An Analysis of the Impact of Forest Policy on Rural Areas of Chile

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Abstract: The relationship between the forest sector and the well-being of people that depend on it for their economic livelihoods in rural areas is of strong interest in forest policy. In this sense, Chile has developed a forest policy that has had positive impacts, particularly on economic and productive aspects, but also negative impacts, such as the reduction of natural forest area, biodiversity, and provision of ecosystem services, as well as the increase in social conflicts and land abandonment. However, there are few studies that have evaluated the impacts of forest policy on rural population and development of the territory. Therefore, the objective of this research is to evaluate the impacts of Chilean forest policy on rural communities, particularly in terms of demographic variables and indicators of community well-being. The study area corresponds to the Bio Bio and Ñuble Regions (Chile), and the analysis includes productive, demographic, socioeconomic, and educational characteristics of population. The results show that the forestry policy implemented was able to generate a significant increase in the proportion of forest area. However, when this increase is mainly of the type of exotic forest plantations, it is associated with a demographic and socio-economic detriment of the population in some counties of the study area.

Keywords: rural poverty; afforestation; migration; forest policy; Chile

1. Introduction

There is no question that forests have a key role to play in efforts to mitigate global biodiversity loss and combat climate change by sequestering carbon as biomass. In fact, the literature has widely addressed the contribution that forests make to society through their various functions and their capacity to provide ecosystem services [1–4]. These multiple services include energy generation through forest biomass [5–7], reduction of greenhouse gas emissions and global warming [8–10], and production of non-wood forest products [11–15], among others.

Making the traditional economic-productive goals of the forest industry compatible with the key functions forests provide is of strong interest in forest policy [16–18]. Despite the difficulties that this may entail, authors such as Chazdon [19] and Messier et al. [20] suggest that this could be feasible through the development of dynamic and flexible practices that are adaptable to a scenario of global change. However, there is also questioning of whether it is possible to integrate the diverse functions forests provide in forest policy. For Kopnina [3], some functions such as carbon sequestration and provision of ecosystem services are being promoted under the commodification of nature with an anthropocentric vision, neglecting social and ecological justice. This view gets stronger if we analyze the relationship between natural forests and tree plantations [21], which are frequently the results of mere political decisions to face problems such as floods, degraded lands and, more recently, climate

change [22]. In the world, forest plantations have experienced a growth of 66% of their surface between 1990 and 2015, while natural forests have decreased their surface by 11% in the same period [23].

In this context, Chile developed a forestry promotion policy during the 1974–2012 period, which in the first stage (1974–1996) subsidized 75% of the net costs of establishing forest plantations, providing incentives and tax benefits for plantation management preferably planted in soils suitable for forestry and the obligation to reforest in similar conditions all felling actions in natural or artificial forests. Subsequently, Decree Law 701, which was the origin of this policy, was modified by Law 19,561 in 1998 to facilitate access to this policy for small forest owners and to encourage the afforestation of degraded soils (in article 2 of this decree, afforestation is defined as "the action of populating, with tree or shrub species, land that lack vegetation or which, being covered with vegetation, is not susceptible to economic exploitation or improvement through management"). Finally, on 31 December 2012, this afforestation incentive policy expired [24,25].

This forestry promotion policy was part of the common objective of stimulating the competitiveness of the agricultural and forestry sector and thus promoting its integration into the international market [26–28]. Although the results of the policy were positive in terms of promoting agricultural and forestry exports [29,30], they also generated an uneven development process, especially in social areas (in which there was a significant increase in proletarianization and social differentiation) and economic areas (as reflected in the accentuation of land concentration and unequal economic growth between geographical areas) [31–36].

Several studies have described the positive impact on economic growth and development of the forest sector as a result of this policy [21,25,37–39]. However, there are also those that recognize negative impacts due to the reduction of native forest cover and an increase in the area of exotic species [40,41], causing a change in the provision of ecosystem services (loss of biodiversity and endemic species, changes in water flow, landscape, and loss of opportunities for recreation and ecotourism) [42–45], leading to social conflicts [46,47] and land abandonment [48,49].

These investigations represent an important advancement in the analysis of the effects of the Chilean forest policy, however, there are few studies that have evaluated the impacts that this policy has generated, especially on the rural population and the development of the territory. Among them, Torres et al. [50], who studied the vulnerability and resistance of Chilean forest areas to climatic trends derived from institutional changes; Andersson et al. [51], who investigated the relationship between forest plantations and poverty; and Patterson [52] who investigated the relationship between the forest landscape and changes in land use, highlighting the importance of analyzing demographic aspects to understand the transformations of the territory.

The relationship between the forest sector and demographic and educational characteristics of population have been addressed from different perspectives [53–60], but the impacts of forest policy on rural society have not been clearly discussed [61,62]. Furthermore, few studies have analyzed the relationship between poverty and forest expansion, while the analysis has been done in view of forest transition [63,64], or simply looking for context variables to explain this relationship.

The objective of this research is to analyze the impacts of Chile's forest policy on rural society, particularly on demographic characteristics and indicators of population well-being. The study area (Bío Bio and Ñuble Regions) presents the highest proportion of forest plantation area in the country, the largest area of exotic plantations [65] as well as the largest number of pulp mills [66].

2. Materials and Methods

2.1. Study Area

The Ñuble and Bio Bio Regions were a single administrative territory called Bio Bio Region until September 2018. The Ñuble Region has an area of 13,178.5 km^2, which accounts for 35.6% of the surface of the former Bio Bio Region, with a population of 480,609 inhabitants (30.5% rural population). The current Bio Bio Region has an area of 24,021 km^2 and a population of 1,556,805 inhabitants. It is

the second largest urban conglomerate in the country; hence the proportion of rural population only rises to 11.4% [67].

From east to west, the relief of the region has three large distinct geographical areas of agricultural and forest lands under different ecological conditions: the Andes Mountain Range, the central plain, and the Coastal Mountain Range (Figure 1). The Andean foothill zone, which reaches an altitude that does not exceed 1400 meters above sea level, has shown a decrease in native forests and a growth in forest plantation of exotic species. The central plain or intermediate depression corresponds to a wide and relatively flat area of approximately 100 km wide in the northern part of the Ñuble Region. Lastly, the Coastal Mountain Range runs along the Pacific Ocean, becoming increasingly lower to the north and with an altitude of 1400 meters above sea level to the south, and ending with littoral terraces built by marine and continental sediment [67].
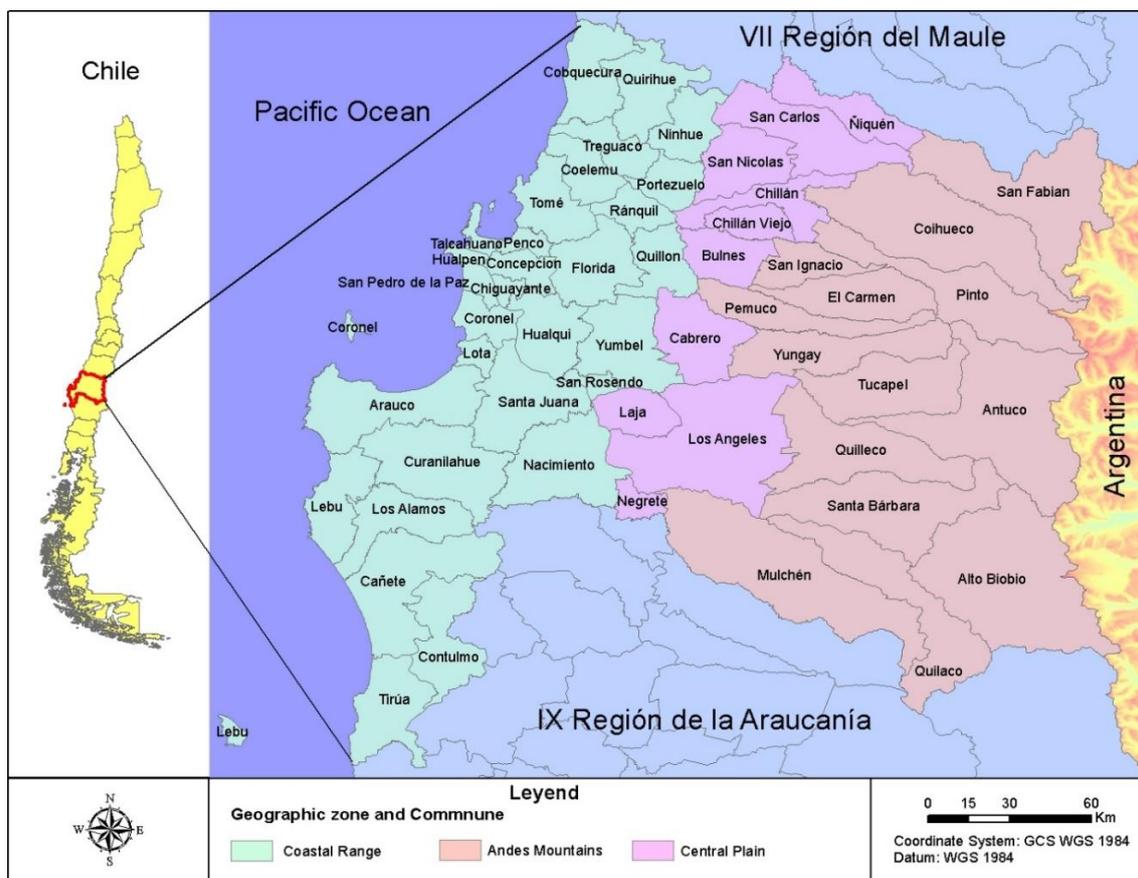

Figure 1. Study area and geographic zones and communes.

According to data provided by the National Forestry Corporation (CONAF) [68], Chile's forest policy subsidized a total of 1,250,878.2 hectares of forest land from 1976 to 2017. The highest proportion of forested area corresponds to plantations in the Ñuble and Bío Bío Regions, accounting for 32.8% of the total area abovementioned (403,786.8 hectares). Regarding land use, CONAF [69] reported an increase in the area of forest plantations and urban areas and a decrease in grasslands, shrublands, and agricultural lands for the period 1998–2008. Most of the agricultural land is located in the intermediate depression, while forest land is mainly found in the Andean foothills and Coastal Mountain Range.

2.2. Research Methods and Phases of the Study

The four steps of the methodology used in this study and the methods involved in each of the phases are shown in Figure 2.
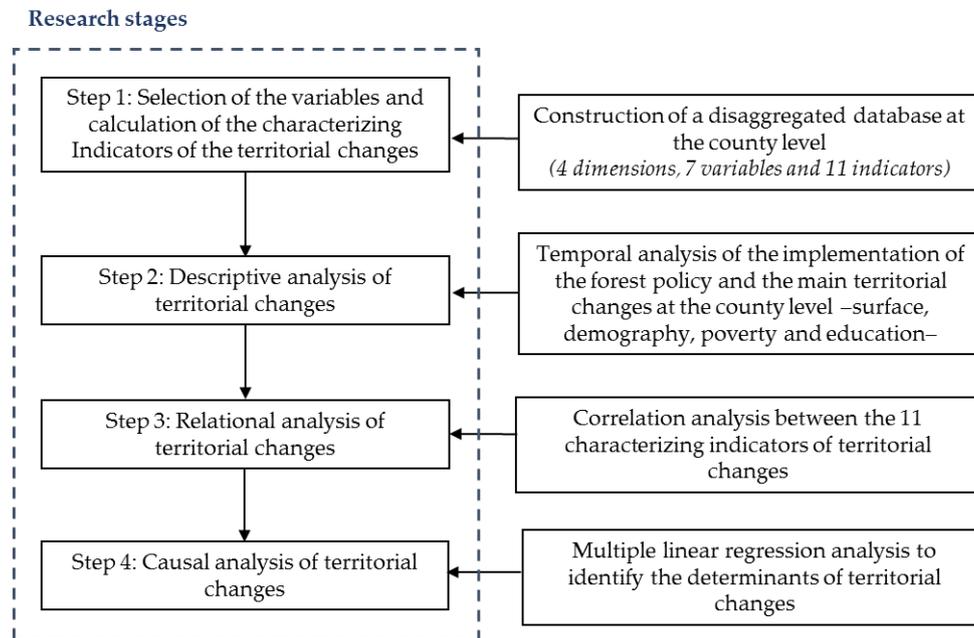
Figure 2. Flow diagram of the methodology used in the study.

2.2.1. Selection of Variables and Indicators of Territorial Changes

Both variables and indicators were selected based on the information provided in the conceptual framework and considering the characteristics of the two regions under study. The 11 indicators selected were associated with variables that allow the measurement of demographic, socio-economic, and educational characteristics of population as well as the evolution of forest cover as the result of the implementation of the forest policy. Table 1 shows the characteristics of population evaluated, variables, and indicators and their corresponding definitions.

The territorial scale of analysis was the county ('comuna' in Spanish), which is the third and lowest administrative subdivision in Chile after province (the second largest administrative division) and region (the largest administrative division). Of the 54 counties that make up both regions, the urban counties were not considered because they were not the object of this research; nor were those created recently, which did not have historical data. Therefore, the universe of study consisted of 37 rural counties, while data to analyze the impacts of Decree Law DL 701 1974 Forest Act on rural society corresponded to the period between 1977 and 2017.

The data on demographic, productive, and educational characteristics were obtained from the Population Censuses of 1982, 1992, 2002, and 2017, and the Agricultural and Forestry Censuses of 1977, 1997, and 2007. The data on socioeconomic aspects were obtained from the Ministry of Social Development.

Table 1. Variables and indicators in land use change.

Dimension	Variable	Indicator	Acronym	Definition
Productive	Forest land	Inter-census variation in forest land	VFL	Percentage variation of forest land between Census 1977 and Census 2007
		Inter-census variation in the proportion of forest land	VPFL	Variation in percentage point changes in forest land proportion between Census 1977 and Census 2007. The forest land proportion corresponds to the county's forest land based on the total surveyed area.
Demographic	Total population	Inter-census variation in total population	VTP	Percentage variation in total population between Census 1982 and Census 2017
	Economically active population (EAP)	Inter-census variation in economically active population (EAP)	VEAP	Percentage variation in EAP between Census 1982 and Census 2017. The EAP corresponds to population aged 15 to 64.
	Rural population	Inter-census variation in rural population	VRP	Percentage variation in rural population between Census 1982 and Census 2017
	Aged population	Inter-census variation in Aging Index	VAI	Percentage variation in Aging Index between Census 1982 and Census 2017. The Aging Index is the proportion of people older than 60 to 100 people younger than 15.
Socio-economical	Poverty	Variation in poverty rate	VPR	Variation in percentage point changes in poverty rate between 1992 and 2013. The poverty rate is the percentage of poor people with respect to the total population in a given area.
		Variation in poverty gap	VPG	Variation in percentage point changes in poverty gap between 1992 and 2013. Poverty gap measures the difference in percentage points between the county's and the country's poverty rate
Educational	Educational Level	Variation in Elementary Education	VEE	Percentage variation in population with Elementary Education between 1992 and 2017
		Variation in High School Education	VHSE	Percentage variation in population with High School Education between 1992 and 2017
		Variation in Higher Education	VHE	Percentage variation in population with Higher Education between 1992 and 2017

2.2.2. Descriptive Analysis of Territorial Changes

This phase consisted of a temporal analysis of the implementation of the forest policy, including the identification of the main territorial changes observed at the county level since the law was enacted, as well as its impact on the different geographical areas under study. To do this, the evolution of the forest area was firstly analyzed under the different stages observed during the execution of the law, and then based on the variables and indicators previously indicated. Changes in demographic, socioeconomic, and educational characteristics of population observed in the Ñuble and Bío Bío Regions were also identified and analyzed.

2.2.3. Relational Analysis of Territorial Changes and Forest Policy

After the descriptive analysis, a relational analysis was conducted in order to obtain information that allowed an understanding of the relationship between the different territorial changes produced in the region as a result of the policy implementation. To do this, a correlation matrix for all the indicators was established. A Pearson coefficient was used to conduct this analysis.

2.2.4. Causal Analysis Framework of Territorial Changes

Once the relationship between the indicators was analyzed, a causal analysis was conducted to explain the relationship between the forest policy and the main territory changes resulting from its implementation. To do this, a Multiple Linear Regression Model was used. Specifically, three regression models were developed between the indicators that showed significant correlations in the previous phase.

The first of these regression models was used to determine the impacts on the geographical characteristics of the two regions under analysis (Ñuble Region and Bio Bio Regions), with the inter-census variation of the total population (VTP) as the dependent variable (selected as an indicator of demographic change), and the rest of the indicators (those that showed a significant correlation with it in the previous phase) as independent variables. Through the application of this model, it was possible to identify which are the main factors that have determined the population variations in the region, among which could possibly be the indicators of the productive area associated with the implementation of the forest policy.

The other two models were developed for the geographical area of the Coastal Mountain Range, which recorded the largest increase in forest area during the time period in which the forest policy was implemented. The dependent variables were the inter-census variation in total population (VTP), while the variation in poverty rate (VPR) was added as an indicator of change in community well-being. The independent variables were the indicators that showed significant correlations in the previous phase of this study. Through the application of both models, it is possible to identify which were the main factors that have determined the variations in population and poverty in this geographical area, inquiring about the impact that indicators of the productive field associated with forest policy could have.

The application of the models complied with the assumptions established for this type of analysis and they were evaluated with Fischer's F test and the t test.

3. Results

3.1. Implementation of the 1974 Forest Policy in the Study Area

One of the main characteristics of Chile's Decree Law DL 701 1974 Forest Act is that subsidies were concentrated geographically. In fact, 73.8% of the area where forests were planted with government subsidies was located in the south central area of the country, specifically in the Maule, Ñuble, Bio Bio and La Araucanía Regions, with 922,991.8 hectares [68].

Of the total subsidized area in the study area, 50% was planted in the first 10 years, accounting for 24.5% of the total afforested and reforested area throughout the implementation of the policy. This shows that a strong effort to incentivize tree plantations at an intial stage would have been enough to increase the area of forest plantations in the study area (Figure 3).
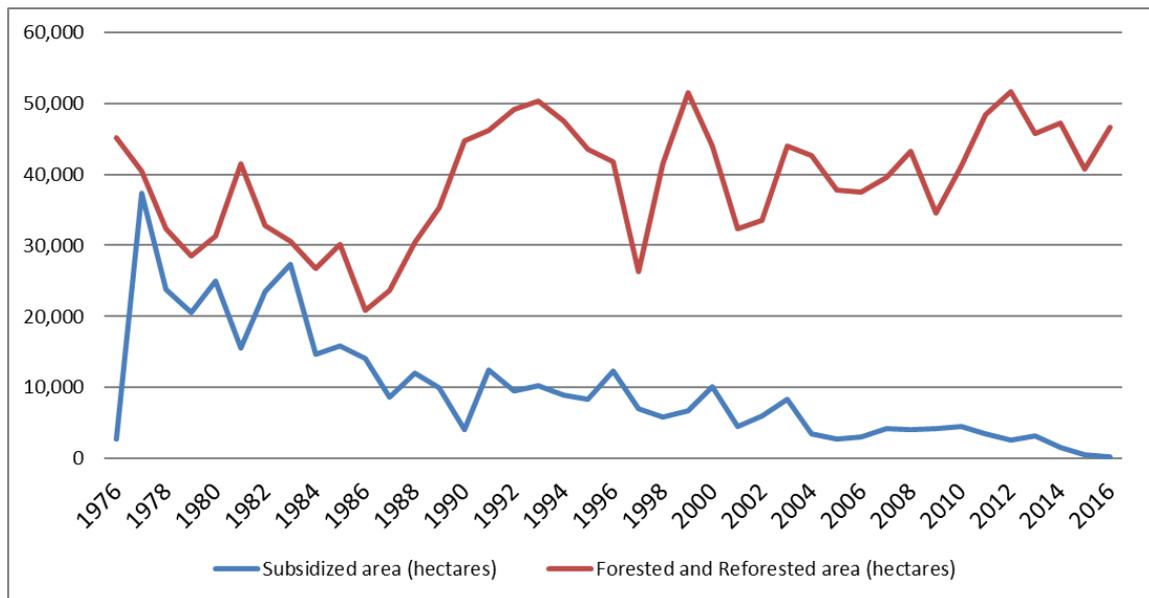
Figure 3. Subsidized, afforested, and reforested area in the study area.

Regarding territorial distribution, the variation between the Agricultural and Forest Censuses of 1977 and 2007 shows that only five counties decreased their proportion of forest land. On the contrary, 81.5% of the counties increased their proportion of forest area in that period (Figure 4).
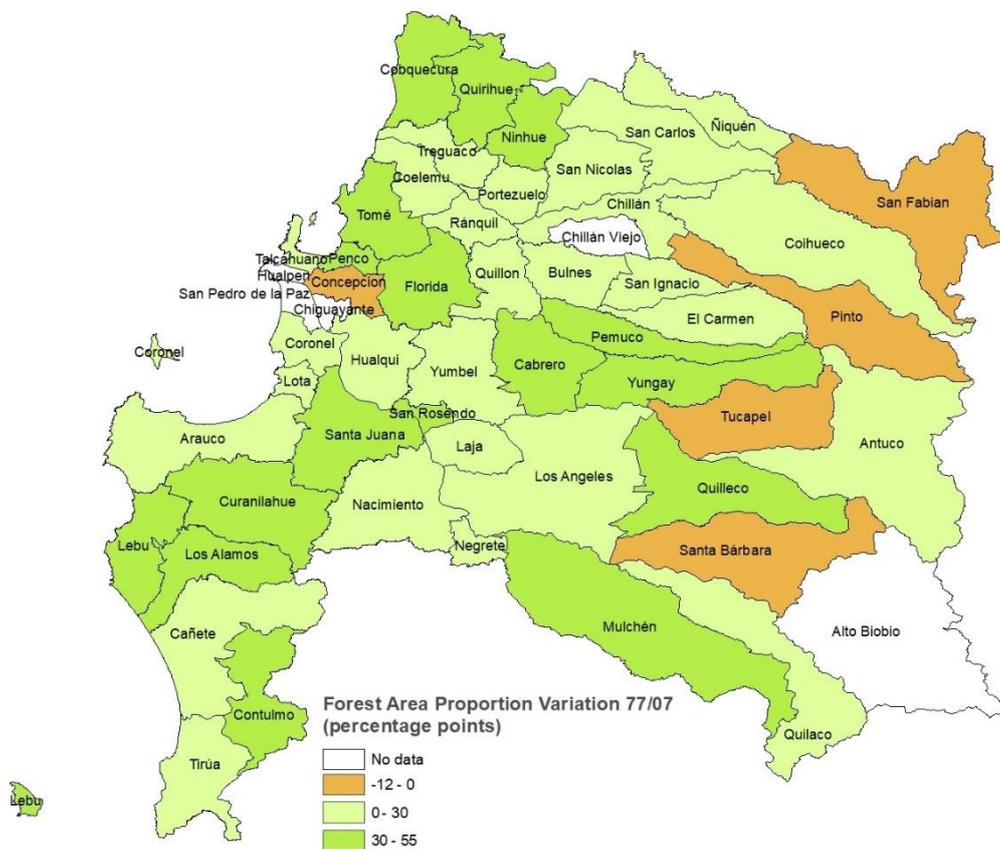

Figure 4. Inter-census variation (1977–2007) of forest land area by county in percentage points.

The data show massive tree planting in the area soon after forest policy was enacted, covering a large area, particularly in the Coastal Mountain Range. According to Nahuelhual et al. [42], higher annual rates of afforestation were recorded in the 1975–1990 period compared to the 1990–2007 period in the coastal zone of Maule, Ñuble, and Bío Bío Regions. However, this rapid afforestation process observed at the beginning of the policy implementation was not observed in other areas of the country, as described by Echeverría et al. [70] in the case of the Maule Region.

Towards the end of the 1980s and the beginning of the 1990s, Chile experienced a sharp increase in forest cover. In fact, land with new forest plantation represented an increase in the annual forest area of around 100 thousand hectares in the period 1990 and 2007 [68]. About four decades have passed since the 1974 forest policy was enacted and almost all of the planted forest land (98.6%) in Chile corresponds to area with new forest plantations [71].

This significant increase derived from the exploitation of plantations is consistent with the increase in forest exports towards the end of the 1980s and the beginning of the 1990s, reaching almost 7000 million dollars in 2018 (Figure 5).
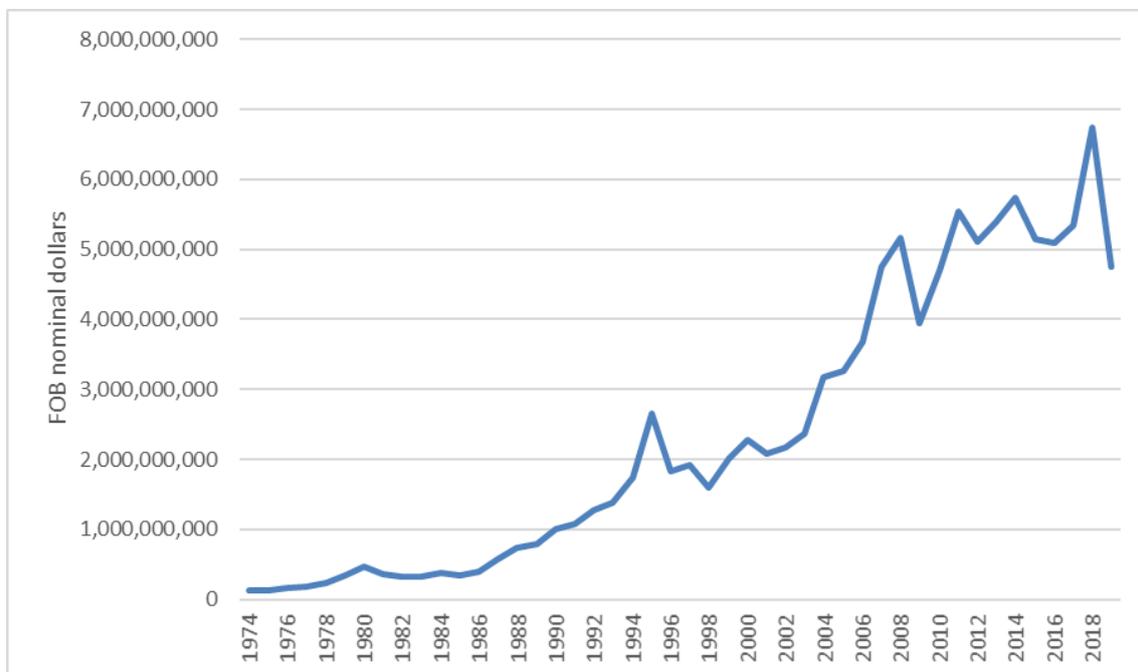
Figure 5. Evolution of forest exports in free on board (FOB) nominal dollars.

3.2. Demographic, Socioeconomic, and Educational Changes in the Study Area

The total population in the study area increased by 34.1% in the period 1982–2017, which was lower than the country's population growth rate (55.1%) in the same period. On the other hand, the rural population decreased by 14.2% in the study area, while there was a 6.7% increase at the country level. Therefore, both variables indicate that there is a lower demographic growth in the study area compared to that of the country.

Furthermore, high variability was also observed when the analysis was conducted by county. In this sense, 38.8% of the counties showed a decrease in their total population (Figure 6) and more than 75% of them showed a decrease in their rural population (Figure 7).
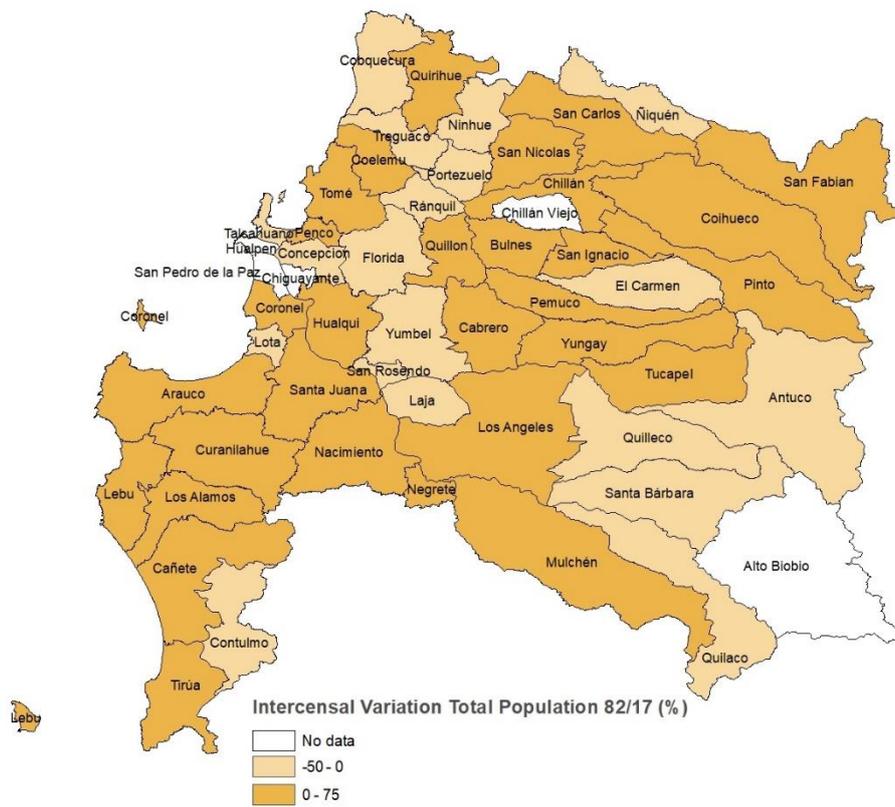
Figure 6. Variation (%) in total population between the Censuses of 1982 and 2017.
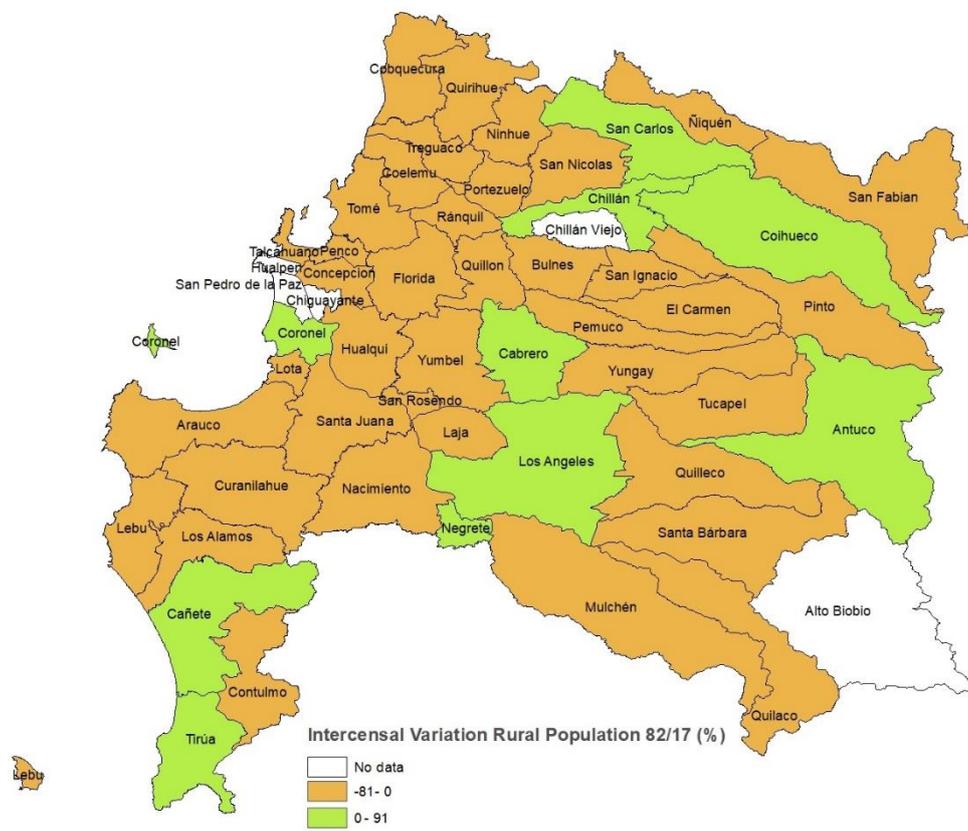

Figure 7. Variation (%) in rural population between the Censuses of 1982 and 2017.

The spatial distribution of both variables shows that there was a negative impact on demographic development, particularly on sectors of the Andean foothills and the Coastal Mountain Range, where most forest production occurred (Figure 4).

Economically active population (EAP) increased by 41.7%, in the period 1982–2017, also showing an uneven growth rate between counties. In general, 26.5% of the counties recorded a decrease in their EAP.

Aging index increased from an average of 17.6% in 1982 to 75.5% in 2017, with similar differences between the counties. This variation in aging index in the area under study coincides with the aging process of the country [72].

The poverty rate recorded in the study area in the period 1992–2013 was higher than that of the country. In 1992, 45% of the population of Ñuble and Bio Bio Regions was living in poverty, while the country's poverty rate reached 32.9%. In 2013, the average povery rate for population in the study area and the country reached 22.3% and 14.4%, respectively. It can be observed that poverty levels decreased at both country and regional levels but not at the same rate. Thus, the poverty gap increased by 18.1 percentage points for the study area in the period 1992–2013. Figure 8 shows that 75.5% of the counties under study recorded an increase in poverty gap in this period. This gap increases by 83.8% if only rural counties are considered.
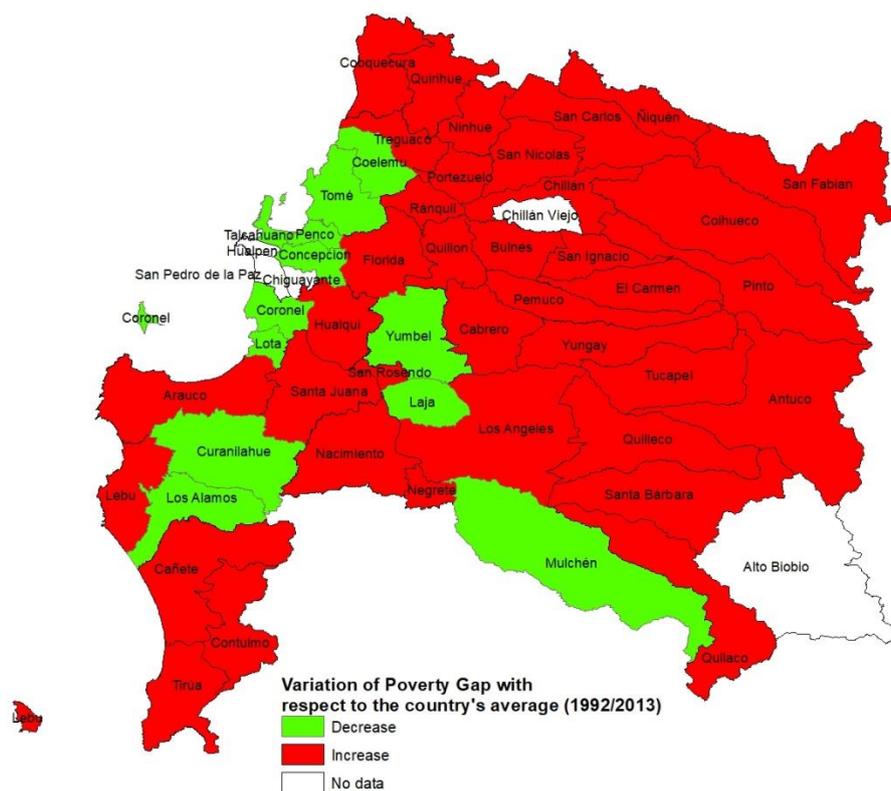
Figure 8. Variation of the poverty gap by county with respect to the country's average value between 1992 and 2013.

With respect to educational level, the proportion of population with higher education in the study area was 1.8% in 1982, while the population with high school education was 11.6%. In 2017, these percentages rose to 13.4% and 34.1%, respectively. On the other hand, the percentage of the population with elementary education varied from 61.7% in 1982 to 38.8% in 2017. This implies that the educational level structure of the people living in this area changed; the population with high school and higher education increased, while the population with elementary education decreased.

Given the fact that access to elementary education has been guaranteed for almost all the population for decades, the downward trend observed in rural areas could be explained by a decrease in elementary school enrolment [73–75] due to a decline in the rate of children. This was observed at the country level, but particularly in the Bío Bio and Ñuble Regions, which recorded the greatest decrease in the proportion of children between the Census of 1992 and 2017 [76]. The changes in the educational level of the population are in accordance with trends observed at the country level. There were significant increases in enrolment and coverage of high school and higher education, shaped by profound political and structural transformations of the Chilean educational system [77–80].

3.3. Relationship between the Territorial Changes Observed

Table 2 shows the significant relationships established between all the indicators included in this study.

Table 2. Pearson correlation indices.

	Productive			Demographic			Socioeconomic		Educational		
	VFL	**VPFL**	**VTP**	**VRP**	**VEAP**	**VAI**	**VPR**	**VPG**	**VEE**	**VHSE**	**VHE**
VFL		0.40 *									0.46 **
VPFL	0.40 *			−0.31 *							
VPT				0.66 **	0.99 **	−0.66 **			0.88 **	0.33 *	0.37 *
VRP		−0.31 *	0.66 **		0.66 **		0.32 *	0.37 *	0.48 **		
VEAP			0.99 **	0.66 **		−0.68 **			0.89 **	0.39 *	0.40 *
RAI			−0.66 **		−0.68 **			0.17 *	−0.60 **		
VPR				0.32 *				0.95 **		0.35 *	
VPG				0.37 *		0.17 *	0.95 **			0.40 *	
VEE			0.88 **	0.48 **	0.89 **	−0.60 **				0.49 **	0.54 **
VHSE			0.33 *		0.39 *		0.35 *	0.40 *	0.49 **		0.67 **
VHE	0.46 **		0.37 *		0.40 *				0.54 **	0.67 **	

* The correlation is significant at the 0.05 level (bilateral). ** The correlation is significant at the 0.01 level (bilateral).

The following are the main relationships established:

(1) The results show a significant and inverse correlation between the variation in rural population (VRP) and the variation in the proportion of forest area per county (VPFL). These results are consistent with the descriptive analysis conducted before, which showed an increase in the proportion of forest area and a decrease in rural population (Figures 4 and 7). This relationship can be explained by the forest transition theory [81–87], which outlines that the economic development of a territory promotes afforestation and therefore rural-urban migration. In fact, Heilmayr et al. [88] would have identified it in Chile driven by the forestry policy analyzed in this study.

(2) There is a positive and significant correlation between indicators related to the increase in poverty (VPR and VPG) and that related to the increase in rural population (VRP). This type of relationship has been previously described in other studies carried out in depressed territories, where the population finally migrates to escape poverty [89–93].

(3) Demographic characteristics are correlated between them. The correlation index that is established between the variation in total population (VTP) and the variation in economically active population (VEAP) is particularly high. In addition, the indicator associated with the increase in aging population (VAI) shows negative correlations with the other two demographic indicators (VTP and VEAP). These results reveal that there is a demographic transition at both regional and country levels, characterized by a decrease in fertility and mortality rates, which results in a lower growth of the total and economically active population and an increase in aging population [72,94].

(4) In terms of educational level, the results show that there is a significant correlation between the variation in elementary education (VEE) and demographic indicators. This correlation is positive in all the indicators, except for the variation in aging population (VAI). These results show that

counties in which the proportion of population with elementary education decreases also decrease total (VTP), rural (VRP) and economically active (VEAP) population, but they present an increase in aging population (VAI).

(5)   The changes observed in high school education (VHSE) and higher education (VHE) are positively correlated with the variation in total population (VTP), variation in economically active population (VEAP), and also with indicators from other areas. In this sense, the variation in high school education (VHSE) has a positive and significant correlation with the indicators related to the increase in poverty level (VPR and VPG). Similarly, the variation in population with higher education (VHE) is positively correlated with the variation in forest land (VFL). However, these relationships need to interpreted cautiously since, as abovementioned, the trends observed for high school and higher education would be mediated by the political and structural changes of the Chilean educational system.

3.4. Determinants of Territorial Changes

Table 3 shows the results of the three regression models performed. The analyses showed optimum values for the coefficients of determination (R^2), which indicates that the counties in this study were properly analyzed by the selected indicators.

Table 3. Results of the regressions to identify the determining factors of territorial changes.

Dimension	Variables	Multiple Linear Regression Models Dependent Variables		
		VTP (1)	VTP (2)	VPR (3)
		All the territory	Coastal Mountain Range	
		Standardized regression coefficients (B)		
	Constant	75.39 **	96.5 **	−38.82 **
Productive	VPFL		−0.89 *	0.99 **
Socioeconomic	VRP	0.3 **		0.3 **
Demographic	VAI	−0.28 *		
Educational	VEE	1.78 **	2.47 **	
Model diagnostics				
R^2 adjusted		0.88	0.86	0.62
F **		78.99 **	41.82 **	1.31 *
N		37	17	17

* Significant at 5 percent level ($p < 0.05$). ** Significant at 1 percent level ($p < 0.01$).

In relation to model 1 (applied in the geographical area of the two regions under analysis), the results show that the variation in total population (VTP) is significantly and positively influenced by the increase in population with elementary education (VEE) and the increase in rural population (VRP), while it is negatively influenced by the variation in aging index (VAI). In this sense, the counties that recorded an increase in population are those in which the young population with access to elementary education also increased [76], presenting rural territories with demographic vitality. These results are similar to those observed in other geographical areas, in which population aging [91,95–99], low birth rates [100], and imbalances in rural-urban relationships [101–103] become determining factors in the processes of territorial development. In general, the changes observed in these parameters with the application of model 1 explain 88% of the variations produced in the total population of the counties of the two regions.

Due to the fact that the Coastal Mountain Range recorded the greatest increase in forest area during the period of implementation of the forest policy, the other two models (2 and 3) were applied to this geographical area. The results of model 2 show that the variation of total population (VTP) is significantly and negatively influenced by the increase in the proportion of forest land (VPFL),

and positively influenced by the increase in population with elementary education (VEE). In this case, the explanatory power of the regression model is 86%. On the other hand, the results of model 3 show that the increase in poverty rate (VPR) is significantly influenced by the increase in both the proportion of forest area (VPFL) and rural population (VRP). In this case, the explanatory power of the regression model is 62%.

The results obtained show that the proportion of forest area is positively correlated to the poverty rate, and negatively correlated to total population. This is very clear in the geographical area of the Coastal Moutain Range, but not in the other areas. In these areas, there are other variables that would influence these relationships, explaining what the linear regression model is unable to explain.

4. Discussion

The results show that there are important territorial changes in terms of community well-being, and productive, demographic, and educational variables. In particular, there is a significant increase in forest land and a decline in demographic and socioeconomic characteristics of population. This turns out to be a rare relationship at a global level and therefore little studied, probably because analyses usually include both forest surface and tree plantation area as one single element, without considering that both perform very different functions [21,104,105]. Furthermore, it is difficult to separate global statistics into figures corresponding to natural forests, passive restoration (natural regeneration) in forests, regeneration with human intervention, and tree plantations [23].

In general, studies on this area tend to focus on the relationship between deforestation and impacts on the territory and its population [106–111]. For instance, the Forest Transition Theory developed by Mather [82] approaches afforestation as a subsequent stage in the development of a society. However, in our study, afforestation has a causal relationship with the decrease in population and the increase in poverty. Therefore, it differs from Mather's theory and from most of the studies previously published.

The causes of this behavior could be associated with the fact that the increase in the proportion of forest land in the counties under study was due to plantations of exotic species and not due to natural forests, which perform different functions. Therefore, they have different impacts on the territory and population [112–114], affecting the productive structure and livelihoods in the case of tree plantations [102,115].

Another aspect to consider is that the causal relationship occurs in those counties located in the geographical area that records the greatest increase in forest cover (Coastal Mountain Range), affecting the provision of ecosystem services, particularly water supply [116–118], and generating adverse conditions for the settlement of population.

When analyzing the entire area under study, three different dynamics can be identified: (i) forest transition, which would explain the relationship between the increase in forest land and the decrease in population; (ii) demographic transition, which would explain the increase in population aging and the decrease in population growth rate; and (iii) the relationship between poverty and rurality. This suggests the need for local in-depth analyses to quantify the impacts of policies in rural areas.

There are few studies on the impacts of forest expansion on the territory and population. However, the trend of this process is upwards, if the greater appreciation of the forest plantation society is considered as a strategy to weaken the effects of global change, the provision of ecosystem services and the care of the environment. Therefore, to avoid negative impacts of this type of forest policy, the design and implementation should be broadened, incorporating the different functionalities of the forest industry.

5. Conclusions

Chile has made efforts to promote the development of the forest sector by providing subsidies for the planting of tree plantations. Decree Law 701 1974 Forest Act allowed the subsidization of afforestation costs and support for ongoing plantation management for about four decades (1974–2012). Official evaluations of the policy, which mainly focus on economic and productive aspects, confirm

that the law resulted in changes in land cover in a wide geographical area of the south-central zone of the country, contributing to the increase in forest cover and growth of Chile's forest exports. However, there is scarce information on the impacts on rural society, its population, and community well-being.

This study addressed this knowledge gap, analyzing the impacts of the policy on demographic, socioeconomic, and educational characteristics of population. For this, we used different methods in order to understand the different territorial changes produced in the Ñuble and Bio Bio regions, which is the area with the highest increase in tree plantations as a result of the policy implementation.

The results show that those areas in which the proportion of forest area increased also presented an increase in poverty rate and a decrease in population. In this way, counties that experienced a strong expansion of their forest cover also had to face higher poverty rates and a decline in demographic growth.

When the entire study area is analyzed, these relationships are not clear because there would be context variables that influence these relationships differently. Therefore, it is relevant to identify and analyze these variables involved and, particularly, to quantify the limit proportion of forest plantation in a county, from which negative impacts could be generated on the population and its well-being. This is a possible line of research that is opening up and which should be further explored in the future.

The results obtained demonstrate that policies to incentivize tree plantations that do not consider the diversity of forest functions end up generating negative impacts on the territory and population. In this sense, it is essential to differentiate between natural forests and tree plantations, since they serve different functions, and in turn make different contributions to rural territorial development.

There is a need to acknowledge the importance of population as well as the provision of a wide range of forest products and services within the landscape and land use when it comes to establishing tree plantations. For this, it seems necessary to implement forest policies that integrate such views.

Chile's current forest policy is aimed at promoting productivity and economic growth, considering inclusion and social equity, but also pursuing the objective of protecting and restoring the forest heritage. This seems to be a good start to help mitigate the negative impacts of the previous forest policy.

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