figure for the state (i.e., higher concentration of the income). Compared to the average figures of Santa Catarina, wealth distribution is even worse in the other municipalities assessed (Benedito Novo and in Rio Negrinho) (IBGE, 2016).

Table 17: Gini index (based on salaries) in Santa Catarina and in specific municipalities; estimates for 2014 (IBGE, 1016).

	Gini index (based on workers' income)	
	All economic sectors	**Wood & forest**
Santa Catarina	0.622	0.715
Lages	0.668	0.635
Benedito Novo	0.749	0.753
Rio Negrinho	0.718	0.724

Complementary information about wealth distribution is presented in Table 18, based on the same data source. In all cases (i.e., the state and the three municipalities considered), and for the whole economy or for the wood and forest sector, 50% of the employees receive no more than two minimum salaries per month. The mode of salaries distribution (the value that appears most often) is also presented in the same table: in the wood and forest sector the largest share of workers (31% to 38%) earn 1 to 1.5 minimum wage, in this figure is equal or slightly worse than in the economy as a whole.

Table 18: Average income (number of minimum salaries per month) in Santa Catarina and in specific municipalities: median and most frequent case (IBGE, 2016)

	Median		**Mode (% of workers)**	
	All sectors	**Wood & forest**	**All sectors**	**Wood & forest**
Santa Catarina	1.51 to 2.0	1.51 to 2.0	1.51 to 2.0 (25.6%)	1.01 to 1.5 (31.9%)
Lages	1.51 to 2.0	1.51 to 2.0	1.01 to 1.5 (34.5%)	1.01 to 1.5 (32.2%)
Benedito Novo	1.51 to 2.0	1.51 to 2.0	1.51 to 2.0 (33.4%)	1.51 to 2.0 (31.4%)
Rio Negrinho	1.51 to 2.0	1.51 to 2.0	1.01 to 1.5 (35.1%)	1.01 to 1.5 (38.3%)

Figure 12 shows the income distribution (based on salaries earned) in the wood and forest sector in Lages (based on statistics for 2014). As previously mentioned, this income distribution results in a Gini Index 0.635. The 50% poorest workers hold about 25% of the whole income in the wood and forest sector, while the 20% richest workers hold 46% of the total income.

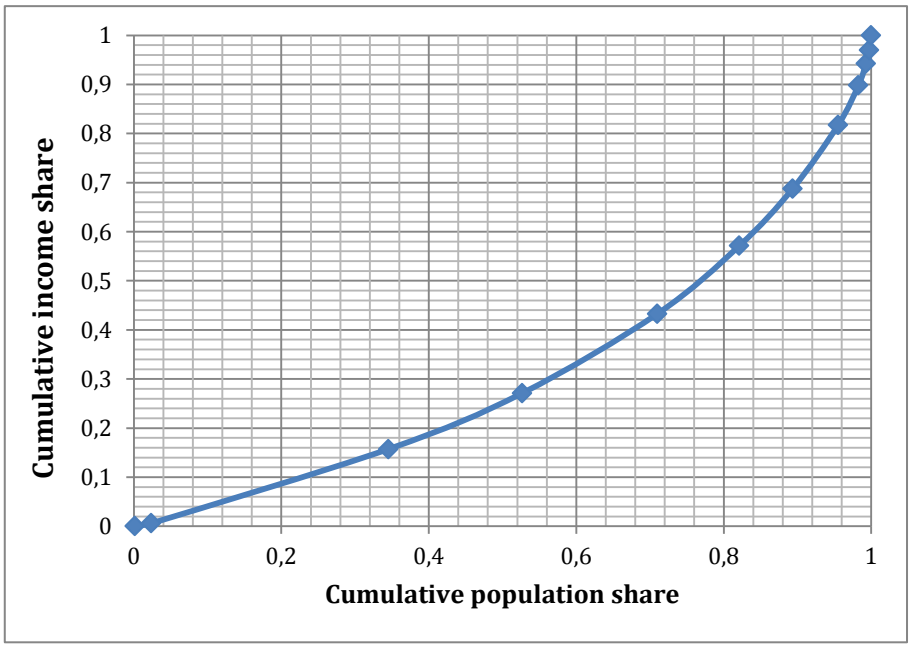


Figure 12: Income distribution in 2014 (based on salaries earned), in the wood and forest sector in Lages. (IBGE, 2016)

5.3 GENDER

Women's participation in the labour force, is indicated as women's share of income for Santa Catarina, is clearly a challenge for the forest sector, with great possibilities for improvement. Although in the total economy the number of women has increased in the job market, the sector does not show any patterns of improvement, while the manufacturing industry related to wood also shows growth, but with results much lower than in the rest of the economy. This can seen in the selected municipalities also (

Table 19). In general, there is a need for the development of incentives from local governments and companies to attract women to sectors (such as forestry) where culturally women have been deprived of entering.

Table 19 –Women's share of income for Santa Catarina state and selected municipalities in 2000, 2010 and 2014

Indicator	Sector	Year	State/Municipalities			
			Santa Catarina	Lages	Benedito Novo	Rio Negrinho
Women's share of income (% of total income for women)	Whole economy	2000	32.0	28.3	41.6	27.2
		2010	37.3	36.1	42.1	37.1
		2014	39.3	39.1	42.9	38.7
	Forestry	2000	4.5	13.6	0.0	0.9
		2010	11.4	7.7	5.7	13.9
		2014	7.6	6.8	22.4	4.8
	Manufacturing	2000	11.9	6.8	6.7	14.3
		2010	17.9	11.7	17.1	23.2
		2014	19.4	13.0	19.5	26.0

The participation of women (job wise) in the whole economy (all economic sectors) and in the wood and forest sector) is presented in Table 20. It can be seen that the share of women among the workers is much lower in the wood and forest sector in comparison to other economic activities, and that this difference is much larger in Lages.

Mechanized harvesting is a more recent tendency (it started about a decade ago) but the local topography imposes constrains (it is estimated that 30% of harvesting is mechanized) (*pers comm.* Giovani Arruda, 2015). In out-grower's areas, due to the required investment, mechanised

harvesting is limited (estimated at 30 million R$ for fully mechanical harvesting in order to get 50-60 thousand tonnes of wood per month) (*pers comm.* João de Liz).

Table 20: Share of women among workers and average workers' age in Santa Catarina and in specific municipalities; figures for 2014 (IBGE, 2016).

	Share of women among workers (%)		Average workers' age (years)	
	All sectors	**Wood & forest**	**All sectors**	**Wood & forest**
Santa Catarina	45.1	25.1	35.3	35.9
Lages	43.1	14.4	36.0	37.2
Benedito Novo	48.2	24.0	35.6	35.7
Rio Negrinho	43.5	34.6	36.0	36.5

The research team has no hypothesis for explaining these figures except that the forestry work has been "traditionally" a work engaging more men than women. In the same table it is presented figures of the average workers' age and it can be seen that there is no significant difference comparing the municipalities and Santa Catarina, and also comparing the wood and forest sector and the figures for the whole economy.

5.4 HUMAN DEVELOPMENT INDEX

From 1990 until 2014, Brazil had the most profound evolution of HDI in Latin America and the Caribbean, raising 36.4% in that period. The improvement corresponded to an increase of 11.2 years in life expectancy, 55.9% in income, 5.3 years in expected years of study for children and 4.6 years more of study for adults. Despite this increase, Brazil is still 74th in the world's HDI ranking, and this indicates a still long path to become a just and equal society (PNUD 2014). Santa Catarina, in turn, has the third highest HDI in the country since 2000.

The Municipal Human Development Index (MHDI) for Lages and Benedito Novo, in 1991, 2000 and 2010 is presented in Table 21. For comparison, the figures for Santa Catarina, Florianópolis (state's capital) and the best result for Brazil in the same years are presented. In Brazil, Florianópolis has good results, being in the top five municipalities in two surveys and among the top ten in one survey (2000). In case of Lages, the indicator is similar to the average in Santa Catarina in all years, while the indicator for Benedito Novo is 5-10% lower than the state average in all surveys. Figure 13 shows the comparative data between Lages, Itajai and Florianopolis (the

State's capital) along 30 years.

Table 21: Municipal Human Development Index (IBGE, 2016)

Year	Lages	Benedito Novo	Florianópolis[1]	Santa Catarina	Best result in Brazil[2]
1991	0.551	0.517	0.681	0.543	0.697
2000	0.674	0.617	0.766	0.674	0.820
2010	0.770	0.740	0.847	0.774	0.862
Relative change	39.7%	43.1%	24.4%	42.5%	23.7%

[1] Considering all municipalities, Florianópolis had the third best result in 1991 and in 2010, and the sixth in 2000.
[2] São Caetano do Sul, in São Paulo state.

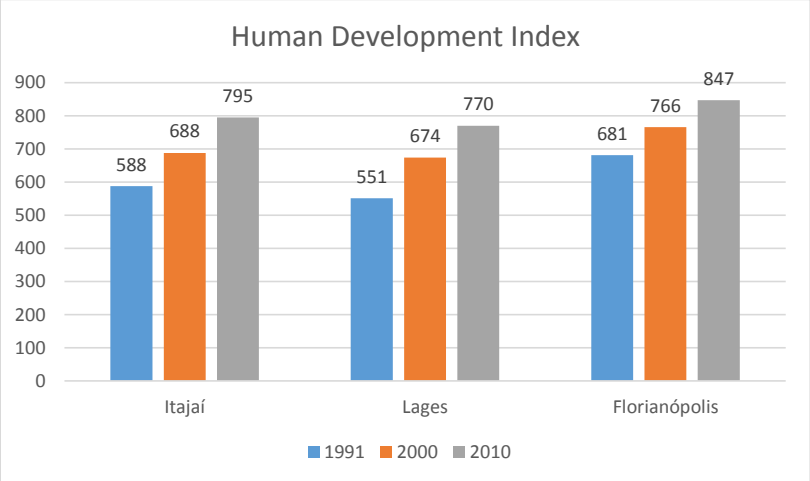


Figure 13. Human Development Index changes (IBGE, 2015)

5.5 LAND SECURITY AND LAND PRICE

According to Bolanos (20144), although Indigenous Peoples and local communities in Latin America legally own or control almost 40 percent of the region's forest, the lack of political will to clarify and safeguard these rights has created a tenure system with several conflicts mainly contesting land.

Brazil hosts extensive forests, grasslands, and wetland ecosystems. Despite legal provisions to provide protection to an estimated 3.7 million square kilometres of public and private lands, there are significant human and development pressures on all of these areas. An estimated 1% of the population owns 45% of all land in Brazil (USAID, 2012).

The land prices (just land, without facilities) and price's growth in some municipalities in Santa Catarina are shown in Table 22. The cases shown are Lages and Otacilio Costa, in the Serrana region, and Curitibanos. Lages is the main case in this study and Otacilio Costa is a nearby municipality. In both municipalities there are large areas of planted forests and in both cases there is the influence of a large pulp and paper industry. In Curitibanos there is a pellets industry and the region is a pole of timber industries.

Land price presented in Table 22 are for the most suitable land and for the second best option for agriculture. The information available is for a range of typical prices and the most common value in this range was chosen. For instance, in the case of Lages, the prices in 2015 varied between 10,000 and 30,000 R$/ha for the best suitable land for agriculture (6,600 to 15,000 R$/ha in the case of the second best land for agriculture), being 18,000 R$/ha the most common figure that year. Prices growth is compared with the inflation in the same period, based on the General Prices Index (IGP-M), by Fundação Getúlio Vargas, evaluated at a national level. It is worth to mention that land prices have grown more than inflation, except in one case, and in the period 2010-2015 the growth of prices in Lages was much more than the inflation (EPAGRI-CEPA, 2016).

Table 22: Land prices and price's growth in Municipalities in Santa Catarina (EPAGRI-CEPA, 2016)

Municipality	Description	Price in 2015	Growth	Period	Inflation in the period
Lages	Best available	18,000 R$/ha	125%	2010-2015	37.4%
Lages	Second option	12,000 R$/ha	140%	2010-2015	37.4%

[4] http://www.landesa.org/commentary-series-part-ix-forest-tenure-security-for-long-term-security-against-deforestation/

Otacilio Costa	Best available	23,000 R$/ha	91.7%	2009-2015	43.1%
Otacilio Costa	Second option	16,000 R$/ha	77.8%	2009-2015	43.1%
Curitibanos	Best available	24,790 R$/ha	71.4%	2009-2015	43.1%
Curitibanos	Second option	14,460 R$/ha	40%	2009-2015	43.1%

Another figure related to land price is the average price for renting land, aiming at soy cropping. In Lages it was mentioned that some farmers decided to cut their forests in order to take advantage of the opportunity of renting. The information provided by EPAGRI-CEPA (2016) is for average prices in Santa Catarina (and not specifically in Lages). Prices paid grew from 280 R$/ha in August 2007 to 1,204 R$/ha in July 2016, i.e., a growth of almost 330% in the period. In the same period the inflation was estimated at 84.3%, based on the General Prices Index (IGP-M), by Fundação Getúlio Vargas, evaluated at a national level. Land prices and policies related to the expansion on planted forest are important issues that affect mainly small producers (pers comm. Arruda, 2015; pers. comm. Murara, 2015).

5.6 WORKING CONDITIONS

The current state of the International Labour Organisation (ILO) conventions in Brazil is shown in Table 23. The ratification of conventions needs to be translated into the legal system of the country. Therefore a link to the enforcement of legislation is also in place and can be seen in the table below.

Table 23. ILO Conventions and state in Brazil (ILO)

ILO Number	Name of Convention	Ratified
29	Forced or Compulsory Labour	√
87	Freedom of Association and Protection of the Right to Organise	N
98	Right to Organise and to Bargain	√

	Collectively	
100	Equal Remuneration of Men and Women Workers for Work of Equal Value	√
105	Abolition of Forced Labour	√
111	Discrimination in Respect of Employment and Occupation	√
129	Inspection of Agriculture	√
138	Minimum Age for Admission to Employment	√
182	Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour	√

In Lages, there is no constraint for rural workers to be a member of the Union, but only 30% of about 15,000 small rural producers are members (by option). For the Union, small producers are those who have up to 80 hectares (regardless the crop). The Union estimates that in the region there are 25,000 rural workers (people who do not have their own land) and only 10% are members of the union (*pers comm.* Carlos Peron, 2015) by option.

The Brazilian Ministry of Labour has a regular procedure of inspection of labour conditions. The inspections are made in response to complaints and when an irregularity, or violation, is observed (after local inspection) the company is included in a "black list" that is publically available. A company in this list neither can get loans in public banks nor sell to government organizations. The list of violations is wide and includes non-regular payment, child labour, the lack of protective equipment, excessive working journeys, non-adequate conditions for resting, inadequate place for lunching, etc. A company only can be excluded of this list paying the fines and acting for eliminating the irregularities.

The list published in 2016 has 575 companies/entrepreneurs and the bulk of economic activities are related to agriculture and livestock. The list is available at http://pacto.reporterbrasil.org.br/listasuja/lista (the webpage of a NGO). Out of 575 companies listed (12,290 workers), 38 are involved with the wood and forest sector (378 workers), being seven of them in Santa Catarina (in seven different municipalities). Out of the seven cases in Santa Catarina, three are in the region studied in this project: one in Lages (activity classified as forest production; 11 workers), one in Capão Alto (activity classified as wood extraction; 13 workers), and one in Santa Cecília (activity classified as wood extraction; 6 workers). Based on

the list it is not possible to know the violation. The total number of companies of Santa Catarina included in the list is 20, and the total number of workers in these companies is 187.

Figure 14. Pellet company in Benedito Novo

During the field trip, no stakeholder mentioned (including the representative of the Union of rural workers) problems that could be classified as violations of the Workers' Law and working conditions that could be classified as inadequate.

5.7 LOGISTICS

In general, the quality of roads in Brazil is reasonable. Secondary roads are a constraint in Santa Catarina and transport of wood from the forest to the mills is limited to 80 km (although other interviewees and Escobar 2016 reported 100km). The largest wood consumer in the region (Klabin) maintains the secondary roads the company is interested to keep in good conditions. For the same reason, it is not feasible to transport forest residues for more than 30 km, from the field to the wood mills or manufacturing companies (*pers comm.* João Liz, 2015).

To consider exports, the Brazilian port system is administrated by the Secretariat of Ports of the Presidency (SEP-PR) of the Ministry of Transport. The SEP-PR is in charge of policies, programmes and support to the development of seaports. Out of the 34 public maritime ports under the management of SEP, 16 are administrated by state or municipal governments (Mello, 2012).

Itajai is the first port in Santa Catarina. It is the second largest in Brazil considering the movement of containers (after Santos, in São Paulo state) (in general terms, Itajaí is the fourth largest port in Brazil). The distance between Lages and the Port of Itajaí is 270-305 km, depending on the roads used.

The port of Itajai's main export products include: timber and related products; frozen meat (chicken); ceramics; kraft paper; machinery; tobacco; vehicles; textiles; sugar and frozen meat (pork). There used to be a rail service, not currently in use but there are regional plans to develop it to the region of San Francisco (pers. comm. Heder Moritz, 2015).

The port is well served mainly by road transport. It has the advantage of the experience of exporting wood to the USA and to the EU, although exports to the EU depend on sanitary conditions and conditions to export to the USA seem to be more flexible. There are eight transport companies in the region and considering second levels of the supply chain, other industries

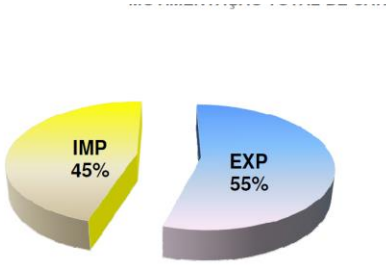
involved (e.g. fuels, machinery and tools) (pers. comm. Heder Moritz, 2015).

Logistics are the main consideration for pellets exports because rail transport is not available to take the pellets to the port and transport by trucks will increase costs and emissions. Nevertheless, the economic benefits for the state for road transport will need to be assessed (*Figure 15*).

a)

b)

c)



d)

Figure 15 a) Itajai port; b) Infrastructure at port; c) Transport companies; d) Percentage of imports and exports in 2014 (Itajai Port)

The Port of Itajai relays on the use of containers to export due to the current infrastructure. Tanac's possibilities to export (see Appendix x) in Rio Grande do Sul is based on the use of the existing infrastructure for shipping soy.

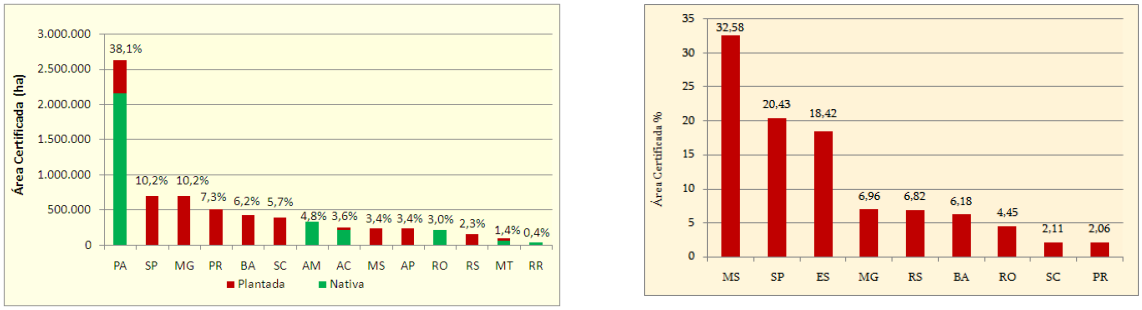
5.8 CERTIFICATION

The most common frameworks used for certification in Brazil are the FSC (Forest Stewardship Council International/Brazil) and the PEFC (Program for the Endorsement of Forest Certification Schemes). Both systems include social and economic criteria which companies and producers have to comply with in order to obtain the certificate.

Certification started in Brazil in 1994, with FSC first area certified in 1995. The other used certification system, since 2002, is CERFLOR (Programa Brasileiro de Certificação Florestal),

recognised and approved by PEFC (SNIF, 2015). There are around 15 main certifiers in Brazil. Figure 16 shows the certified area in hectares and by percentage in different States. Santa Catarina shows that all the area certified is for planted forests, which are mainly those used for the pulp and paper industry, making nearly 2.11% of the area of the State certified. Comparing with other Brazilian states, the certified area in Santa Catarina is relatively small, mainly because the total area is not large.

The most important certification scheme for wood producers and timber companies, in Lages, and in the region around, is FSC (*pers comm*. Giovani Arruda, Martha Brand, 2015). The most important companies have all forest area certified, but it was also mentioned that small wood producers cannot afford the costs (*pers comm.*. Joseli Stradioto, 2015) and that the average cost of certifying forests in the region is R$ 15,000 (*pers comm.*. Mauro Murara, 2015).



A B

Figure 16. Area certified under FSC (A) by type of forest and state and by CERFLOR (B) total certified area by state (SNIF, 2015).

Until the end of 2012 there were 919 chain of custody certifications by FSC of wood products and 93 combined certifications of forest management and chain of custody by FSC which made an average of 7.2 million hectares of managed forest (3.9 million hectares of plantations, 3 million hectares of native forests and 300 thousand hectares of mixed forest managed (SNIF, 2015). Until 2012, CERFLOR certified around 1.5 Mha of forests, from which 65 thousand ha were native and 1.4 Mha were plantations (SNIF, 2015).

5.9 FOREST SECTOR AND DEVELOPMENT

A simple Pearson's correlation (Table 24) helps to understand the link between forestry production (including production of feedstock and final products) and the selected indicators (Table 24). Since this correlation was calculated using time series, it captures the evolution over time for the State of Santa Catarina. In Santa Catarina, the forest sector shows positive correlation with HDI and income. This correlation is statistically significant at a level of 99%. This correlation, although not a cause-effect analysis, indicates that variables are associated in a significant manner.

The HDI evolves positively with forestry production, which indicates that there is no negative impact of this activity on HDI. The positive correlation with income is also an evidence of the positive outcome on social well-being, since evidence shows that there is a link between well-being and increasing income (Stevenson & Wolfers, 2013).

Table 24 – Forestry production in Santa Catarina state for 1991, 2000, 2010 and 2014 and total correlation between forestry production and selected indicators.

		1991	2000	2010	2014
Forestry production in SC ($x10^6$ EUR)		657.24	1,912.98	5,474.80	5,689.18
Correlation	Forestry X HDI	0.160, significant at 1%			
	Forestry X Gini	-0.043, not significant			
	Forestry X Income	0.132, significant at 1%			

Although numerically negative, the correlation between forestry production and inequality (Gini index) is not statistically significant.

6. Discussion

During this research it was not possible to get accurate figures about the current production of pellets in Santa Catarina. It seems that in the state there are three companies regularly producing pellets and that production is not large enough in order to match the local growing demand. Production in 2014 was about 40,000 tonnes (Escobar, 2016), representing more than 50% of the national production that year. The consumption is mostly by hotels, restaurants, gyms, clubs and laundries. From a socio-economic point of view, the relevance of pellets production on such small scale is very low as production at small municipalities, such Benedito Novo, where a pellet production plant is located is also almost insignificant. But according to the SNIF (2015), pellets production for exports, it seems the bulk is located in Santa Catarina state (about 93%, in 2015, considering all pellets exports).

The production of wood and wood products in Santa Catarina is important from a socio-economic point of view. The indicators that were analysed demonstrate an incipient pellet production but linked to the other forestry and wood sector. For instance, the number of jobs in the wood and forest sector, Santa Catarina has 13% of the total national. In 2014, the number of jobs in Santa Catarina in the wood and forest sectors was 96.500, slightly more than 4% of the total formal jobs in the whole state in that year. During the visits, it was mentioned that the indirect jobs are created in a proportion of about 3:1 compared to direct jobs. In the same year for the whole state, about 8.5% of the jobs in the forest and wood sector were in Lages. The wood and forest sector is the third most important sector in Santa Catarina considering jobs, and the second considering its contribution to the GDP. In Lages, the income related to the wood and forest sector is 17% larger than the total average. It is estimated that the salaries in the wood and forest sector represent about 25% of the local GDP. Around Lages, there are 3,300 rural properties involved with wood production, being a large number small and medium-size properties.

There is an organized wood supply chain in Lages because of the local importance of the industrial sectors (pulp and paper and timber, mostly). And it is also evident that the local culture is linked with the wood sector. At the local university, there are experts in different areas of wood production and conversion, including a researcher who has studied pellets for some years. Specifically regarding pellets production, the supply chain is not organized.

For pellets production, the most important local constrain is biomass availability. Considering the total planted area (mainly with pine), in Santa Catarina biomass supply should not be a constraint for pellets production, but it is necessary to go for assessments in specific areas. In Lages, in particular, biomass supply is a constraint for pellets production – despite the large area of planted forests in the region. One pulp and paper company (Klabin, with two industrial units close to Lages) owns 20% of the total planted forest area in the region and is the main buyer of wood produced by out-growers (25-30% of the wood supply to the two industries is by out-growers). Thus, the market is to some extent controlled by Klabin. Regarding wood and forest residues, the local market is impacted by a co-generation unit of 28 MW (owned by Tractbel) (and in a smaller extent also by other consumers). This explains the non-existence of pellets producers close to Lages as basically most of low-value feedstocks not suitable for material purposes are used for the production of bioelectricity.

In addition, the large number of small and medium forest plantations and the absence of good secondary roads, make it difficult to recover forest residues for pellets production. During the visits, it was said that it is not feasible to transport forest residues for more than 30 km, from the field to the industry. In summary, for producing pellets on a large scale it would be necessary to enlarge wood production – supposing the alternative of using self- dedicated plantations -, or to

diversify the supply of residues. In this case, the lack of good roads could be a serious constraint. In this sense, a combined action of the State and the local governments would be necessary, supposing that investors would not have capacity to invest in basic infrastructure in the very first years. Improving the secondary roads just for wood pellet production may not be feasible, but might also have other, secondary benefits, which will need to be further explored.

Regarding sustainable forest management certification, almost all large scale wood producers in Santa Catarina have FSC certification; this is the information received during the field trip, and confirmed by literature. *Per se,* this is not a guaranty that the production is sustainable, but it is obvious that the most contentious problems (e.g. labour problems, deforestation) do not exist or can be addressed by companies that are able to get a rigorous certification. According to the information gathered during the field trip, most of medium and small wood producers do not have financial resources to get certification. Vice versa, this does not mean that production is by definition unsustainable, but it would be more difficult for wood pellets produced from small and medium plantations to demonstrate compliance with Sustainable Forest Management principles[5]. In practice, a possibility to enhance sustainability is through technical support by the organization that is responsible for giving it (technical support) to farmers (EPAGRI). A set of best practices should be defined, and their accomplishment should be required either during the licensing process or by the largest consumers.

It is not possible to directly assess socio-economic impacts of large-scale wood production, and also of wood products (as a proxy for assessing impacts of pellets production). The data analysis was based on secondary data (based on national and regional surveys), complemented by the information gathered during the visits. In a region like Lages, the socio-economic impacts of wood and forest sector are important, considering jobs creation and the importance of this sector to the local economy. Quality of jobs is good, on average, and salaries are similar – or even better – than in other economic sectors. No comments about bad working conditions were received during interviews with the Workers Union in Lages and with SINDIMADEIRAs. The only drawback, from the point of view of the researchers, is the unequal number of jobs for women in the wood and forest sector – both in the field and in the industries. As mechanization is limited in harvesting, because of the low capacity of investment by small producers, and also because of the topography, this could be one possible explanation. As explained in the section of indicators, there is not at the moment other additional explanation that the researchers can provide.

The current domestic market for pellets in Brazil is small, and is in its first steps of development. It is not clear if the domestic market is going to increase in the years to come, despite the fact that there are efforts from the producers, industrial associations and state agencies (e.g. in Santa Catarina) aiming at fostering the consumption. Despite the existence of technical quality standards (e.g. from ISO), producers are not following them as consumers do not really demand them. One producer mentioned this as a drawback, because, from his point of view, producers are using inadequate machines to produce the pellets (although this was also the case during the start-up of the pellet market in other regions such as Europe). Thus, it could be necessary to start regulating the production of pellets, but taking into account that it is better to have international technical standards as reference. It is worth mentioning that the producers that want to be competitive in

[5] Sustainable Forest Management principles derived from the original document of "Forest Principles" adopted at The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Since then criteria and indicators have been adopted. This report did not focused on them but an overview ca be found at the Food and Agriculture Organisation (FAO) http://www.fao.org/sustainable-forest-management/toolbox/en/

the international market are able to follow technical standards, such as the EN Plus A1[6]. In fact, some Brazilian producers stated that they hold the certificate but for a steady export market it will be necessary that all producers apply the standards but as mentioned above this will depend if the market grows.

Clearly, logistics is a bottleneck for the production of pellets and also for exporting. The first constraint is regarding the lack of adequate roads in the countryside, making it difficult to reduce feedstock costs (due to the freight costs and reducing biomass availability) and to recover forest residues. Particularly in case of Lages, it rains very often. In recent years, short- to medium-distance freight costs have become more expensive in Santa Catarina. A second constraint is the distance from Lages to the ports (mainly the port of Itajaí) and the necessity to transport pellets by trucks. The lack of good railways in Brazil is a bottleneck for different economic sectors. In this sense, Lages is not the ideal site for pellets production aiming at exporting. As for the ports, at least in Itajaí (the Port of Itajaí) the conditions for exporting using containers seem to be adequate. In addition if pellets are pre-packed in bags, the export would be facilitated. All stakeholders interviewed in Santa Catarina mentioned that in short- to mid-term it is not possible to consider the production in large-scale for the industrial market elsewhere.

A Business Journal (Jornal do Comercio, 2017) reported that a pellets mill (Tanac, in Rio Grande do Sul, further south from Santa Catarina and Lages) will have a large production joining three plants in the region. The installed capacity is 400,000 tonnes per year, and all production would be exported. What makes this plant so different regarding the region studied in this project? The first main difference is that the company is a traditional producer of chemicals from wood, and owns a large planted area and has contracts with many wood suppliers. The company has a large amount of residues available and, with pellets production, it is just diversifying the use of residues. All wood supply is certified by FSC. Second, and a very important point, the industry is very close to a port (Rio Grande), and transport costs are not expected to be high, even transporting by trucks. Third, the existing infrastructure of shipping soy will be used for pellets, and investments will be minimum at this stage. The estimated number of jobs that the new mill will bring to the region is around 1000 along the whole supply chain from the production to the harvest, production and transport (Jornal do Comércio, 2017).

The socio-economic opportunities that were reported through the interviews and the data analysis in the region showed that the benefits of the forestry sector with the pellet production in the selected region in Santa Caterina exist but are still at a low level. A larger production based on demand may produce additional benefits in the region through more jobs and development of infrastructure such as secondary roads. Nevertheless, this last issue may continue to restrict an international market but does not necessarily impede a larger production for the domestic market. The possibilities to export from Rio Grande do Sul may even jeopardise the development of this international market for Santa Catarina despite that the resources are available. This may not improve the socio-economic conditions in Santa Caterina but the development for the national market if properly improved and incentivized may bring more positive outcomes.

[6] http://www.enplus-pellet

7. Conclusions and recommendations

This report examined selected socio-economic criteria for the forestry sector in Santa Catarina in Brazil. It sought to understand the impacts of the sector on local communities through job creation, income generation and the benefits reported in the human development index in the last decades. Incentives and regional policies have helped shape the local landscape by promoting plantations associated with specific markets, such as pulp &paper and timber. Nevertheless, recent changes in policies have affected small growers and other small business as reported by stakeholders.

As the pellet sector has only recently began to emerge, there is only very limited data that is readily available, and most of it is not related to the smallholders production. Lack of disaggregation is also an issue for data for the transport sector, which limits the scope of any assessment. In general, logistics are a key factor constraining the development of pellets production in Brazil, which is largely due to difficulties associated with transportation of feedstock and biomass products to the production areas, both to rural areas and to ports.

In the case of transportation in rural areas, the key measure needed is improvement in the quality of marginal roads to allow the supply of round wood and residues over larger distances. The current economic climate in Santa Catarina, for example, has been proving a pivotal constraint to development of road infrastructure and investors interested in exporting pellets are likely to choose plant sites that favour the lowest freight costs associated with transportation to ports.

A further factor hindering the production of pellets in Santa Catarina are the high costs associated with accessing feedstocks in Lages. Ideally, the production of pellets should take place well away from large pulp and paper plants so as to reduce competition from these heavy consumers of wood which help exert an upward pressure on prices and they use to the residues of the pulp and at least in SE and South Brazil, pulp and paper mills use as much as possible the residues available in the field and in the industrial site. Thus, it would be advisable to make more efficient use of wood residues as well as ensuring the use of forests that are no longer being harvested by other local wood markets.

Overall, the forest sector in Santa Catarina has shown signs of growth over the last few decades. Such growth may be partially attributed to the close relationship that developed between the sector and local communities. From a socio-economic point of view, our research has shown that the wood and forest sector plays a crucial role in the Lages region, through jobs and income creation, by contributing to local GDP, and other multiplier effects on the local economy.

Nonetheless, the continuing socio-economic impacts of the forest sector will necessarily be conditioned by the business model adopted by firms to expand the production of pellets in Brazil. For example, the growing trend towards automation of pellet mills for reducing costs and achieving quality standards may limit the scope for job creation. Regarding the forestry sector, more mechanisation seems to be required in Santa Catarina, but such strategy needs to be sensitive to the needs of small and medium sized forest owners to minimise any negative impacts. In spite of limited job creation, the socio-economic impacts should generally be positive due to the additional income brought to the region, and also as a result of other indirect effects of this economic activity. Importantly, a positive side of automation might – at least theoretically - be the creation of more and better employment opportunities for women. Until now there is no evidence of this. Nevertheless, in other regions in the forestry sector more women are working as foresters and in the audit and certification area.

The Human Development Index (HDI) has grown in general in Brazil, and that is reflected in in the main cities in the State of Santa Catarina. The HDI should be used as a socio-economic indicator that is more integrative rather than simply reflecting job creation alone. However, the Gini index, a socio-economic index that helps to assess the progress towards equity, has not shown much evolution for Santa Catarina in the years examined in this report. Given that it was not possible to gather primary data from the main companies in the forestry sector in the region, it was necessary to combine macro indicators (for the whole municipality and the region) with the information provided in the in-depth interviews with local stakeholders (qualitative information).

Furthermore, the socio-economic impacts should be considered not only in relation to job creation. The quality of the job, working conditions, income, correlation between income and land property, and how overall the sector impacts the society's development in the region need all to be taken into account. It is also important to recognise that despite the data limitation, it is possible to highlight the conditions in the region regarding the economic activity of the forestry sector. For instance, there has been economic growth, growth in the number of jobs and income. Further, such income is not more concentrated (in terms of inequality) than in other regions, whilst the human development index has increased, and there was not report of workers experiencing inadequate working conditions.

The forestry sector in Brazil still lacks significant participation of women. The empowerment of women should increase in the sector, especially in view of the proposed objective of global exportation of sustainable biomass. The participation of women in sustainable bioenergy projects should become a key factor in local development, especially in those regions where agriculture and forestry constitute the major share of economic opportunities. When women are excluded from the opportunities provided by jobs in the bioenergy sector, such as farming and logging, their risk and vulnerability increases, affecting their ability to provide income for their households. The forestry sector, including feedstock production, should increasingly accept and incentivize women to join their employees, as exemplified by the case of Benedito Novo, whose indicators showed a higher participation of women in the sector. This, however, was not achieved by particular incentives of the forest sector, but follows the local trend in overall higher share of women in the economy. It is important to consider that working conditions for women in the sector may constitute a barrier, especially where the harvest is still not mechanised. Nevertheless, in other regions such as in the SE of the USA, women's participation

As general conclusions it can be said that: 1) the current forest production could be deemed 'sustainable' as the wood production is mostly from certified sources; 2) working conditions and respect for workers' rights is mostly acceptable, as verified by the certification schemes that are in place; 3) institutions exist that contribute to prevent environmental and social problems in the sector in Santa Catarina, including awarding of permits for operating, as well as a range of measures that support producers and research; 4) improvement in the production of dedicated pellet value chains requires the application of guidelines and technical sustainability standards. The implementation of policies applied to the sector need to consider the long term and the impacts for small producers.

Regarding the methodologies for the socio-economic assessment, they need to move away from a strategy of focusing on job creation alone (direct and indirect) and working conditions; it will help to have better assessments (when data is available as the sector matures) with a combination of in depth interviews of specific projects results, with input-output data; although this was not the main objective of this report, it would greatly help improve the assessments.

8. References

ACR (2014). Anuário Estatístico De Base Florestal Para O Estado De Santa Catarina 2014. Asociacão Catarinense de Empress Florestais. Url: http://www.acef.org.br/uploads/20140613104756.pdf Accessed: July 2015.

ABIPEL 2016. Associacão Brasileira de Pellets. Available at: http://www.biomassabr.com/bio/detalhes.asp?id=274&idatividade=4 Accessed October 2016.

ABRAF 2013. Anuario Estatistico. Assoiacão Brasileria de Produtores de Florestas Plantadas. Url: http://www.ipef.br/estatisticas/relatorios/anuario-ABRAF13-BR.pdf Accessed October 2015.

Azanha Ferraz Dias Moraes M, Ribeiro Oliveira FB and Diaz-Chavez R. (2015). Socio-economic impacts of Brazilian sugarcane industry. *Environmental Development* Volume **16**, December 2015, Pages 31–43.

Bellen, H.M. Van, (2004). Indicadores de Sustentabilidade: Uma Análise Comparativa. In Encontro da Associação Nacional de Pós-Graduação e Pesquisa em Administração (EnANPAD). pp. 1–16. Available at: http://www.anpad.org.br/diversos/trabalhos/EnANPAD/enanpad_2004/GSA/2004_GSA569.pdf.

BNDES (2008). Bioethanol from sugar cane. Energy for Sustainable Development. BNED and CGEE. Chapter 7. Pages 179-221.

Diaz-Chavez, R. (2011). Assessing biofuels: aiming for sustainable development or complying with the market? Energy Policy39 (2011) 5763–5769

Diaz-Chavez, R. (2014). Chapter 2. Indicators for socio-economic sustainability assessment. In: Rutz D and Janssen R. (Eds) Socio-Economic Impacts of Bioenergy Production. Springer. Pages 17-38.

Diener, E. & Suh, E., (1997). Measuring quality of life: economic, social, and subjective indicators. Social Indicators Research, 40(1/2), pp.189–216. Available at: http://link.springer.com/10.1023/A:1006859511756.Brasil. 2009. Florestas do Brasil em resumo – dados de 2005-2009. Brasília: Ministério do Meio Ambiente – Serviço Florestal Brasileiro.

EC 2016. Voluntary schemes. European Commission. Url: https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes Accessed November 2016.

EPAGRI-CEPA. (2016). Custos de produccão. Centro de Socioeconomia e Planejamento Agrícola. URL: http://www.epagri.sc.gov.br/?page_id=2696 Accessed June 2016

Escobar, JF. 2016. O Uso da biomassa para bioenergia. Presentation at the III Forum de Ensino Técnico na Área Química. Available at http://www.crq4.org.br/sms/files/file/forum_ens_tec_2016_biomassa_escobar.pdf

EPE/MME. 2015. Balanço Energético Nacional. 2015. Ministerio de Minas e Energia. Url: https://ben.epe.gov.br/ Accessed November 2015.

European Commission, (2008). *Poverty and social exclusion in rural areas*. Directorate-General for Employment, Social Affairs and Equal Opportunities.

Garcia, DP. (2016). Pellets no Brasil: desafios e oportunidades. In: 4º Anuário Brasileiro das Indústrias de Biomassa e Energia Renováveis.

Glasson J, Therivel R and Chadwick A. 2012. Introduction to environmental impact assessment. Routledge Pub. UK

IBA (2015). Relatorio 2015. Industria Brasileria de Arvores. URL: http://iba.org/images/shared/iba_2015.pdf Accessed June 2015.

IBGE (2016). Censo 2015. Instituto Brasileiro de Geografia e Estatística. URL: www.ibge.gov.br. Accessed July 2015

ILO. (2015). Conventions ratification. International Labor Organization. http://www.ilo.org/dyn/normlex/en/f?p=1000:11200:0::NO:11200:P11200_COUNTRY_ID:102871

ISO 2015. Sustainability criteria for bioenergy. ISO 13065:2015.

Jornal do Comércio. (2016). News published in March, 2016. URL: http://jcrs.uol.com.br/site/noticia.php?codn=173078. Accessed July 2016.

Jornal do Comércio (2017). Três fábricas de pellets impulsionam o mercado da madeira no Rio Grande do Sul. By Carolina Hickmann (http://jcrs.uol.com.br/_conteudo/2017/05/economia/560896-tres-fabricas-de-pellets-impulsionam-o-mercado-da-madeira-no-rio-grande-do-sul.html) Accessed June 2017

Jonasson, E. and Helfand, S. (2010). How Important are Locational Characteristics for Rural Non-agricultural Employment? Lessons from Brazil. *World Development*, 38(5), pp.727-741.

Locke A and HenleyG. 2014. Biofuels and local food security. What does the evidence say? Overseas Development Institute. Briefing 86. UK

Matarrita-Cascante, D., (2010). Changing communities, community satisfaction, and quality of life: A view of multiple perceived indicators. Social Indicators Research, 98(1), pp.105–127.MTE. (2016). Relação Anual de Informações Sociais. Retrieved October 31, 2016, from http://bi.mte.gov.br/bgcaged/login.php

Mello J. 2012. Ports of Brazil. Url: http://thebrazilbusiness.com/article/ports-of-brazil Accessed March 2015.

MTE. (2016). Relação Anual de Informações Sociais. Retrieved October 31, 2016, from http://bi.mte.gov.br/bgcaged/login.php

Nones, DL. (2014). Cadeia produtiva de compactados de biomassa residual para geração de energia em Santa Catarina. Dissertação de Mestrado, UESC, Lages.

Portal do Agronegócio. (2016). News published in March, 2016. Information available at http://www.portaldoagronegocio.com.br/noticia/porto-do-rio-grande-tera-terminal-para-embarque-de-pellets-141232

PNUD. (2016). Atlas do Desenvolvimento Humano no Brasil. Retrieved October 27, 2016, from http://www.atlasbrasil.org.br/2013/

Rasga, ROS. (2013). Pellets de madeira e sua viabilidade econômico-financeira na substituição do

óleo BPF-A1 em pequenos e médios consumidores no Estado de São Paulo. Dissertação de Mestrado. FGV, São Paulo.

Rutz D and Janssen R (Eds) 2014. Socio-Economic Impacts of Bioenergy Production. Springer. Pp.297.

Shore, R. (2013). Retrieved from: Wood biomass an untapped resource, climate group says: http://www.vancouversun.com/news/Wood+biomass+untapped+resource+climate+group+says/8840225/story.html

SNIF 2015. Sistema Nacional de Informações Florestais. URL: http://www.florestal.gov.br/snif/ Accessed August 2015.

Silveira, CR. 2005. História da Indústria da Madeira: Serra Catarinense – 1940-2005. Lages: Trafine.

Spanhol, A. 2015. Proposta para normalização de péletes de biomassa florestal produzidos em Santa Catarina para a geração de energia. Dissertação de Mestrado. UESC, Lages.

Stevenson, B., & Wolfers, J. (2013). Subjective Well-Being and Income: Is There Any Evidence of Satiation?

UN. (2014). Gender equality and sustainability. URL:www.unwomen.org Accessed October 2016

UNDP. (2016). Human Development Data (1980-2015) | Human Development Reports. URL:http://hdr.undp.org/en/data accessed September 2016

USAID. 2012. Brazil. Land Tenure and Property Rights Portal. Url: http://usaidlandtenure.net/brazil Accessed March 2015.

Vis M, Dornbrack AS and Jaye S. (2014). Socio-econmic impact assessment tools. In: Rutz D and Janssen R (Eds) 2014. Socio-Economic Impacts of Bioenergy Production. Springer. Pages 1-16.

Wear DN, Huggett R and Greis GJ. 2013. Constructing Alternative Futures. Chapter 2. In: Wear, David N.; Greis, John G., eds. 2013. The Southern Forest Futures Project: technical report. Gen. Tech. Rep. SRS-GTR-178. Asheville, NC: USDA-Forest Service, Southern Research Station. 103-121. http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178/gtr_srs178_103.pdf

World Bank. (2016). GINI index (World Bank estimate). URL: http://data.worldbank.org/indicator/SI.POV.GINI?end=2013&locations=US&start=1986&view=chart November 3, 2016

Zero Hora. 2016. News published in August, 2015. Information available at http://zh.clicrbs.com.br/rs/noticias/economia/noticia/2015/08/fabrica-de-biocombustivel-em-rio-grande-recebe-apoio-do-bndes-4821672.html# Accessed October 2016

Appendix 1 – Interviews in Brazil (Summary of Transcripts)

Giovani Pereira Arruda – Sindimadeiras (Sindicato das Indústrias de Serrarias, Carpintarias e Tanoarias de Lages[7]).

Sindimadeiras is the regional union of sawmills and it exists since 1957. The headquarters are in Lages and companies of 18 municipalities within the region are members of the Union. In the website of Sindimadeiras, 41 companies are listed (it seems that there are about 260 sawmills in the region) and they are the most important considering the total annual production. Some members of Sindimadeiras are also wood producers and manufacturers of final products (e.g., furniture).

The area covered with planted forests in the region is estimated at 400 thousand hectares, that is more than 60% of the total planted area in the state (650 thousand hectares). Some companies have their own forests while the ownership of forests is diverse, including independent investors.

In the region, large wood producers are those who have planted areas surpassing 30 thousand hectares, but there are few of them; in general, they are suppliers of the pulp and paper industry. Very small wood producers are those who have no more than one thousand hectares planted. An average figure of medium size producers is 6 thousand hectares planted with forests. Wood producers can both harvest or let the harvest to be done by sawmills. Mechanized harvesting is a more recent tendency (it started about a decade ago) but the local topography imposes constrains (it is estimated that 30% of harvesting is mechanized).

Some companies (eight were mentioned) act in the region for transporting wood from the forest to the industries. In general, vertical companies (i.e., sawmills that also have planted forests) also have their all fleet of trucks.

In the 1980s there was more sawmills in the region, but the tendency has been the concentration, with few units of more capacity (a medium-size sawmill processes 10 thousand tonnes/month). Standard requirements and scale effects explain this tendency. The industrial units are more efficient and nowadays a small sawmill is no longer competitive. In the region sawmills started to produce for exporting in the 1980s. Considering the production of panels and MDF plates, 60 to 70% of the production is exported and the bulk is for the USA (other markets are China, Caribbean countries and Emirates); the local industry has constrains for exporting to Europe due to the required sanitary certifications. For reaching the ports (there are five in Santa Catarina), it is not possible to use the local railroad.

The most important certification scheme in the regions is FSC, and four members of Sindimadeiras are certified.

About the future production of pellets in the region, the evaluation is that people are more speculating than really interested on investing. There is a potential for using wood shavings for pellets production, but constrains include logistics (considering the distances and the lack of storing capacity in the ports).

Martha Andreia Brand – UDESC (State University of Santa Catarina, campus of Lages, Department of Forest Engineering)

She has large experience with biomass production and its use, mainly with the production of pellets in Brazilian south. She was supervisor of some Masters' dissertations that addressed different aspects of pellets production.

Mrs. Brand stated that the production of pellets at the state level is very small, and that even the local demand is not matched. According to her, there is only three producers of pellets in Santa Catarina (one of them addressed during the field trip) and the supply chain is not well organized. Most of the producers use machines designed for producing animal feed, with low efficiency, and standard requirements are barely matched. At the university she and some colleagues designed a pelletizing machine with automatic control. In general, for reducing production costs, the biomass

[7] http://www.sindimadeira.com.br/

is not dried, and this imposes additional drawbacks to the industries (e.g., low efficiency and/or high costs of the raw material).

In September 2015 Mrs. Brand indicated that the price paid by the consumers in Santa Catarina was between 520-560 R$/t and that in one year it grew significantly. Considering consumers like hotels, clubs and gyms, the producers sell and delivery at least 8 tonnes each round.

About biomass availability in the region she reported that in 2001 Tractbel decided to build a 28 MW cogeneration plant in Lages (commercial operation started in 2013), fuelled with biomass, and at that time there was no constrain regarding the biomass supply and the prices were relatively low. This was not the case in 2015. Different industries (including a pulp and paper plant), the thermal power plant and also pig and chicken farmers (they use residual biomass to cover the soil) demand residual biomass from industries and the demand heated up. Recovery and commercialization of forest residues is not common in the region, also due to the size of the plantations and the lack of good roads. Most of the wood producers and timber companies in the region have the Forestry Stewardship Council certification.

Carlos Peron (Union of Rural Workers)

The union was established in 1970. Members are rural workers, small producers and farmers renting their land.

The Union considers a small producer who (no matter the crop) has up to 80 hectares. There are about 15,000 small rural producers in the region, and approximately 30% are members of the union. Also in general, the small producers involved with planted forests are far away from Lages and most of them have no access to the electric grid. About 3,500 farmers are renting their lands and among them 70% are members of the union. It is estimated there are 25,000 rural workers in the region (people who do not have their own land) and only 10% are members of the union.

During the 1990s, the State government created a program for fostering pine production by small farmers. Basically, a regular income (on month basis) was assured, and additionally it was proposed about 70% of the income at the harvesting. Mr. Peron indicated that the program was not a success due to the very low income received by rural workers.

Small wood producers have difficulties for selling as the main buyer in the region is a large pulp and paper industry (Klabin) that has its own production and imposes low prices. More recently (the last 3-4 years) no one is interested to start wood production.

Mr. Peron stated that in the region the farmers do not have cooperatives, despite the fact –as he knows – there are successful initiatives in other regions in Santa Catarina.

In the region the minimum salary for rural workers is 918 R$/month. Mr. Peron indicated that the working force is limited, and temporary rural workers use to go to Santa Catarina from other states.

When asked about pellets production, Mr. Peron indicated that has never heard about that production.

João Paulo Czarnecki de Liz (Klabin industry / Lages unit)

Klabin is originally a Brazilian pulp and paper industry that is about 80 years old. In the studied region Klabin has two industrial units since early 2000: the unit in Otacilio produces pulp and paper and needs wood that is 13-16 years old, while the unit in Correia Pinto produces bags, besides pulp and paper, and needs wood that is 18 years old (or even older). The total demand is estimated at 230 thousand tonnes per month.

The company has 130 thousand hectares and preserves about 50% of the total area it owns; the area with eucalyptus corresponds to eight thousand hectares, five thousand hectares have been managed with pine and eucalyptus, and 60 thousand hectares is the area with pine plantations. For producing in this area, 250 people work in the forests. All production is certified by FSC and IMAFLORA is the certifier agent. In recent years the area with planted forest grew, and the expansion has occurred over pasturelands.

Klabin also buy wood from out-growers, and it is estimated that this supply corresponds to about 60 thousand tonnes/month. About 30 wood out-growers are selling to Klabin. The prices paid are 55 R$/t of pine and 65 R$/t of eucalyptus. The cost of the own production is estimated at 35 R$/t. It is estimated that 40% of the production cost of paper is due to wood; each tonne of paper has

been sold by 1,000 R$. The average yield is four tonnes of wood per each tonne of paper produced.

In the region the average yield is 44 m^3/ha/year.

Wood is transported over 10 to 80 km from the forests to the industry. It was said that in the region it rains very often, and a lot during the year (2,500 mm) and this imposes a constraint due to the quality of marginal roads. It was mentioned that Klabin maintains the secondary roads the company is interested to keep in good conditions.

Mr Czarnecki de Liz indicated it is not feasible to transport forest residues for more than 30 km, from the field to the industry. In case of eucalyptus, because of the procedures during harvesting, the residues – about 20 thousand tonnes/month – the residues are disperse. On the other hand, in the case of pines, as the trees are processed close to the boards of the roads, the residues are concentrated – the availability is estimated at 180 thousand tonnes/month. The residues are transported to the plant as much as possible, but a certain amount remains over the soil and this is enough for keeping the nutrients. A service supplier works on recovering the residues and on transforming them to wood shavings.

In Klabin's lands most of the wood is harvested with machines, but it is different in out-grower's areas, due to the required investment: estimated at 30 million R$ for fully mechanical harvesting in order to get 50-60 thousand tonnes of wood per month.

Regarding the potential of producing pellets in Santa Catarina, the evaluation done was not optimistic. One constrain is logistics, and it was highlighted the difficulties to transport wood from the forests to the industries. A second constrain would be wood availability, mainly around Lages.

Joseli Stradioto Neto – EPAGRI (Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina)

EPAGRI is a company that gives support to farmers and ranchers in Santa Catarina. The office in Lages provides support to people in 18 municipalities, and they are mainly small and medium producers. EPAGRI has worked in order to enlarge the productivity of pine plantations. The company has also researched for developing species of eucalyptus more resistant to the cold weather.

It is estimated that around Lages there are 3,300 rural properties involved with wood production. A very small producer is the one who has up to 10 hectares of forests and this represents about 10% of the total. About 2 thousand units are classified as small (up to 80 hectares of forests) and medium (up to 300 hectares) producers. In the region covered by EPAGRI (i.e., by the local office), the area with planted forests is estimated at 193 thousand hectares.

In 2015 the prices paid were very low and this was the main reason for changing wood for soy. Some producers decided to go to clear-cut with just 10 years, when the cycle is about 20 years. In fact, these producers were more speculators that entered in the forest business when it seemed a good opportunity. In the region, in general, 50% of the price paid covers the cost of harvesting and transporting from the field to the industry. In 2015 it was estimated that the cost of harvesting in the region was 35 R$/t. The cost of maintenance of a pine forest is not high, because the requirement of fertilizer is low; the cost is higher in case of a eucalyptus plantation but, on the other hand, the productivity is also higher.

Considering pine production in the region, the first cut is after eight years and the wood is, in general, used for pulp production. The second cut is when the tree is 13-14 years old and the wood can be used for timber. The third and last cut is when the tree is 18-20 year old. After the third cut it is necessary to clear the field, removing the roots. In order to keep wood production, it is necessary to plant again. In recent years, the number of companies involved with preparing pine seedlings was reduced to approximately half.

The number of wood producers who hold certification is not high, due to the costs. Only the largest producers can afford certified production.

Mauro Murara Junior – ACR (State Association of Forest Companies)

Mr. Murara Junior is the executive director of ACR.

ACR[8] is an association of planted forest companies (created in 1975) that acts at the state level (Santa Catarina) and has headquarters in Lages. The associates are companies and investors acting on planting, harvesting and processing wood; in its website, 35 companies are listed as members.

Mr. Murara Junior said that about 650 thousand hectares in Santa Catarina are covered with planted forests, and that 83% of this area is with pine. Around 30 companies that are members of ACR own 60% of the planted forests in Santa Catarina. He indicated that the most recent tendency is a reduction of the forest area due to the expansion of soy (farmers are also cropping wheat during the off-harvesting). Considering land availability, the enlargement of planted forests in Santa Catarina is currently limited by the attractiveness of agriculture and by environmental constrains (e.g., requirements for preserving areas with natural vegetation). ACR believes it would be necessary to enlarge forest productiveness and there is room for that taken into account the results achieved by investors on eucalyptus.

The wood and forest sector is the third most important in Santa Catarina, considering jobs, and the second considering its contribution to the GDP. In the state Mr. Murara Junior evaluated at about 95 thousand direct jobs (see Table 5) related with the wood and forest sector, and at 300 thousand the indirect jobs. The average production of wood logs in Santa Catarina in recent years is estimated at 29 million m^3, and this is about 13% of the national production. Nationwide, Santa Catarina has a relevant position in what concerns timber exports (38% of total exports), paper exports (10%), furniture exports (34%) and exports of offset plates (27%).

All members of ACR are certified by FSC. On average, the cost to get FSC certification is about R$ 15,000.

For industrial purposes, the maximum distance from the harvest area to the industry is 100 km. As consequence, all industries located in Lages are supplied by nearby forests.

Mr. Heder Cassiano Mortiz Port of Itajaí Manager–– hosted the research team in a visit on September 24, 2015.

Santa Catarina has five ports (Itajaí, São Francisco do Sul, Imbituba, Itapoã and Navegantes), being Itajaí the second largest in Brazil considering the movement of containers (after Santos, in São Paulo state) (in general terms, Itajaí is the fourth largest port in Brazil). The distance between Lages and the Port of Itajaí is 270-305 km, depending on the roads used.

The Port of Itajaí is in the river Itajaí, very close to the sea. It has two terminals for containers (with different operators), one in the right bank and the other in the left bank of the river. The operation with containers started in the 1980s. The most important product exported from Itajaí in recent years is frozen meat.

Currently, the maximum draft in Itajaí is 12.5 m. The largest vessels operating in Itajaí have 306 meters (in Santos and Itapoá the largest vessels have 336 meters). According to Mr. Mortiz, the maximum capacity of vessels in Itajaí would be 7,500 teus (twenty equivalent units – containers equivalent to 20 feet length).

The Port of Itajaí could be used for exporting wood pellets, but Mr. Mortiz believes the best option, in short term, would be the Itapoá terminal, at the Port of São Francisco do Sul, that has tradition on exporting logs. In case of shipping wood pellets already packaged in bags, using containers, Mr. Mortiz did not see constraints.

Lucca – Energia Futura (http://www.energiafutura.com.br/)

The owners are migrants from Italy; the company is exporting pellets in small scale and the company has a partnership with a company in Italy. The company has the same name of an

[8] http://www.acr.org.br/

Italian energy group, it was said that there is only a partnership with the Italians. The owners are brothers and one of them hosted the researchers in September 25. The company is producing pellets since 2007 and is established in Benedito Novo since 2010.

The municipality is at the north of Santa Catarina. It was said that the current production is 450 tonnes per month, operating about 100 hours per week, but this amount is not compatible with the declared output of the single pelletizer currently available (750 kg/h). In partnership with two other entrepreneurs, a new plant able to produce 1,000 tonnes/month was under construction at the time of the visit; the new industrial plant is nearby Benedito Novo. The investment, according to him, is 5 million R$.

They intend to export to Italy all production of the new plant. The final destination will be the residential market. The product will be packed in bags of 20 kg or in big-bags. The bags will be assembled in containers and transported by trucks to the Itajaí port. Mr. Lucca said they will be able to hold a technical standard (e.g., the ENplus standard (EN 14961-2)).

The feedstock used is residues of pine processed by timber industries located around. They buy residues from suppliers, who regularly deliver residues at the industrial unit. In the new plant, in order to improve the quality of pellets, they intend to use residues of better quality. It was said that the supply of residues is assured by contracts.

Currently the company is producing pellets that are mostly sold to hotels and gyms located about 250 km far from the industrial plant. At the end of September 2015 the price was 55 R$/kg at the industrial site. Mr. Lucca recognized that in 2015 they were not producing pellets of good quality, mainly due to the constraints of the pelletizer.

For the current production (possibly about 350 tonnes per month), 10-12 people are involved, but only six of them are permanent employees. During the visit it was observed that the level of automation is very low. Mr. Lucca said that the operators of the pelletizer were trained by them and that they earn the equivalent to three minimum salaries per month. As presented in the next section, the average salary of employees in Benedito Novo is about 2.1 minimum wage per month. He said that only the employees with no qualification earn the minimum wage.

During the visit Mr. Lucca mentioned many times that it would be necessary to have technical standards for pellets in Brazil, in order to differentiate the prices and/or to impose constraints to producers that are not able to produce pellets of good quality. He said that they are able to – or will be able to fulfil environmental standards in case of further requirement.

Figure 17. Plantations and log companies in Lages

Appendix 2 – Calendar of Interviews

Interviews conducted in Santa Catarina, Brazil September 21-25, 2015.

Monday 21/09/15	Tuesday 22/09/15	Wednesday 23/09/15	Thursday 24/09/15	Friday 25/09/15
Contact: Giovani Pereira Arruda Institution: FIESC (Santa Catarina State Industry Federation) E-mail: giovanni.arruda@fiesc.com.br Telefone #: +55 49 3224 5460	Contact: Carlos Peron Institution: Lages Rural Workers Union Telephone #: +55 49 3222-2747			
		Contact: Martha Brand Institution: State University of of Santa Catarina E-mail: martha.brand@udesc.br Telephone #: +55 49 2101-9279		
Contact: João Paulo Czarnecki de Liz Institution: Klabin (Pulp and paper factory) E-mail:JPCLIZ@klabin.com.br Telefone #: +55 49 3275-8214	Contact: Joseli Stradioto Neto Institution: Agricultural and rural extension research Company of Santa Catarina E-mail: grl@epagri.sc.gov.br Telephone #: +55 49 3289-6400	Contact:Mauro Murara Institution: Forest companies' Association of Santa Catarina E-mail: mauro.murara@acr.org.br Telephone #: +55 49 8413-0582	Contact:Heder Cassiano Moritz Institution: Port of Itajaí E-mail: heder@portoitajai.com.br Telephone #: +55 47 3341-8029	Contact:Lucca Institution:Energia Futura E-mail: energia.futura@hotmail.com Telephone #: +55 47 9946-1680

Appendix 3 – Additional Pellet producers in Brazil

Table A3.1 presents a list of pellets production plants in Brazil, in 2014. The information is based on Escobar (2016). All plants producing in 2014 used pine as feedstock, and all were located in São Paulo state (Southeast region) (indicate as SP in the table) or in the South region (Parana – PR -, Santa Catarina – SC –, and Rio Grande do Sul – RS). According to the information presented, the total production in 2014 was 74,200 tonnes, while the nominal capacity of the existing plants was 201.6 thousand tonnes per year (annual capacity factor about 37%).

Company	Municipality	Production (t/year)		Feedstock	First year of operation
		Nominal capacity	Actual, in 2014		
Briquepar	Telêmaco Borba/PR	7,800	4,000	Pine	2004
Pellets Braz	Porto Feliz/SP	12,000	4,800	Pine	2004
Energia Futura	Benedito Novo/SC	9,000	4,800	Pine	2007
Koala Energy	Rio Negrinho/SC	60,000	30,000	Pine	2008
Piomade	Farroupilha/RS	3,750	2,400	Pine	2010
Biopellets	Lins/SP	30,000	2,000	Pine	2010
Timber	Pien/PR	45,000	6,000	Pine	2012
Resisul Pellets	Itapeva/SP	3,000	2,400	Pine	2012
Iemol Pellets	São João Boa Vista/SP	3,000	2,000	Pine	2014
Araupel	Quedas Iguaçú/PR	6,000	5,000	Pine	2014
Vale Tibagi	Telêmaco Borba/PR	7,000	5,000	Pine	2014
Chamape Pellets	Vale Real/RS	3,000	1,800	Pine	2014
Incobio Pellets	Concórdia/SC	12,000	4,000	Pine	2014

Source: Escobar (2016)

The authors of this report compiled additional information about some of the plants listed in Table A3.1, and also other plants (plants that were not producing in 2014). In some cases, the capacity listed in Table A3.1 does not match with the information presented below possibly because the capacity was updated from 2014 onwards.

PelletBraz (http://pelletbraz.com.br/produtos)

Pelletbraz is located in Porto Feliz (state of São Paulo) and produces pellets from pine sawdust. The company states that consumers include laundries, hotels, pizzerias, bakeries, gyms, schools (for heating swimming pools) and industries (textiles, ceramics, food and beverages).

A M.Sc. dissertation (Rasga, 2013) is based on the company and reports an industrial plant with an installed capacity of 6t/hour (estimated by the author based on a predicted production of 36,000 t/year along 6,000 hours/year).

Koala Energy (http://www.koalaenergy.com.br/)

The company is located in Rio Negrinho, in Santa Catarina, that is a traditional forest region. According to the company, the production of pellets started in 2007 and it is currently able to export. The feedstock is certified by FSC and pellets production follows the standard EN Plus A1 (an industry quality standard). The company is located about 100 km far from the harbours north of Santa Catarina.

Tanac (http://www.tanac.com.br/en)

In the company's webpage there is no information about the ongoing production of pellets by Tanac, but the production of wood chips is mentioned. The company is located in Rio Grande, in the Rio Grande do Sul state. Its main product – tannin – is used in leather production; it is extracted from black wattle. Due to the extraction process, the company has a large availability of wood residues and also produces woodchips (estimated as 600 thousand tonnes per year) and wood panels. The feedstock is pine – the total area is estimated at 120 thousand hectares – either from its own land or from out-growers.

In October 2014 it was noticed that Tanac was ready to start to build a pellets plant with capacity of producing 400 thousand tonnes per year. It seems that all production will be sold to Drax Power (UK). The harbour to be used is nearby the industrial plant. The plant should start the production in February 2016, but in July 2016 there was no information about.

It was noticed that the investment sums up 60 million US$, being 40% supported by a loan by the Brazilian Development Bank (BNDES, 2008). Operating at full capacity (24 hours per day), 40 people will work at the industrial plant. It is predicted that the indirect impact includes 300 more jobs. (Zero Hora, 2015).

FINAGRO Pellets (http://www.finagro.com.br/home_p_finagro.htm)

FINAGRO is a company based in Belo Horizonte, state of Minas Gerais, that acts for promoting investments in agriculture and in forest sector. It has been noticed (e.g., Jornal do Comércio, 2016; Portal do Agronegócio, 2016) that FINAGRO and a group of investors intend to build a pellets plant with capacity of producing 600 thousand tonnes per year aiming at exporting. The investment is estimated as 200 million US$ and the plant would be installed in Pinheiro Machado, state of Rio Grande do Sul.

In a workshop in Florianópolis, Santa Catarina, in November 2016 (Bio.ComBrasil 2016), Alfredo Bertucci, from FINAGRO, states that the project is for producing 900 thousand tonnes of pellets per year. FINAGRO is still negotiating funding and the production will not be before 2018. The feedstock will be mostly pines from a forest that already exists (98,000 hectares); the company is buying the portfolio of 500 out-growers who have been involved with a pulp and paper project that failed.

According to Mr. Bertucci, an existing railroad will be used for displacing the production to the Rio Grande harbor. The railroad is not modern, but the cost will be relatively low (it was mentioned 7 US$/t). At the port the infrastructure to be used is what has been used for exporting soy. Vessels with 60 thousand tonnes of capacity will be used. It was said that pellets could be available in

Europe for about 150 US$/t and this would be a very competitive situation vis-à-vis the competitidors.

It was explained that the project includes a combine heat and power plant, with capacity of generating 50 MW, being 36 MW surplus electricity to be sold to the grid.

Mr. Bertucci said the company is currently negotiating off-taking contracts and the intention is to sell part of pellets production in Europe and part in Asia (South Korea and Japan).

There are two particularities that make differences in case of this project. First, the existing forest area, reducing the risk of wood supply and making it possible to start industrial production in few years. Second, the existence of a nearby railroad, reducing transportation costs to the harbor, despite the fact that industrial plant is not close to Rio Grande.

Timber Creek Pellets (http://tcfpellets.com.br/)

The company is located at Pien, Southwest of Paraná, and very close to the border with Santa Catarina. The company is able to produce pellets according to the standard EN Plus A1 and the commercial production started in 2012. According to the company, the feedstock is pine from reforested areas.

Piomade (information available at http://pelletsdemadeira.blogspot.com.br/2014/12/piomade-primeira-certificacao-enplus-do.html)

The company is located at Farroupilha, north of Rio Grande do Sul. It's a wood company that is operating since 1993 and started to produce pellets from its own residues in 2011. According to the company the production reaches 12 t/day. Also according to the company, it is the first producer in Brazil that got the ENplus standard (EN 14961-2).

Nones (2014) reported that at that time there was three pellets producers in Santa Catarina. A summary of information is presented below.

Popinhak (Industria de Pellets Popinhak Ltda)

Located in Curitibanos (with about 40,000 inhabitants and nearby Lages), in Santa Catarina, is a wood company founded in 2008 and that has produced pellets since 2011. Industrial residues (from *Pinus spp*) have been used (Nones, 2014). The company doesn't have driers and need to buy residues (wood shavings) with very low moisture (8-10%), that have been more expensive along the years due to alternative local markets.

Le Eireli (Industria e Comercio de Briquetes e Pellet'S Le Eireli)

Located in Campo Alegre (with about 12,000 inhabitants), at the north of Santa Catarina, the company is a producer of briquettes and pellets since 2011. Industrial residues (from *Pinus spp*) have been used (Nones, 2014). The same constrains mentioned above applied to this producer.

Energia Futura (http://www.energiafutura.com.br/)

Located in Benedito Novo (about 11.5 thousand inhabitants in 2016), at the north of Santa Catarina. The owners are migrants from Italy and the company is exporting pellets in small scale. Pellets production started in 2007. The company was visited by the research team.

IEA Bioenergy

Further Information

IEA Bioenergy Website
www.ieabioenergy.com

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