Water **2011**, *3*, 576-589; doi:10.3390/w3020576

OPEN ACCESS

water

ISSN 2073-4441

www.mdpi.com/journal/water

Article

Present Characteristics of Northwestern Patagonia (Argentina)

Olga E. Scarpati [1,2,*], Maria I. Botana [1], Alberto D. Capriolo [2], Veronica Pohl Schnake [1], Yamile Puga [1] and Edgardo Salaverry [1]

1 Department of Geography, National University of La Plata, La Plata, Argentina; E-Mails: botana.mariaines@gmail.com (M.I.B.); veropohls@yahoo.com.ar (V.P.S.); yamilepuga33@hotmail.com (Y.P.); edgardosalaverry@hotmail.com (E.S.)

2 National Research Council, Argentina. Av. Rivadavia 5485 (1424), Buenos Aires, Argentina; E-Mail: albertocapriolo@yahoo.com.ar

* Author to whom correspondence should be addressed; E-Mail: olgascarpati@yahoo.com.ar; Tel.: +54-011-4432-7034; Fax: +54-011-4962-4431.

Received: 13 April 2011 / Accepted: 13 May 2011 / Published: 13 May 2011

Abstract: Changes experienced in temperature, precipitation, demography and land coverage are the main themes studied in northwestern Patagonia, Argentina, which includes part of Neuquén, Río Negro and Chubut provinces. The precipitation shows important interannual variability and decreases during the warm semester. The mean minimum temperature in January in Neuquén city increased with statistical significance. Forests and steppe are the more important ecosystems of the area and the native forests of *Nothofagus* sp. are located mainly in protected areas like National or Provincial Parks. Twenty-eight percent of the Andean—patagonic forests are in the Río Negro province, while Neuquén province has 9% and Chubut province has 26%. The censuses of 1991 and 2001 showed that Los Lagos, Lacar, Picún Leufú and Cushamen are the counties with increasing population.

Keywords: northwestern Patagonia; climate variability; land use; population and housing census

---

1. Introduction

Argentine Patagonia region includes the provinces Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego. Water has been the greatest limiting factor for this area, conditioning the development of the region. Thus, the population has settled near the watercourses to fulfill the main needs of potable water.

The topography of the study area is complex with a succession of valleys and mountains. In general the altitude increases towards the west but near some rivers and lakes, like Azul River and Puelo Lake, the height is low (200–300 m). Some important cities are situated at 800 meters (San Carlos de Bariloche, San Martin de los Andes, Esquel, *etc.*) but they are located very near to mountains such as Tronador, Lanin and Fitz Roy which reach 3,000 meters.

Patagonia draws tourists for the quality and the diversity of its natural attractions, as well as for its geographic location, which make it particularly attractive to foreign tourists. In fact, although the main market of Patagonia is still national tourism, the arrival of foreign tourists has increased considerably in the last decade.

The two main ecosystems are the forest and the steppe. The Patagonian forest extends along the Andes from Neuquén province to Tierra del Fuego province, occupying a total surface of 1.2 million hectares. Only 4% of this area is occupied by afforested forest producing in a few years timber with the value of 2 million $US. This percentage of forest changed to afforested land in the according provinces is 23% in Neuquén, 5% in Chubut and 4% in Río Negro [1]. The native forest contains mainly *Nothofagus* sp. (lenga, cohiue, ñire, *etc.*) while the afforested forest contains exotic species, above all, the *Pinus* sp. characterized by quicker growth than the native species.

In this paper the study area is northwestern Patagonia (20 million hectares) which contains part of Neuquén, Río Negro and Chubut provinces. This region is very important for tourism, forestry, water power generation and agriculture. The goal of this study is to analyze the climate variation, as well as the demography and the main land coverage of this subregion.

Precipitation is scarce, with the exception of areas in or near the Andes Mountain Chain where the rivers crossing the Patagonian plateau start.

The region has scarcely available meteorological data mainly because the National Meteorological Service (NMS) has few stations. There is only one station belonging to the National Institute of Agronomic Technology—INTA (Bariloche INTA), which is located very close to the corresponding one from NMS. National Water Resources holds precipitation measurements but the data series have serious problems: they are not of the same period, the locations of the pluviometers do not answer the specifications of the Meteorological World Organization, they are not complete records and so they cannot be used to study climate variation.

Barros *et al.* [2] used all the available information of Patagonia—and more stations located in other Argentine areas—to show that monthly precipitation has negative trends over the northwestern of Patagonia and the simulations carried out using climate models suggest that this variability is related to the atmospheric circulation changes in the Southern Hemisphere and is linked with climate change. In fact, the Antarctic Oscillation (AAO) exerts a significant influence on the precipitation trends in the region, when the sea level pressure decreases at polar latitudes it increases at middle latitudes altering the precipitation regimes in the entire region.

At the mid- and high latitudes, the Arctic and Antarctic oscillation (AO and AAO) are the dominant modes of the interannual climate variability. The AAO, also referred to as Southern Annular Mode (SAM), is the dominant pattern of non-seasonal tropospheric circulation variations below 20 °S, and it is characterized by positive pressure anomalies over Antarctica and negative anomalies over an area centered at about 40–50 °S, or *vice versa*. According to New *et al.* [3], the AO explains 48% and 35% of the area-averaged winter precipitation variability over land in the latitude bands 60–80 °N and 40–60 °N, respectively. On the contrary, in the area included between 40 °S and 60 °S a marked and univocal trend has not been observed, the land precipitation was inferior to the average until 1930, above the average in the period from 1930 to 1960 and again below average until 2005. It should, however, be noted that this domain is represented only by southern South America and New Zealand, and therefore has a relatively small land area.

Recent studies realized by Kayano and Andreoli [4] provided diagnostic evidence on modulations of El Niño–Southern Oscillation (ENSO) teleconnections by lower frequency climate modes. One of these modes is the well known Pacific (inter-)Decadal Oscillation (PDO), which explains part of the decadal–multidecadal variability in the tropical and mid latitude Pacific.

All these climate variations influence the ecosystems of Patagonia and so the treelines.

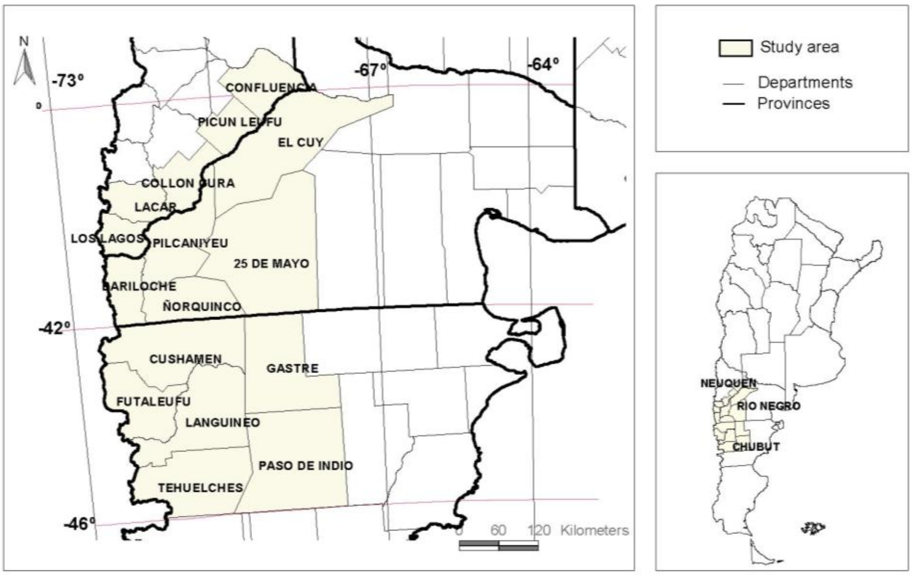
According to Daniels and Veblen [5], despite the broad-scale constraints on treelines imposed by global-scale thermal trends, factors other than temperature influence treeline elevation and structure at fine spatial scales. Regional- to local-scale factors are particularly important in mountainous terrain, where topographic effects modify coarse-scale climate trends. They studied one of the species of *Nothofagus* (*N. pumilio*). The *Nothofagus* sp. are very important in Patagonia. The tree radial growth and seedling establishment of *Nothofagus pumilio,* at alpine treeline near 40 °S latitude in Chile and Argentina, showed time- and site-dependent relationships to interannual-and decadal-scale climate variation. A shift in climate from cool–wet to warm–dry conditions facilitated comparison of climate–vegetation relationships during two distinct periods: 1957–1976 and 1977–1996. Consistent with the Pacific trend, Argentine moisture indices were mostly positive from 1914 to 1976, and warm, dry conditions have dominated since 1977. The 1976–1977 shift in Argentine climate coincides with shifts in ENSO and the PDO, and suggests hemispheric-scale climatic controls. After 1976, there was an increase in the relative importance of El Niño years (negative phase) compared to La Niña years (positive phase), which is linked with marked changes in regional climates worldwide. Understanding climatic influences on *Nothofagus pumilio* growing at treeline at mid-latitudes in Argentina has proven complex. Temperature and moisture availability do not have significant influences on tree radial growth and seedling establishment at treeline, but the traditional temperature paradigm nor moisture availability explains treeline dynamics adequately for all sites or during both warm-dry and cool-wet periods. Rather, temperature and precipitation interact and climate relationships have been unstable through time and among study areas.

2. Materials and Methods

Figure 1 shows the study area which comprises sixteen departments (counties): five in the province of Neuquén (Collón Curá, Confluencia, Lacar, Los Lagos and Picun Leufú), six of the province of Chubut (Cushamen, Futaleufú, Gastre, Languiñeo, Paso de los Indios and Tehuelches) and five in the province of Río Negro (25 de Mayo, San Carlos de Bariloche, El Cuy, Ñorquinco and Pilcaniyeu). This area was selected because data of climate and vegetation were available.

INDEC Argentina (acronym for National Institute of Statistic and Census) has provided the Population Census data. The corresponding statistics referring to the 1991 and 2001 censuses have been studied for each departments of the study area, with the aim of carrying out a comparative analysis of both censuses. The considered indicators are total population, population growth and population density for the period 1991–2001 [6,7].

Figure 1. Location of the departments in the northwestern Patagonia region, adapted from [10].



Daily precipitation data and the daily mean values of maximum and mean minimum temperatures were provided by the National Meteorological Service. Tables 1 and 2 show the meteorological stations used, their coordinates and the period of available data and Figure 2 shows the location of the stations.

According to the data, for all stations the warmest month is January (summer) and the coldest is July (winter), considering the minimum and maximum temperatures.

The Mann Kendall non parametric test, one of the most commonly used tools for detecting trends in climatic and hydrologic time series has been applied to meteorological data by taking as null hypothesis the assumption that the data are independent and randomly ordered. This method has the advantage of being insensitive to the true (unknown) form of the distribution involved. Moreover, as indicated by Yue *et al.* [8] the power of the Mann–Kendall and Spearman's rho tests depend on the pre-assigned significance level, magnitude of trend, sample size, and the amount of variation within a time series after both tests are analyzed by Monte Carlo simulation.

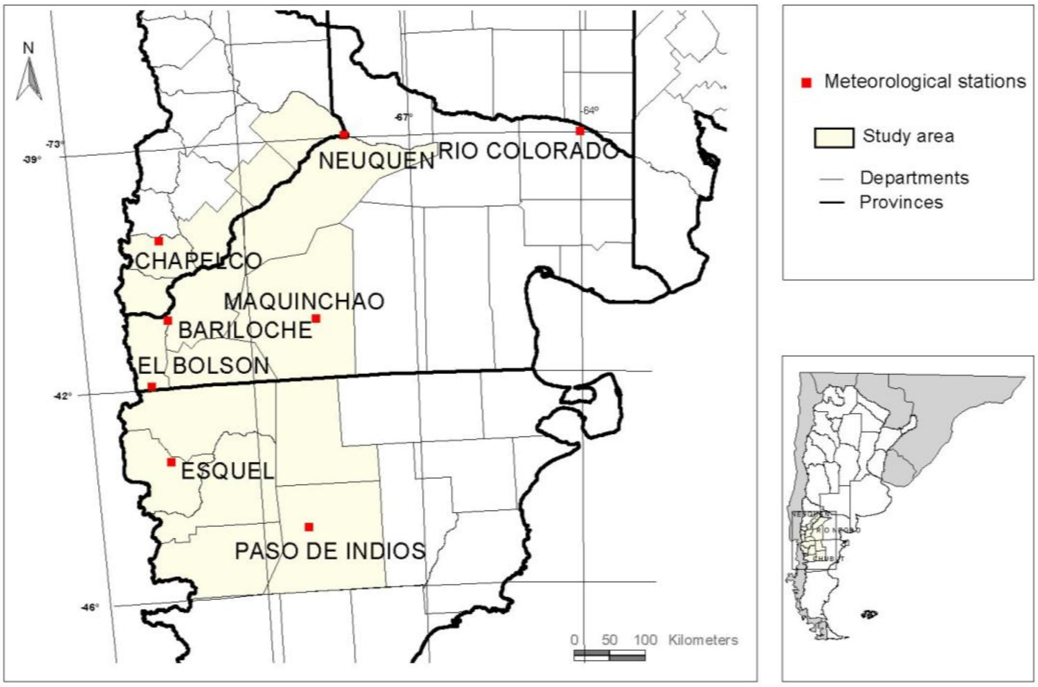
Table 1. Characteristics of the meteorological stations used for the temperature analysis.

Station	Latitude	Longitude	Height (m)	Period
Bariloche	42°06′ S	71°10′ W	836	1980–2008
Esquel	42°54′ S	71°09′ W	785	1980–2008
Neuquen	38°57′ S	68°08′ W	271	1980–2008
Maquinchao	41°15′ S	68°44′ W	888	1980–2008

Table 2. Characteristics of the meteorological stations used for the precipitation analysis.

Station	Latitude	Longitude	Height (m)	Period
Bariloche	41°09′ S	71°10′ W	840	1960–2008
El Bolsón	41°58′ S	71°30′ W	337	1978–2008
Maquinchao	41°15′ S	68°40′ W	888	1960–2008
Chapelco	40°05′ S	71°10′ W	779	1990–2008
Neuquén	38°57′ S	68°10′ W	271	1960–2008
Esquel	42°56′ S	71°10′ W	797	1960–2008
Paso de los Indios	43°49′ S	68°50′ W	460	1968–2008
Río Colorado	39°01′ S	64°05′ W	79	1960–2008

Figure 2. Location of the meteorological stations used in this work. [Realized by the authors].



The indicators of soil coverage used are forestland, type of forestland (only one predominant specie or mixed forest), forest of native or exotic species, degraded forests and shrublands. Other forestlands are those with more than 20% of shrub in their composition and the heights of the trees are lower than 7 meters. All these data have been obtained from the National Environment [9].

3. Results

3.1. Population Data Analysis

The study area has a total population of 558,471 inhabitants according to the 2001 Census, which corresponds to the 1.54% of the total population of Argentina [7]. The sum of the total population of Neuquén, Río Negro and Chubut provinces is 1,440,214 inhabitants (3.97% of argentine population). Thus the study area contains the 38.78% of inhabitants of the three above mentioned provinces.

As can be seen in Figure 3, the most populous counties are:

- Confluencia, in Neuquén province, with 314,793 inhabitants;
- San Carlos de Bariloche, in Río Negro province, with 109,826 inhabitants;
- Futaleufú, in Chubut province, with 37,540 inhabitants.

There are also some counties with less than 5,000 inhabitants:

- Picún Leufú and Collón Curá, in Neuquén province;
- El Cuy and Ñorquinco, in Río Negro province;
- Paso de los Indios, Languiñeo and Gastre, in Chubut province.

Figure 3. Population Census in 1991 and 2001 in the studied region. The river network is superimposed on the map, adapted from [10].

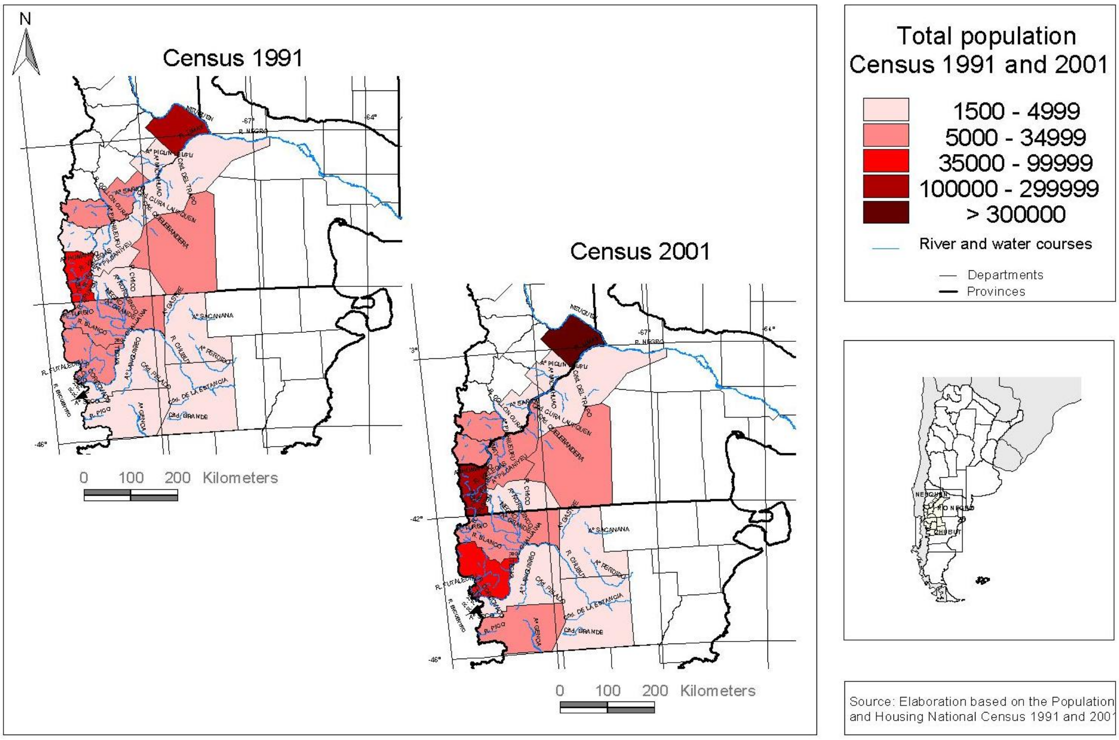


Figure 4 shows that Los Lagos, Lacar, Picún Leufú and Cushamen are counties with increasing population (+107.0%, +44.4%, +28.2% and +23.4% respectively), while Languiñeo (−9.2%), Gastre (−20.6%), Ñorquinco (−11.8%) and Collón Curá (−44.1%) show a decrease in their population, which is mainly rural (Figure 5).

In general, population/counties are small, with low population density and prevalence of working-age population [7,10].

In the most populated counties (Confluencia and Bariloche, in which urban population is 96% and 93%, respectively), commerce, public administration, industry and services are the most important activities.

Figure 4. Population variation between Census 1991 and Census 2001, adapted from [10].

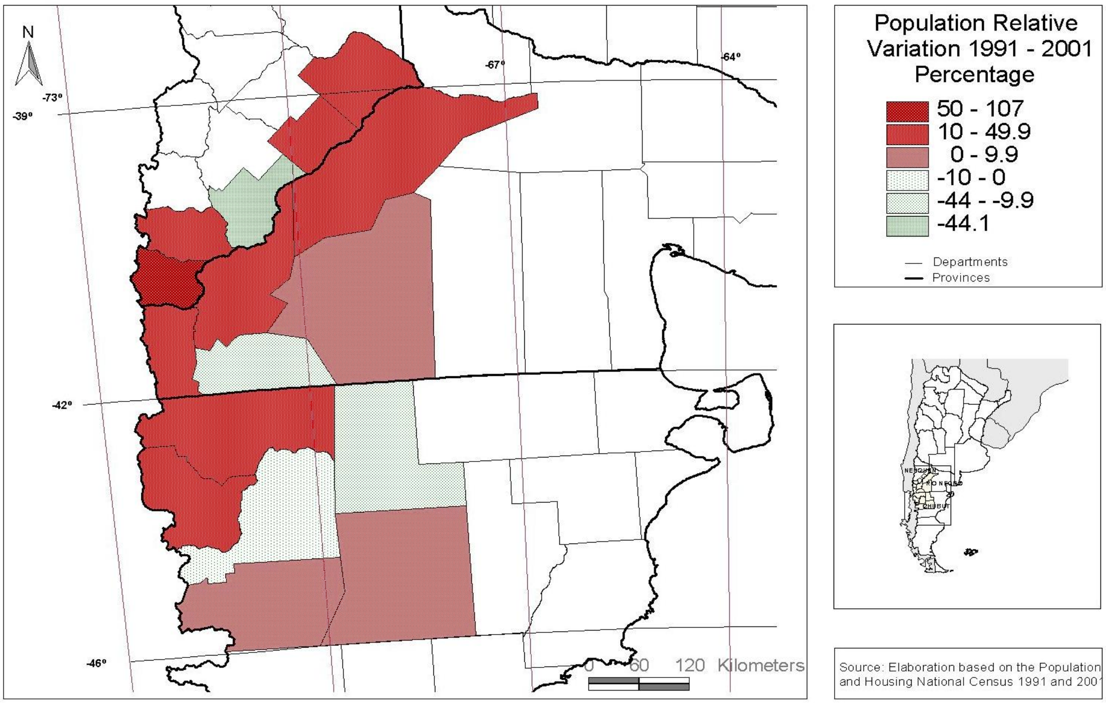
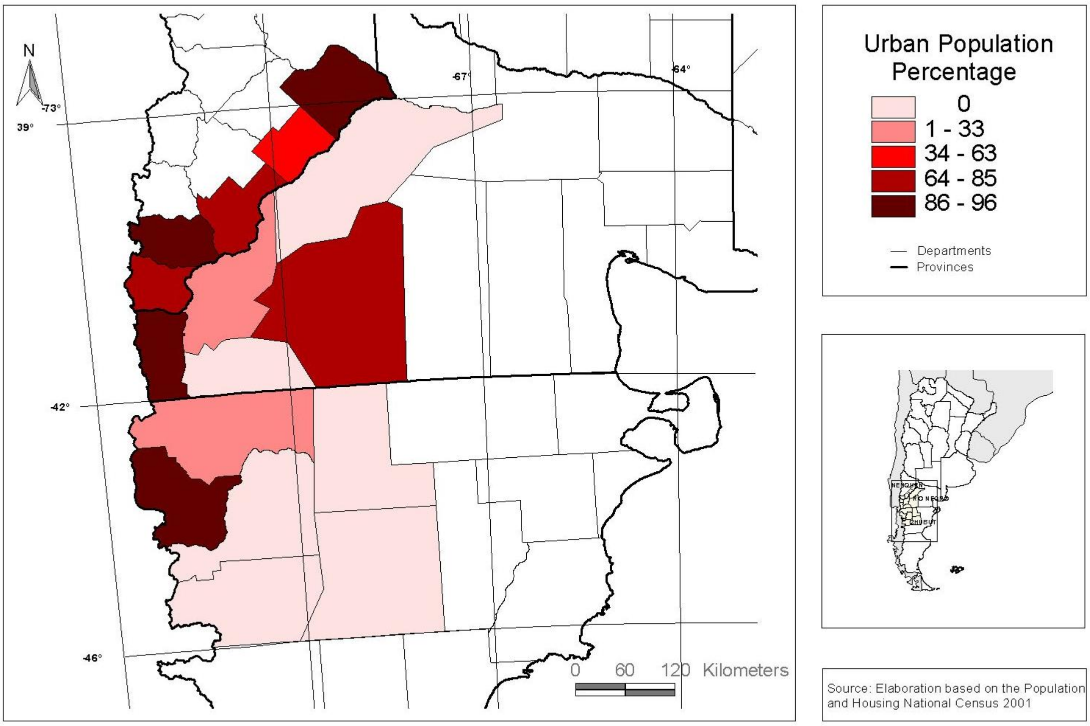


Figure 5. Percentage of urban population in the studied region in 2001, adapted from [10].



The level of coverage of basic sanitation services can be considered acceptable, particularly concerning the availability of potable fresh water: the percentage of inhabitants that do not have this service in their house is 8.5% [10].

3.2. Climate Data Analysis

The Mann-Kendall test has been applied to detect trends in the minimum and maximum temperatures recorded in the four stations in Table 1. Neuquén is the only city in which the Mann-Kendall test is significant. Thus, it is possible to conclude that the mean minimum temperature in July recorded in this station is increasing.

Figure 6 shows the mean maximum and mean minimum monthly July temperature for this station for the period 1980–2008.

Figure 6. July mean maximum (orange) and mean minimum (green) temperatures, together with the corresponding linear trends (black), recorded at Neuquén.

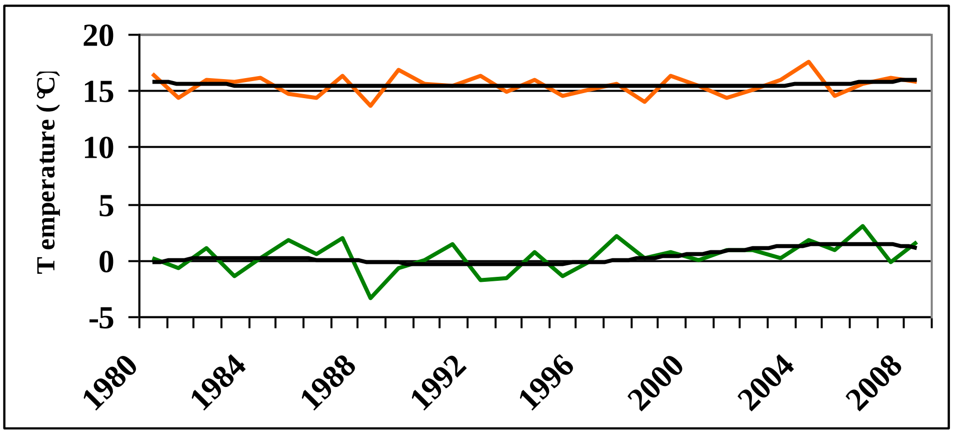


Table 3 shows the results of the Mann-Kendall test for the temperature data.

Table 3. Results of Mann-Kendall test for assessing a trend in the July temperature.

Mann-Kendall test for the trend					
Station	**N cases**	**Confidence Levels p = 95%**		**τ**	**Significance**
Esquel	28				no
Bariloche	28	+0.257	−0.257	−0.032	no
Neuquén	28	+0.257	−0.257	+0.310	yes
Maquinchao	28	+0.257	−0.257	−0.012	no

The results of the application of the Mann-Kendall test have led us to test the correlation between the mean minimum temperature in July at Neuquén and the AAO and PDO indices. The low values assumed by the correlation coefficient (0.08 and −0.31, respectively), however, clearly indicate the absence of a relationship between those parameters. Nevertheless, all four meteorological stations show a consistent interannual variability: for example, the year 1988 (a La Niña year) presents low values of mean minimum temperature.

Annual cumulated precipitation varies according with altitude and longitude. It increases with the altitude and with the longitude from W to E according to Landsberg [11], the Atlas Total [12] and Barros *et al*. [13]. This is the main reason for the presence of the two different ecosystems in Patagonia: forest and steppe [12,14-16].

The annual precipitation shows a consistent interdecadal variability. The study of the series of monthly cumulated precipitation in northwestern Patagonia has confirmed the presence of negative trends in summer, even if the Mann-Kendall test did not show any statistical significance (Table 4). According to Kayano and Andreoli [4] these trends could be explained using the Pacific Decadal Oscillation (PDO).

Table 4. Results of Mann-Kendall test assessing a trend in the warm semester precipitation.

Mann-Kendall test for the trend					
Station	**N cases**	**Confidence Levels p = 95%**		**τ**	**Significance**
Bariloche	49	+0.193	−0.193	+0.002	no
El Bolsón	49	+0.248	−0.248	+0.140	no
Maquinchao	49	+0.193	−0.193	+0.071	no
Esquel	49	+0.193	−0.193	+0.003	no
Chapelco	19	+0.328	−0.328	−0.076	no
Neuquén	49	+0.193	−0.193	−0.024	no
Paso de los Indios	41	+0.213	−0.213	+0.122	no
Río Colorado	49	+0.193	−0.193	+0.129	no

The negative trends of precipitation during the warm months will surely influence the soil water budget, increasing the soil water deficit. Thereby it will also influence the possibility of fires in forest ecosystems. Fire generally of human origin, under warmer and drier conditions would have greater chances to start and to spread [2,17-19]. The persistence of the precipitation negative trends would also favor the growth of the Patagonian bushes over the forest [20].

3.3. Vegetation Data Analysis

The composition of the Andean–Patagonic forests do not show a predominant specie (with few exceptions), and almost 50% of them are native forests. The total of public lands and protected areas in all of Patagonia is 4,119,145 ha [1,9].

Twenty-seven percent of the whole Andean—Patagonic forest is strictly protected at National Parks, and another 1,903,300 ha are protected as provincial reserves, forest reserves or touristic places, natural monuments and private lands. The native forests are located mainly in protected areas like National or Provincial Parks, this represents 26% or 1,098,860 ha [9]. The study area has almost a million ha (998,400 ha) located in National Parks and Neuquén province is the most active in this context [9].

The main forests of the native species are listed in Table 5 and Figure 7. The *Nothofagus sp* are located at different altitudes of the landscape [17,18] and are characterized by slow growth, so they suffer the competition of exotic species (*Pinus* sp.) with high yield in wood production. In the zones covered by a mixed forest, the typical and prevailing species are *Nothofagus* sp. and *Austrocedus* sp.

Table 5. List of the prevailing native species in Patagonian region.

Scientific name	**Common name**
Nothofagus nervosa	Raulí
Nothofagus antarctica	Ñire
Nothofagus dombeyi	Coihue
Nothofagus pumilio	Lenga
Nothofagus oblicua	Roble pellín
Nothofagus betuloides	Guindo
Maytenus boaria	Maitén
Guevina avellana	Avellano
Embothrium coccineum	Notro
Discaria serratifolia and *Chacaya trinervis*	Chacay

Figure 7. Distribution of native forests [Realized by the authors].

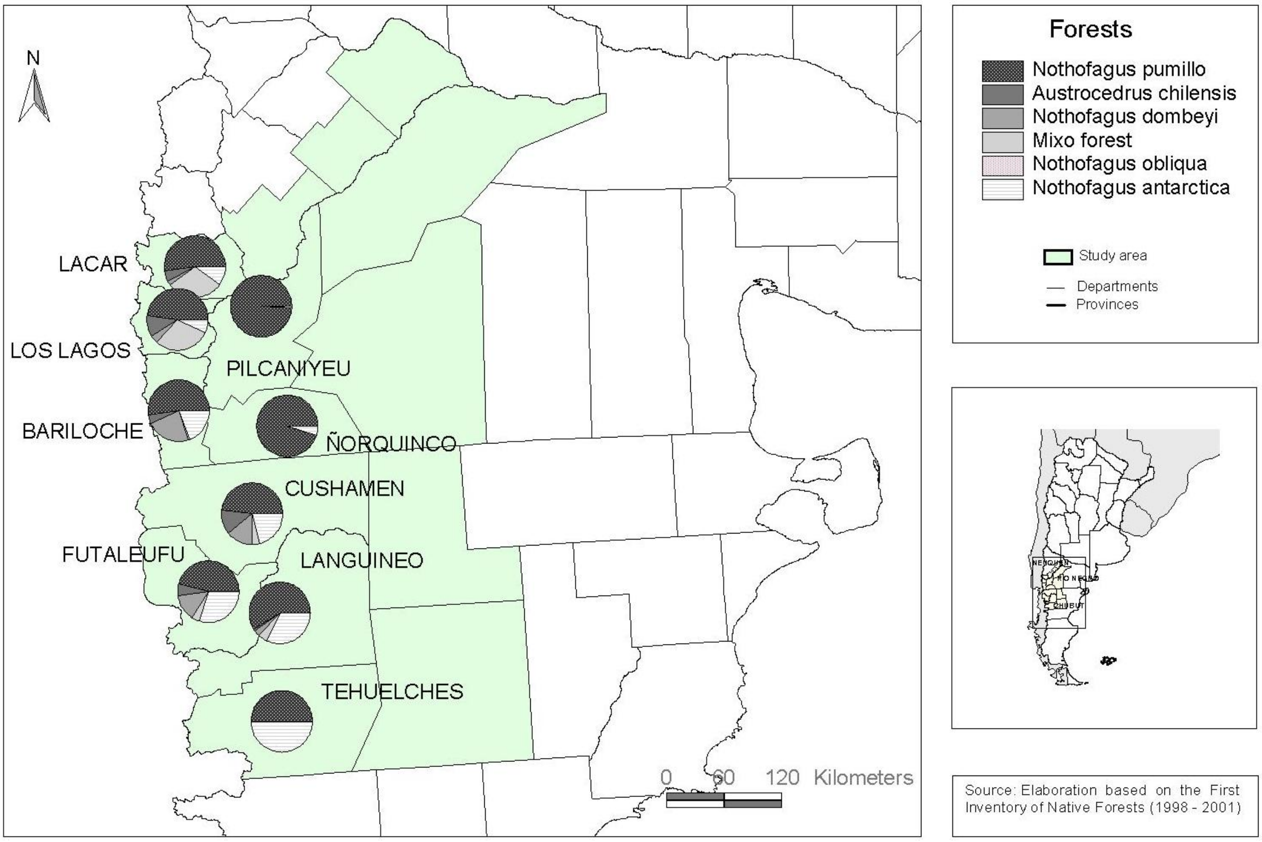


Table 6 shows that Río Negro province possesses 28% of the Andean–Patagonic forests, while Neuquén province has 9% and Chubut province has 26%. In this table the distribution of the different type of forests by counties is considered. For example, Bariloche County possesses 93.12% of the forest and 84.22% of other forestlands of Río Negro province. This is the result of microclimates created by the presence of rivers, lakes and topography [21].

Table 6. Surface (%) of native forests and other forestlands with respect to the total area of the province.

Province	Percentage of forest cover	County	Forest (%)	Other Forestlands (%)
Río Negro	28	Bariloche	93.12	84.22
Neuquén	9	Lacar	24.04	10.57
		Los Lagos	30.52	10.57
Chubut	26	Cushamen	18.85	28.60
		Futaleufú	43.81	39.93

Table 7 shows the surface of the main type of forests indicating the predominant specie. Table 8 presents the type and distribution of forests in Other Forestlands (OFL).

Table 7. Surface of main forests (ha).

	Total	Lenga	Ciprés	Coihue
Río Negro	254,320.6	162,494.5	14,158.9	75,817.7
Bariloche	236,819.8	144,993.7	14,158.9	75,817.7
Ñorquinco	9,337.0	9,337.0	no	no
Pilcaniyeu	8,163.8	8,163.8	no	no
Neuquén	579,267.4	181,297.9	42,835.8	32,084.1
Lacar	139,241.2	63,789.3	12,701.3	2,979.7
Los Lagos	176,769.9	79,166.6	24,036.1	8,632.9
Chubut	339,030.2	192,316.7	37,539.0	82,826.2
Cushamen	63,921.8	11,456.1	15,616.3	29,452.5
Futaleufú	148,542.6	60,823.3	21,265.5	51,190.1
Tehuelches	43,143.6	43,143.6		
Languineo	31,007.6	24,477.7	657.2	2,183.6

Table 8. Distribution and type of forests in Other Forestlands (ha).

	Total OFL	Lenga	Ñire	Ciprés	Degraded forests	Shrubland
Río Negro	120,505.6	44,735.2	63,176.7	2,969.1	4,549.4	5,075.2
Bariloche	101,487.6	27,091.8	61,802.1	2,969.1	4,549.4	5,075.2
Ñorquinco	17,326.1	16,001.3	1,324.8			
Pilcaniyeu	1,692.1	1,642.2	49.9			
Neuquén	539,901.4	157,251.7	124,987.0	233,881.7	1,327.0	
Lacar	72,265.8	38,426.0	18,942.0			14,897.8
Los Lagos	57,056.2	25,625.0	15,226.8		1,305.2	14,899.2
Chubut	741,971.3	270,511.6	260,762.0	12,025.9	15,397.4	183,277.5
Cushamen	212,185.8	89,239.1	45,875.0	11,701.0	5,583.7	59,787.0
Futaleufú	296,272.1	110,548.5	114,031.0	324.9	3,623.4	67,744.3
Tehuelches	106,085.3	14,752.0	58,684.2			32,649.1
Languineo	53,319.2	22,830.6	25,962.8		468.2	4,057.6

It can be seen than *Nothofagus* sp. is prevalent in the forest lands of the study area, mainly forests of lenga and ñire (Tables 7 and 8) and this corroborates that the local climate had different influences on treeline elevations east of the Andes [9,15,17].

4. Conclusions

This paper aimed to present to the scientific community the results of a wide collection of several types of data in a specific region; the northwestern Patagonia in Argentina. The data collection has been difficult due to the lack of knowledge and basic information on many topics that is an obstacle for any analysis, in particular, scarce meteorological information and vegetation maps at different scales.

The study area had experienced changes in climate, demography and land uses.

The population in the studied area increased by 18.3% in the period 1991–2001 and the population density, according to Census 2001, was 2.9 inhabitants per km^2, clearly lower than the national population (13 inhabitants/km^2).

The growth of urban areas does not consider an urbanization plan, leading to danger for the stability of the ecosystems and the natural resources of the analyzed region, promoting environmental problems.

The development of human activities like agriculture, the construction of wooden houses and afforestation, removed the soil and caused serious disturbances to the ecosystems. The humid Andean stripe has important natural forests that are suffering diverse human pressures like deforestation and fire. Its reduction may also modify the boundaries between forest and bushes.

The climate showed interdecadal and interannual variations, so climate variability should be taken into account in future human activities, mainly when natural resources are involved. The precipitation study of the area is complicated by the high spatial and altitudinal variability. Nevertheless, a continuous decrease in rainfall is expected in future years, caused by the displacement of the Pacific anticyclone towards the south. A decline in precipitation would also lead to an increasing risk of forest fires across the area. The persistence of the precipitation negative trends would favor the advance of the Patagonian bushes over the forest.

As the impacts of climate change in this part of Argentina are not yet as severe as in other areas of the world, there is time to prepare, such as building institutional capacity to adapt to the main threats.

For example: increasing the number of afforestation projects could have consequences for water availability in the future and have other goals:

- To decrease desertification in the area;
- To decrease pressure on native forests;
- To diversify local livelihoods; and
- To contribute to global carbon dioxide (CO_2) fixation.

Several investments have also been made in order to improve the forest fire management and some changes were introduced in the regeneration and the management of native forests; these are not based on climate change perceptions but would be useful adaptations to those changes.

A more coordinated approach may be necessary to specifically address the climatic risk of different forms of agriculture and forestry. Land use planning needs to take better account of the environmental thresholds of different types of agriculture or forest land use—with incentives to induce greater diversity and consequent resilience.

Acknowledgment

This paper belong to the project "Updating the geographic knowledge for the social economic development of Northwestern Patagonia, Argentina" (H514) supported by La Plata National University, Argentina.

References

1. Venere O.; Juan, A. Fundación e Instituto Torcuato Di Tella. Vegetación. In *Final Report*. *Vulnerabilidad de La Patagonia y sur de las provincias de Buenos Aires y La Pampa*; Fundación e Instituto Torcuato Di Tella: Buenos Aires, Argentina, 7 November 2006; Chapter 10.
2. Barros, V.; Vera, C.; Camilloni, I.; Fernandez, A. Comunicación Nacional de Cambio Climático. In *Informe Final*. *Vulnerabilidad de La Patagonia y sur de las provincias de Buenos Aires y La Pampa*; Fundación e Instituto Torcuato Di Tella: Buenos Aires, Argentina, 7 November 2006; Chapters 2 and 3.
3. New, M.; Todd, M.; Hulme, M.; Jones, P. Precipitation measurements and trends in the twentieth century. *Int*. *J*. *Climatol*. **2001**, *21*, 1899–1922.
4. Kayano, M.; Andreoli, R. Relations of South American summer rainfall interannual variations with the Pacific Decadal Oscillation. *Int. J. Climatol.* **2007**, *27*, 531–540.
5. Daniels, L.D.; Veblen, T. Spatiotemporal influences of climate on altitudinal treeline in northern Patagonia. *Ecology* **2004**, *85*, 1284–1296.
6. INDEC. Argentina. National Institute of Statistic and Census: Buenos Aires, Argentina. 1991.
7. INDEC. Argentina. National Institute of Statistic and Census: Buenos Aires, Argentina. 2001.
8. Yue, S.; Pilon, P.; Cavadias, G. Power of the Mann–Kendall and Spearman's rho tests for detecting monotonic trends in hydrological series. *J. Hydr.* **2002**, *259*, 254–271.
9. National Environment. Secretaria de Ambiente y Desarrollo Sustentable. *Primer inventario nacional de bosques nativos*; Proyecto Bosques Nativos y Áreas Protegidas: Buenos Aires, Argentina, 2002.
10. Botana M.I.; Pohl Schnake, V. Caracterización socioeconómica del noroeste patagónico con vistas a potenciar los recursos naturales de la zona y preservar el medio ambiente en un contexto de variabilidad climática. *GAEA. Contribuciones Científicas* **2008**, *20*, 69–82.
11. Landsberg, H.E. Climates of central and south America. In *World Survey in Climatology*; Flohn, H., Ed.; Elsevier Scientific Publishing Company: Amsterdam, The Netherlands, 1969; Volume II.
12. Atlas Físico de la República Argentina. In *Atlas Total de la República Argentina*; Centro Editor de América Latina: Buenos Aires, Argentina, 1982; Volume 2.
13. Barros, V.R.; Cordón, V.Q.; Moyano, C.L.; Méndez, R.J.; Forquera, J.C.; Pizzio, O. *Cartas de precipitación de la zona oeste de las provincias de Río Negro y Neuquén*. Facultad de Ciencias Agrarias, Universidad Nacional del Comahue: Río Negro, Argentina, 1983.

14. Walter, H.; Box, E. Climate of Patagonia. In *Ecosystems of the World. Deserts and Semideserts of Patagonia*; West, N. Ed.; Elsevier: Amsterdam, The Netherlands, 1983; Volume 5, pp. 440–454.
15. Lori, D.; Veblen, T. Spatiotemporal influences of climate on altitudinal treeline in Northern Patagonia. *Ecology* **2004**, *85*, 1284–1296.
16. Prohaska, F. The climate of Argentina, Paraguay and Uruguay. *Climates of Central and South Americ*. In *World Survey of Climatology*; Schwerdtfeger, W., Ed.; Elsevier: Amsterdam, The Netherlands, 1976; Volume 12, pp. 13–122.
17. Scarpati, O.; Faggi, A. Posibles consecuencias del Cambio Climático Global en bosques del Lago Puelo. *Revista de la Facultad de Agronomía (UBA).* **1996**, *16*, 79–87.
18. Scarpati, O.; Faggi, A.M. Probable incidence of the Climate Global change in the vegetation of Puelo Lake National Park (Argentina). *In Proceedings of International Conference on Global Change and Geography of the International Geographical Union,* Moscow, Russia, 14–18 August 1995.
19. Torres Curth, M.; Ghermandi, L.; Pfister, G. Los incendios en el noroeste de la Patagonia: Su relación con las condiciones meteorológicas y la presión antrópica a lo largo de 20 años. *Ecología Austral*. **2008**, *18*, 153–167.
20. Kitzberger, T., Raffaele, E.; Heinemann, K.; Mazzarino, M. Effects of fire severity in a north Patagonian subalpine forest. *Int. J. Veg. Sci*. **2009**, *16*, 5–12.
21. Scarpati, O. Analyzing different patagonian ecosystems using Topoclimatology. In *Proceedings of 15th International Congress of Biometeorology & International Conference on Urban Climatology,* Sydney, Australia, 8–12 November 1999.