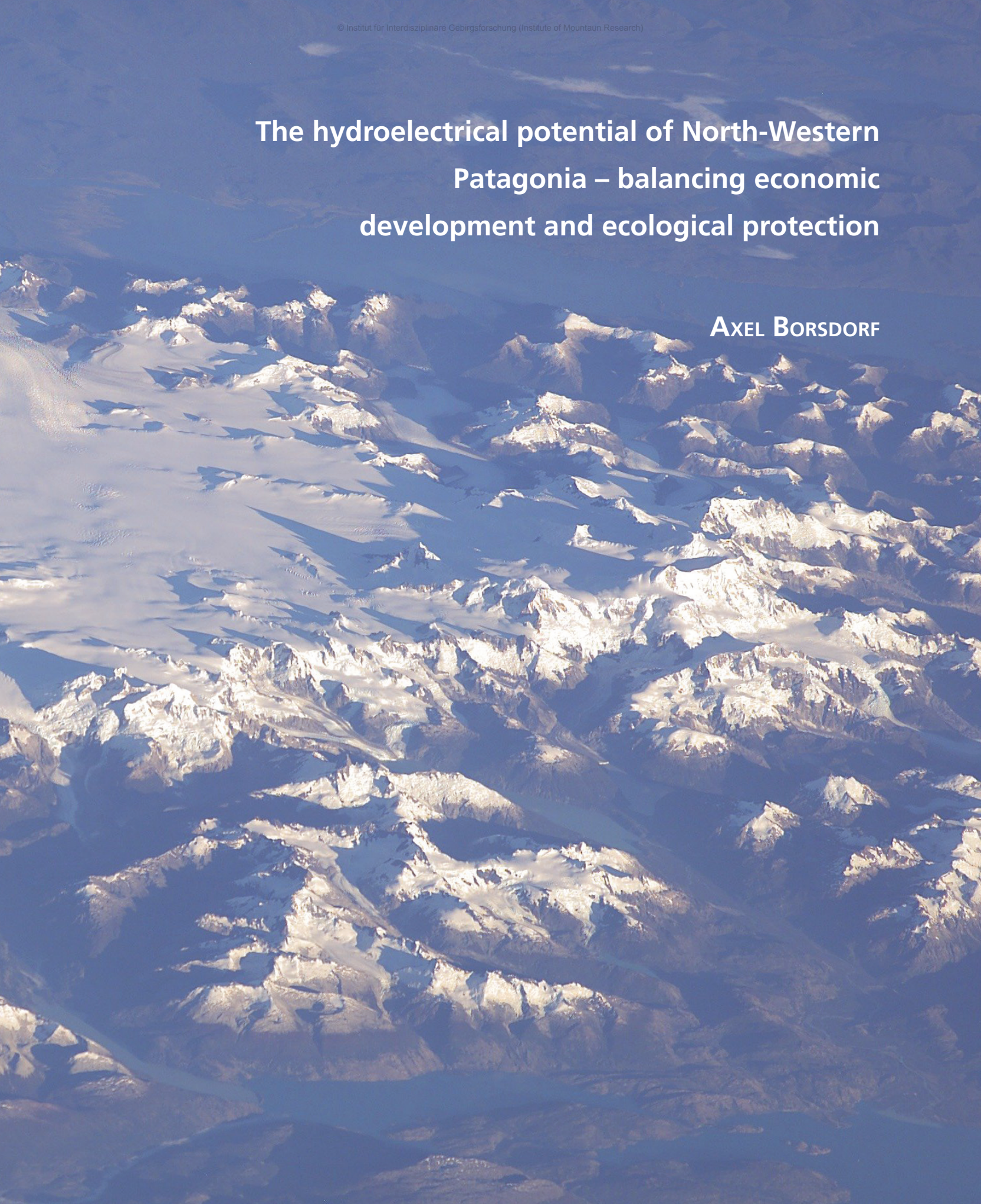
The hydroelectrical potential of North-Western Patagonia – balancing economic development and ecological protection

Axel Borsdorf



Introduction

"The portal into the future of Chile stands in Aisén[1]. But nobody knows where to look for the key." This is how Aisen senator Antonio Horvath summarized the situation 30 years ago in a conversation with the author about the constraints and opportunities for development in Western Patagonia (published in Borsdorf 1987). Since then a lot of water has passed down the Río Baker. Chile has pursued a consistently neoliberal economic policy and opened itself up to the world market, in the process changing from a developing country (Lauer 1962) into a newly industrializing one. With a population growth rate of only 0.8% / a, an unemployment rate of 6.9%, an average life expectancy of 78 years, GDP growing by up to 10% per year in the 1990s, a national income per head of USD 6 810 (2006) and a trade surplus of USD 9 billion (2004), Chile is not only the most developed society in South America but also the most prosperous country (Fischer Weltalmanach 2009). Despite great differences in earnings, poverty in the country is now the lowest in Latin America (4.2% poor with an income of <1 USD/day, compared with Ecuador: 20.2%; Guatemala: 39.8%; Honduras 40.5%, figures taken from Sangmeister 2001).

The country has reduced its debt from over 100% of GDP in den mid-1980s to just 4.4%. The state pension pay-as-you-go system has been replaced by pension funds in the capital cover system. Education has been improved and partly privatized. The central bank enjoys autonomy and since 2002, Chile, as the only country worldwide, has a private unemployment insurance. Such deregulation steps were inconceivable even in Europe. In recent years, the Andean country enjoyed strong economic growth and, unlike its neighbours, survived the global economic and banking crisis remarkably well despite great foreign investment in Chile.

The peripheral Undécima Región Aisén del General Carlos Ibañez del Campo has no part in this development, despite the road now finished that links it with the rest of the country. The new Carretera Austral now connects even the village of Villa O'Higgins (pop. 463) in the deepest south with the capital Coihaique (pop. 43 000). Previously, this was the most isolated settlement in the whole of mainland Chile (Borsdorf 1985). In the last 30 years, the population of the region has grown by a third to 91 492 inhabitants (2002).

Road construction is behind the above-average population growth in this Chilean region, the third-largest in surface area (108 494 km²). It enabled an ecologically questionable agrarian colonization and the intensification of existing agriculture (beef production and sheep farming) and brought a certain amount of tourism and impulses for forestry. Aqua culture (salmon farming) is another important sector.

The region is exposed to numerous natural risks. In 1991, the volcano Cerro Hudson erupted, covering large parts of Aisén with its ashes. On the 2nd of May, 2008, a catastrophic eruption of the volcano Chaitén completely destroyed the city of Chaitén, capital of Chiloe Continental. Climate change not only affects the icefields of the region (Campo de Hielo Norte, 100 km long, 80 km wide) and the Patagonian cordillera with its massive glaciers, it also offers opportunities for the extensively managed farms at the southern limit of wheat cultivation.

30 years on from the initial survey, the time has come for a new analysis of developments in Aisén. Surprisingly, in these three decades only a few titles on regional development have been published (Borsdorf 1995; Baeriswil 1992; Herrmann 2000). The results of this survey thus have to rely essentially on my own fieldwork. It centres on the issue in how far an expansion of the hydroelectric potential, first proposed 30 years ago (Borsdorf 1987: 156ff), can be ecologically sound and can enhance sustainable regional development.

Other questions which arise with respect to the Aisénian development are: how can the potential of Aisén support Chile in becoming an even more prominent player in the global stage? How can this most beautiful region harness tourism to its fullest potential? And can Chilean companies strike a positive balance between growth and environmental protection?

[1] There are various spellings of the name. Here we use the official spelling "Aisén", not "Aysén", also for the capital "Coihaique", not "Coyhaique" or "Coyhayque".

Increasing clean electricity production – a major challenge for South America and Chile

In South America, more than 50% of electricity generated comes from hydropower, compared with 17% of the global electricity production. In Chile, which lacks nuclear plants, the proportion of hydroelectric energy was 78% in 1995, falling to 38% today, because Chile has been importing natural gas from Argentina since 1997. Worldwide, and particularly in South America, hydropower is by far the largest renewable source of electricity. Nevertheless, Chile uses only approximately 18% of the exploitable hydro-resources, making it one of the regions with the largest potential for expanding hydropower (cf. Nauditt et al. 2002, Rudnick et al. 2008).

In comparison with other Andean countries, Chile's efforts to increase its hydroelectric power generation were limited. While Venezuela increased its production 55-fold within the last 40 years and Argentina 34-fold, Chile only doubled its installed capacity over the same period (Molina et al. 2008: 26). The total capacity installed by 2008 was 4767 MW (2002), which corresponds to an exploitation rate of 18.3% of the existing potential (Table 1), but there are projects to increase hydroelectric power generation to 8420 MW or 39.6% of the potential by 2018 (Table 2).

In 1957, only 2.0% of the hydroelectric potential of Chile was exploited (Table 1). Whereas in the northern regions (Norte Grande) with their hyper-arid climate only very few new dams have been constructed since then, the capacity was multiplied in the central (Zona Central) and southern central (Sur Chico) parts of the country. Given the transmission technology of the time, exploitation of the capacities in the most southern regions of Chile (Sur Grande) was only designed to fulfil the needs of the local and regional population.

It is interesting to compare the estimate of 21279 MW in Table 1 with a calculation made by the UN in 1960 (Naciones Unidas 1960: 77), when it estimated the total capacity of Chile as 20294.4 MW and the potential of the southern provinces (Aisén and Magallanes) as 9956 MW. Based on the technology available in 1960, the UN estimated that 4900 MW would be exploitable at that time. With the current plans (Table 2), Aisén alone could provide 74.6% of the hydroelectric potential of the southern regions.

Table 1: Hydropower in Chile: installed capacity 1957 and 2007 (data source: Rudnick & Mocarquer 2008, and Naciones Unidas 1960, recalculation and compilation by the author).

Zone	Installed capacity (MW)		Total capacity (MW)	Exploited (%)	
	2007	1957		2007	1957
North	27	23.2	259	10.4	9.0
Central	2193	464.9	5806	37.8	8.0
Central South	2500	25.5	10325	24.4	0.2
Austral	18	0.2	9624	0.2	0.0
Total	4738	513.8	26014	18.3	2.0

Table 2: Proposed dam projects in the extreme south of Chile until 2016 (data source: Rudnick & Mocarquer 2008).

Project	MW	Start date
Baker 1	660	2015
Baker 2	360	2018
Pascua 1	460	2018
Pascua 2.1	770	2014
Pascua 2.2.	500	2016
Total	2750	

Chilean power companies have been forced to find new energy sources since Argentina began cutting natural gas exports to Chile in 2004. HidroAysén, a joint venture between the Chilean companies Endesa and Colbun SA, is proposing a solution of vital importance for the country's future energy supply. The project moves forward at a time when Chile faces an energy crisis and the need to increase its power generation to meet the growing demand, expected to increase 5% annually until 2030. Debates are raging about how it will affect energy supply, the power capacity required, the impact on the environment and finally, how to evolve to a cleaner energy matrix, eventually becoming 100% renewable of solar, geothermal, biomass, wind and hydropower origin.

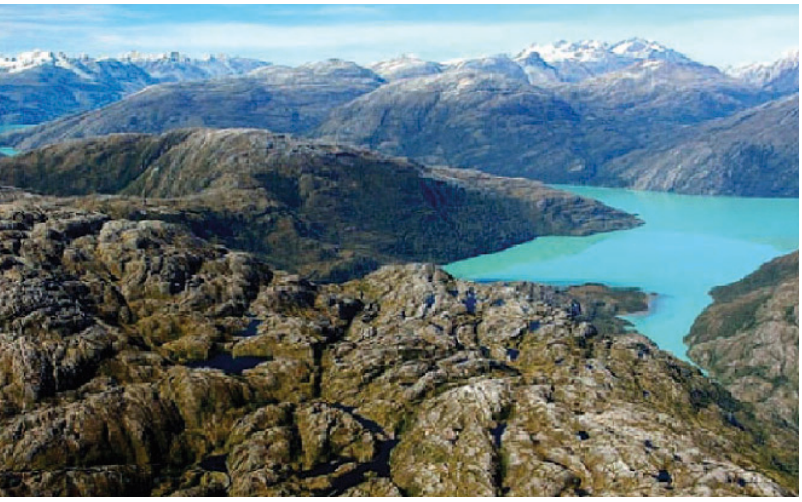


Fig. 1: Reservoir of Río Baker, photo montage by HydroAysén.

Fig. 2: The Baker valley near Cochrane; site of one proposed reservoir. Photograph by A. Borsdorf 2009.

However, the Aisén project is not without its share of controversy, with detractors claiming this is a business that will bury large wooded areas, will appropriate a natural resource, will interfere in tourism, and cause environmental damage (Fig. 1 and 2). The area's valuable environmental heritage is made up of a wide variety of ecosystems and rich aquatic and terrestrial biodiversity. The region is believed to contain some of the few places on earth where anthropogenic activities have not left a significant mark on primary natural cycles. At the same time, this environmental heritage is associated with a certain potential for industrial development.

The study area consists of the Aisén ecosystems from their fluvial or lacustrine origins to the adjacent ocean. This area includes the water system of glacially formed islands and channels that constitutes 95% of the Chilean shoreline. Moreover, it is one of the most complex and pristine hydrological systems on the planet. This vast zone also contains valuable freshwater reserves of global importance. We can distinguish three relevant hydrographic basins in the region. These have large, trans-Andean, mixed regime rivers (Baker, Pascua, Vagabundo) and an extensive icefield, the Campo de Hielo Norte.

The existence of the extensive Northern and Southern Icefields, even today and considering the atmospheric and oceanic circulations patterns of the Southern Pacific, is unique in the world at this latitude. Important records of climatic changes in the Holocene associated with the displacement of the Westerlies drift and the circumpolar Antarctic current make this zone highly vulnerable to global climate change scenarios coinciding with the local intensification of human activities.

The new hydropower plants in Aisén will be located in the Baker and Pascua rivers. A total of five hydroelectric power plants with a joint installed capacity of 2750 MW are to be installed by 2022. In addition, the projects involve the construction of a 2000 km transmission line to link the power plants directly with the centre of the largest demand, the capital Santiago. 4000 million US$ will be invested. The main objective is to increase Chile's production of clean energy, to decrease CO_2 emission and to reduce foreign fuel dependency.

The hydropower produced in Aisén would complement that from rivers that currently feed the main Chilean interconnected electricity system. Another advantage is the abundant availability of water in the Baker and Pascua, located as they are in the Westerlies drift and fed by the Northern Icefield, so that even during periods of extreme drought in the central zone, electricity production in Aisén would not suffer. In the national system the interannual variation would be reduced from 21% to 12% if the Baker and Pascua rivers are added.

Effects on the regional economy of Aisén

During their construction period, these projects would give an important economic boost to the respective areas. In a study developed for TIWAG, the Tyrolean hydropower corporation, on an alpine power plant project at Kühtai (Tyrol), Borsdorf & Pfurtscheller (2009) showed that the benefits of large hydropower plants for the regional and national economy are considerable.

As advantages for the national economy they mentioned an increase in the gross domestic product and a more favourable trade balance through reduced energy dependency on neighbouring countries. Currently, Chile depends on Argentina for natural gas. However, since Argentina cannot guarantee that the exported gas stems completely from Argentinian gas fields without any portion of Bolivian origin, Bolivia is fighting its gas war not only with Chile but also with Argentina (Linkohr 2006: 112). This is why Chile has to import expensive liquid gas from Asia and already suffered a severe energy shortage in 2008. The country is thus forced to look for and exploit its own energy resources to become more independent.

In terms of the regional economy, Borsdorf and Pfurtscheller argued that new hydropower plants contribute to reducing the costs for flood protection, improve the road infrastructure and accessibility, have considerable employment effects, enhance municipal incomes and give impulses to the regional economy through cheaper energy supply. There is also a remarkable rise in the regional economic value added (EVA). Based on an input-output analysis, they proved that the EVA amounted to the equivalent of 4000 new jobs. The multiplier effect of each euro invested is 1.59 in production; 1.61 in income and 1.63 in employment.

Furthermore, the Austrian examples – not only in the cited study – imply a positive effect of the hydropower plants on tourism. The artificial lakes with their light blue water are perceived as positive elements in the aesthetics of the landscape. The technical installations, presented in visitor centres and educational trails, are regarded as tourist attractions in their own right.

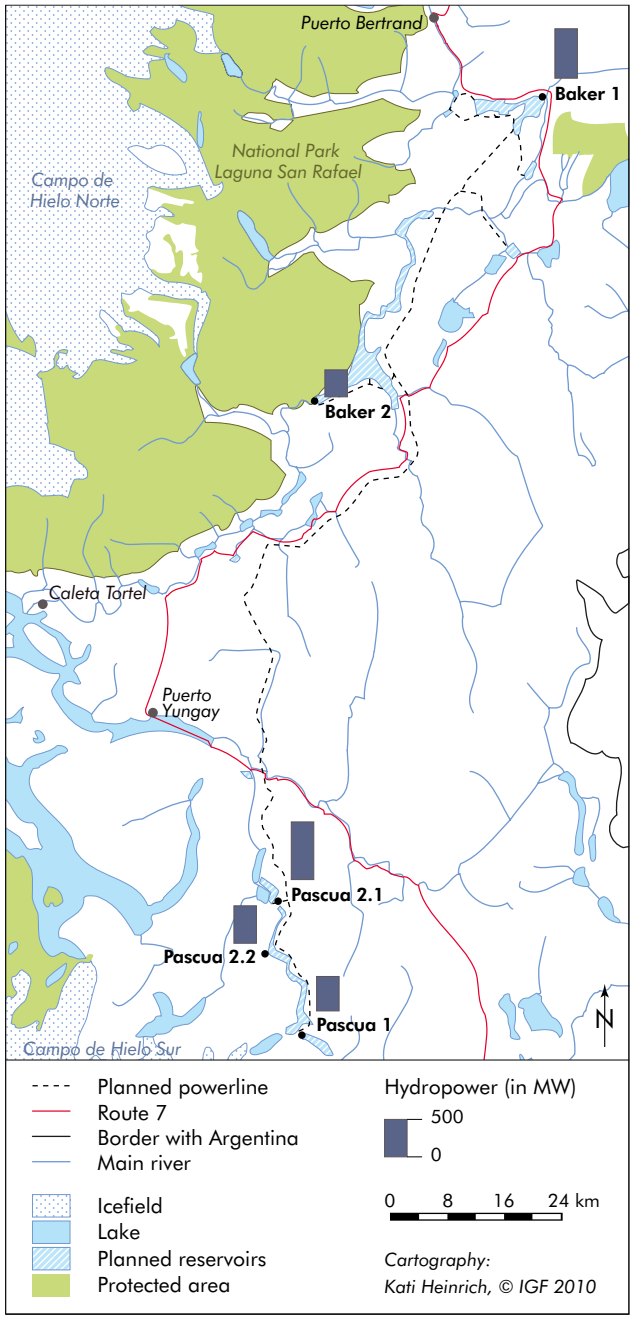


Fig. 3: Dam projects and road infrastructure in Aisén.

In terms of technology, the high efficiency and the long operating life of the installations are major benefits. In addition, such a power plant is able to provide flexibly for daytime and seasonal changes in demand. In environmental terms, Borsdorf & Pfurtscheller (2009)

Fig. 4: Poster of the anti-hydropower campaign. Photograph by A. Borsdorf 2009).

mentioned the reduced dependency on fossil energy sources and the CO_2 emission-free energy production.

Effects on the ecology of Aisén

It is important to recognize that these power stations would be inserted into areas of great natural beauty as yet untouched by man. Without a doubt, the construction would change the ecosystems of the area and possibly also traditional local civilizations. It is still the retreat of autochthonous Indians. While the 18 remaining Alacalufes and the six Yamanas living in the coastal area (Puerto Eden) will not be touched by the projects, the 245 Mapuche living in the region might be affected. The surface to be flooded is located in the valleys which are partly used for agriculture (mainly grazing). However, it must be pointed out that the total flooded surface would only be 5 910 ha or to 2 ha per megawatt. This is much lower than for example the flooded areas of Brazil. Today, only six farming families live in the space which is to be flooded. The companies offer compensations but so far these have not been accepted.

It is clear from the important resources that are being mobilized to fight the construction of the Aisén project that it has provoked heavy protests by Chilean environmentalists. One initiative is the network "Patagonia sin represas" (www.patagoniasinrepresas.cl)., which not only published an impressive book and many posters demonstrating in photomontages the loss of landscape aesthetics in Chile (Fig. 4) but also organizes conferences and protest actions. One main criticism is the loss of beautiful scenery as a consequence of dams, lakes, high-tension power lines and electricity pylons.

The construction of a 2 200 km transmission line to transport the electricity from Region IX to the main consumption area, the Metropolitan Region of Santiago de Chile, is sure to have an impact on unspoilt landscapes. However, a power line of this dimension would also facilitate the exploitation and transport of more hydroelectric power in the regions north of Aisén and could help improve the production of clean energy in Chile as well as alleviating Chile's vulnerability to ongoing shortages of Argentine natural gas (Hall et al. 2009). Opponents argue that renewable energy could also be produced by solar and geothermic plants or windmills (Consejo de Defensa de la Patagonia 2007).

The discussion is already heating up before the required environmental impact assessments are finished. It has also become a source of political fighting with government ministers being questioned for taking one position or the other. However, the alternatives do not offer a sustainable future for Chile. Coal turns out to be the only economic alternative in the medium, and nuclear energy in the longer term. Neither are acceptable for environmentalists, they offer renewable energies like wind or solar as the way forward. It is true that especially the south of the country is windy enough for wind energy, but the huge propellers would also impact on the scenic beauty of the area and the transmission line would still have to be built. Solar energy would be much better for power supply and the roofs of Santiago de Chile might produce enough energy to substitute the demand of the city's population, but still the investment costs are too high. Heat pumps could improve the efficiency of the power supply, but these systems need electricity as well. This is also true for geothermal energy, although the potential of earth-source and geothermal energy is not regarded as a potential for Chile.

Conclusion

Doubtless the hydropower projects in Aisén will have important effects on environment, economy and the social development of this mountain region in the periphery of Chile. However, it can be argued that in terms of sustainability these effects are mainly positive. Only a small percentage of land is to be flooded by the reservoirs, only few farmers to be evacuated, the impact on biodiversity and habitats is likely to be small and the ecological effects relatively insignificant. On the other hand, the effects on the national and regional economy are considerable. Employment and complementary effects on the energy sector, tourism and on regional demand will be lasting. This may even influence the social cohesion and life chances in the region in a positive way.

The development that finally achieves the Aisén project will be a test of maturity for Chilean society and its economic model. Chile needs a long-term vision that goes far beyond any short-term particular interests or necessities. The benefits or costs that come with the construction of these hydropower plants will go on for several generations of Chileans to come.

In a more detailed study, the analysis of the potential for regional development in Aisén, started by the author in 1979, will be continued under added-value aspects of its hydroelectric potential and the effects on the regional ecology, economy and society.

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