

Arauco's Valdivia biomass power station: carbon emissions and conflicts with Indigenous communities in Chile

Increasingly around the world pulp and paper mills are installing over-sized, dedicated biomass boilers alongside more traditional cogeneration units to take advantage of strong support and incentives for producing electricity from burning wood.

These are essentially stand-alone biomass power stations that require more feedstock than the waste produced by the adjacent pulp mills, meaning that additional wood is brought into the mill and burned in order to sell electricity to the public grid. Operators claim that the “renewable” electricity they produce replaces electricity produced with fossil fuels, which helps to reduce emissions—and diversify their income sources and boost profits.

Arauco's Valdivia mill built in the early 2000s in southern Chile is a good example of this. However, in order for these developments to be effective climate mitigation projects and truly “clean”, they must genuinely reduce emissions, and must not depend on destructive processes that undermine the resilience of communities. As this case study describes, the Valdivia mill meets neither of these requirements.

The false assumption that burning wood from “sustainably managed” forests or plantations is carbon neutral means that carbon dioxide emissions from combustion aren't accounted for in Valdivia and

elsewhere, despite the large body of evidence clearly showing that electricity generation from forest biomass is highly emissive except for in a small fraction of cases. On top of this, wood burned in

Valdivia is ultimately sourced from vast areas of industrial eucalyptus and pine plantations that have had profoundly negative impacts on Chile's Mapuche Indigenous Peoples.



Orin Langelle

Carbon offsets for aviation: A false climate solution

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) aims to offset greenhouse emissions from aviation. Rather than reducing emissions by reducing flying, the sector with the fastest growing pre-pandemic emissions plans to compensate for the carbon it releases through offsetting. The Clean Development Mechanism (CDM) is one of the programs approved under CORSIA, whereby airlines will be able to purchase carbon credits sold by certain CDM projects. The Valdivia biomass plant generates carbon credits by burning wood and pulp mill residues, and is indicative of the types of projects CORSIA could use. This case study highlights why offsetting emissions from aviation is such a bad climate solution, and why rolling-out CORSIA at scale would be a disaster for communities and the climate.

1. Introduction: The Valdivia biomass power station and the CDM

This case study assesses the impacts of the Valdivia biomass power plant in the Los Rios region of southern Chile, which is part of the 550,000 ton per year Valdivia pulp mill complex, operated by Celulosa Arauco y Constitución S.A. (referred to throughout as Arauco).

It supplies biomass-powered electricity to the surrounding San José de la Mariquina district, and is next to the important Cruces river that runs through valuable areas of biodiversity-rich wetlands, including the protected Carlos Anwandter Nature Sanctuary, and converges with the Calle-calle (San Pedro) river in the city of Valdivia, the capital of the region.

The Valdivia mill was constructed with two boilers with a combined electricity generation capacity of

115MW. It was deliberately designed to produce energy for the pulp mill and a significant amount of surplus electricity, injecting a maximum of 61MW into the public grid. The recovery boiler burns black liquor¹ generated as a by-product of on-site pulping operations, and the power boiler burns solid biomass, which Arauco claims consists entirely of bark and sawdust residues from its own and third-party operations, but predominantly from off-site sources.

The Valdivia biomass plant is registered as project number 1787 under the Clean Development Mechanism (CDM)² and is selling carbon credits through the [United Nations Carbon offsets platform](#). It is currently in its second carbon credit certification period running April 1st 2016 - March 31st 2023, and claims emissions reductions of 77,973 metric tons of CO₂e per year. The company [justifies the additionality of the emissions reductions](#) it claims under the CDM through the displacement of fossil electricity in the public grid with “carbon neutral” electricity from its operations. It also states that this would not be possible with conventional plant design, which would only burn black liquor and where routine forestry residue management would involve natural decomposition or uncontrolled open-air burning.

The biomass plant has registered 2,146,695 tons of CO₂e in emissions reductions to date, which have been sold for a total of just over two million USD. The main buyers are European-based companies such as Telefonica, Banco Santander, Agile Spain and Choose.today, as well as UN mechanisms such as the Green Climate Fund. Between 2007-2019 [Arauco contributed 8% of all biomass energy-related CDM emissions reductions worldwide](#).



Orin Langelle

¹ Black liquor is a by-product of the kraft process where wood is turned into pulp for paper production.

² The CDM is a mechanism within the Kyoto Protocol that serves as a platform for projects to generate carbon credits from measured emissions reductions.

2. The climate impacts of burning wood at the Valdivia pulp mill

This section focuses on emissions from the wood being burned in Valdivia’s power boiler, and not black liquor. However, it should be noted that, although it is common practice for pulp mills to meet their own energy needs by burning black liquor and in some cases this may cause less environmental impact than if a mill were to use electricity and heat from other sources, converting land to plantations and using the wood to produce short-lived products and then burning the black liquor that is produced, is a highly impactful process.

Arauco claims that the electricity it produces is “carbon neutral” and therefore does not count CO₂ emissions produced from the combustion of wood. It sells carbon credits based on emissions reductions achieved by displacing high-carbon electricity in the public grid, for which CO₂ emissions are counted, and by avoiding methane emissions from waste wood being burned in the open air as an alternative fate to being burned in the power station. For these claims to be reasonable, the additional CO₂ emitted by burning biomass compared to what would otherwise happen to it, i.e. the **cumulative net emissions**, must be low or negligible in a timeframe meaningful for climate mitigation.

CDM monitoring and verification reports are the only publicly-available information on the wood being burned at Valdivia. In the last CDM reporting period for which there is information,³ 227,000 bone dry tonnes of wood were burned in the power boiler over a 15 month period, with more than 50% of this being brought in from outside, and not linked directly to the pulp mill’s operations. In the project’s CDM design document, Arauco states that “All the biomass consumed by

the project activity is generated from sustainable forest operations” (consisting exclusively of exotic pine and eucalyptus plantations) and that “The [biomass] project will not imply the cultivation of land to produce biomass”, indicating that only residues produced by the pulp mill and sawdust and bark from off-site industrial operations are being used. As a consequence, it also discounts any emissions associated with forestry and plantation activities. However, in the same document Arauco also refers to feedstock coming “from

forestry operations, consisting basically in operations of harvesting, pruning and thinning in managed forestlands”.

Verifying the type of feedstock used is therefore vital to accurately assessing the climate impacts of the electricity generated. However, there is no independent verification of the actual feedstock used in the power boiler. Verification reports are conducted by the CDM, but the type of wood entering the plant (or being sourced from within it) isn’t verified, only the



Orin Langelle

³ CDM monitoring and verification reports are only publicly-available for the first crediting period, which ended in 2016.



number of trucks, their weight and the distance they have traveled. Arauco monitoring reports also cast doubt on the claim that exclusively sawdust and bark are burned, which could be considered as genuine industrial residues (though still not carbon neutral).

Firstly, in the [most recent monitoring report available on the CDM website](#), the average truckload of biomass from third-party suppliers is stated to be around 25 tons/truckload. This would seem very heavy for loads consisting of bark or sawdust, given that sawdust for example usually has a density of around 0.2 tons/m³. Secondly, the average calorific values for the biomass residues used to generate electricity are quoted as 18.15 and

18.18 GJ/ton. [According to the FAO](#), expected values for coniferous (pine) residues are in the range of 19.5-20 GJ/ton, whereas coniferous wood (roundwood or trunk wood) is closer to the average value quoted by Arauco.

It is plausible therefore that Arauco could be burning whole trees alongside pulp mill residues, given the large volumes of roundwood that already enter the pulp mill and the fact that it would be economically viable to do this given that electricity is being sold to the grid and the process is being subsidised with carbon credits. Depending on the feedstock being used—sawdust, bark, thinnings, whole trees or a combination of them all—the climate impacts of burning the

wood will be different, [with the larger the diameter of the wood, the greater the impact](#).

However, even burning genuine residues results in significant climate impacts, and cannot be considered carbon neutral. [A recent study](#) looking at biomass power stations that burn forestry residues in the US under comparable circumstances to Chile concluded that, after 10 years, the net emissions impact (NEI) for plants burning forest residues ranges from 41%–95%. This means that if the wood had been allowed to decompose naturally rather than burned, after 10 years there would be 41%–95% less carbon in the atmosphere, due to the fact that decomposition releases carbon much more slowly than



combustion and leaves some carbon behind in the soil. Further still, net emissions may be far higher if whole trees are harvested for feedstock. [Another recent study](#) in the US showed that burning wood pellets made primarily from pine plantation thinnings—which Arauco would class as residues—results in a negative impact on the climate for more than 40 years.

As well as the flawed approach of excluding carbon dioxide emissions from the combustion of wood from accounting inventories, Arauco also makes misleading claims about the methane emissions they are avoiding, which account for almost a third of their claimed

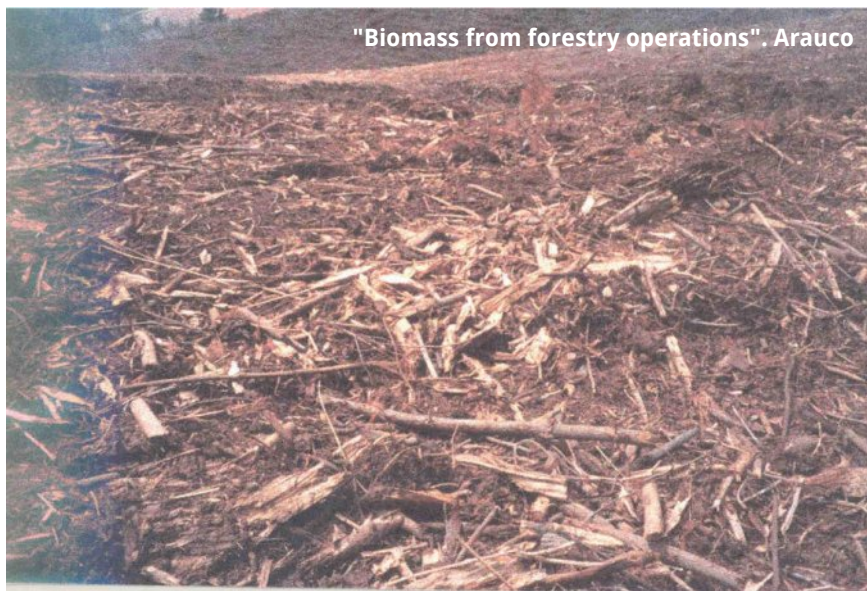
reductions. Unlike carbon dioxide, methane is accounted for in CDM methodologies, and in the project’s [last monitoring period for which there is publicly-available information](#) almost 50,000 tonnes of CO₂ equivalent are claimed in this way. This is due to the fact that the wood is being burned in a power station under high oxygen conditions, rather than burned in piles in the open air under lower oxygen conditions, as is assumed in the relevant accounting methodology.

However, Arauco [clearly states that](#) “...a significant portion of [biomass forest residues in Chile] currently is left in piles to natural decay.” and that “...the majority [of biomass from forestry operations

involving harvesting, pruning and thinning] is left on the ground to natural decay”. An image provided by Arauco titled “Biomass from forestry operations” also clearly shows forestry residues strewn on the ground and not in large piles, which would result in relatively small methane emissions.

On the other hand, [storage of woodchip and sawdust in large piles can result in significant methane emissions](#) that far outweigh other supply-chain sources, even when it is stored for as little as one month. Since it is only required that biomass is not stored at the facility for more than one year under CDM rules, storage could theoretically be a significant source of methane emissions that the project is not accounting for. It is entirely plausible therefore that the project results in significant methane emissions when compared to a realistic baseline scenario, but the lack of monitoring or independent verification of this makes it impossible to assess.

These questions surrounding sourcing and feedstock type have been posed to Arauco, but the company has not replied.



3. The ecological and social impacts of the Valdivia pulp mill

3.1. Carlos Anwandter Nature Sanctuary environmental disaster

The Valdivia plant started operating in January 2004 and from the start it faced opposition from rural and fishing communities.

The project planned to discharge its industrial liquid residues into the sea in the Mehuín area, via a pipeline, claiming that effluents would be treated using advanced technologies. Only a few months later, in May 2004, a massive environmental disaster occurred when effluents were dumped into the Cruces River, with serious impacts on the aquatic biodiversity of the area, including the Carlos Anwandter Nature Sanctuary.⁴

The water pollution caused a steep decline in black-necked swan populations, falling from 8000 individuals to 400 in May 2004 shortly after the dumping took place. The ecological impacts of the dumping affected other bird species too, such as the red-fronted coot, white-winged coot and red-gartered coot and the spot-flanked gallinule, which caused the total number of birds to drop by 74% between 2004 and 2012. Aquatic mammals such as the coypu, fish species such as carp and aquatic plant species such as the large-flowered waterweed were also impacted.⁵

In addition, the environmental disaster had immediate social impacts, including health impacts on communities living up to 60km away from Valdivia, and affected

the coastal community of Mehuín where effluents were discharged from the pipeline.⁶ For a community dependent on artisanal fishing, agriculture and tourism, these impacts were particularly severe.

It is worth noting that in Arauco's application to the CDM, the company stated that the biomass power station at Valdivia was originally scheduled to start operating on July 1 2008, and that this was delayed for eight months due to "technical problems". Contrary to this claim, the entire Valdivia operation had been forced to close by the authorities for over three years due to the environmental disaster that the plant was responsible for.

Following years of pressure from civil society, on July 26 2013 the Civil Court of Valdivia finally sanctioned Arauco due to the environmental damage caused by the discharge of effluents into the

wetland, the plant's negligence, institutional mismanagement and the company's delayed response to the disaster. Although an [independent expert hired by the court](#) stated that the company should be liable for around 100 million Euros in damages, the sentence imposed by the court was far more lenient.

In 2020 the citizen's movement Action for Swans again [requested the preventive closure of the Valdivia plant](#) due to concerns over pollution in the wildlife sanctuary. In early 2020 the Valdivia pulp mill was [upgraded to produce pulp for the textile industry](#), making it the first such producer in Chile. Following the upgrade, residents of the Mariquina Commune [observed changes in the sanctuary](#), such as waterweed detachment and sediment stains, which caused concern for local residents and the scientific community, and are currently being investigated.



⁴ Universidad Austral de Chile (2005). Estudio sobre origen de mortalidades y disminución poblacional de aves acuáticas en el Santuario de la Naturaleza Carlos Anwandter, en la Provincia de Valdivia, informe final. Valdivia, Chile.

⁵ CONAF (2006) Plan Integral de Gestión Ambiental del Humedal del Río Cruces. Valdivia, Chile.

⁶ Palma, K. (2013). Desarrollo Forestal en la Región de los Ríos. Análisis de la resistencia y el impacto en la comunidad Mapuche Lafkenche en la Bahía de Maiquillahue. 1996-2007. Tesis de Pregrado. Universidad Austral de Chile, Valdivia, Chile.

3.2. The social impacts of the Valdivia pulp mill

One of the main socio-economic impacts of the Valdivia plant has been the disappearance of tourism in the Carlos Anwandter Nature Sanctuary, which has affected numerous communities in the area.

Prior to the construction of the plant, tourism in the area generated around 250 permanent jobs. However, after the environmental disaster, many of the ecotourism and bird watching activities stopped altogether, affecting the income and livelihoods of rural families and local businesses.⁷

The waters of the Cruces River and the Sanctuary are also used for agriculture, and many communities draw drinking water

from wells which are connected to the wetland through groundwater. The contamination of the Sanctuary therefore also posed a risk to human health, and international studies have highlighted the potential presence of dioxins and furans in the Sanctuary due the manufacture of chlorine dioxide and other plant operations, without effective mitigation measures in place.⁸

Another impact has been the division and conflict caused within

fishing communities. Mehuín is a small town and harbour of 1000 inhabitants that is located on the Pacific Ocean coast West of the Valdivia plant. Arauco attempted to curb opposition to its discharge pipeline by fragmenting and dividing Mehuín’s fishermen’s organizations through paying some of them off. “Reciprocal Collaboration Agreements” exerted strong pressure on organizations that had historically opposed the pipeline, and allowed the company to extort and harass



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⁷ WWF (2005) Informe de Observaciones y Recomendaciones. Misión Internacional de Evaluación de WWF ante la controversia del Santuario de la Naturaleza y sitio Ramsar Carlos Anwandter y la planta de celulosa Valdivia de CELCO. Valdivia, Chile.
⁸ Instituto Nacional de Derechos Humanos (2019) Informe Misión de Observación Comuna de Mariquina, Valdivia, Chile.



Techo/Flickr

the remaining opposition. This caused conflicts and divisions within the local community that were often irreparable.⁹

There have been several violent incidents in the coastal community since 2007 as a result of the divisions caused by Arauco's payoffs, a few of which have ended in legal proceedings. The response of the authorities has been to militarize the area through permanent surveillance carried out by special police forces, which has benefited Arauco by repressing opposition to the pipeline further.

Health impacts have also been experienced by surrounding Mapuche communities. San José de la Mariquina is a town of about 20,000 inhabitants, of which 97% are Indigenous Mapuche. It is an area with high landscape value,

and is used mainly for peasant agriculture and traditional livestock rearing. A high percentage of Mariquina residents think that pollution from the pulp mill is harming their health, and that air pollution from the plant is related to an increase in the number of people seeking health care and experiencing gastrointestinal and respiratory problems, and complaining of headaches, nausea and eye irritation.¹⁰

Mariquina's residents also **complain about the bad smell** that emanates from the pulp mill, located on the outskirts of the town. At times the odors are so bad that they prevent classes from being held in the local school and put the health of teachers and students at risk, as well as the health of the inhabitants of communities surrounding the site.

Another complaint is that pollution from the plant is also threatening the local drinking water supply, and interfering with the spiritual practices of the Mapuche people.

Further impacts experienced by local communities relate to the extensive pine and eucalyptus plantations that feed the pulp mill and biomass power station. Communities in the area are surrounded by the plantations, and the proximity to houses and height of the trees excludes natural light, which impacts the mental health of residents. Impacts related to mental and physical health and food production are felt more acutely by Mapuche women and girls given their key roles in maintaining community health and the family economy.

⁹ Palma, K. (2013). Desarrollo forestal en la Región de los Ríos. Análisis de la resistencia y el impacto en la comunidad Mapuche Lafkenche en la Bahía de Maiquillahue. 1996-2007. Tesis de Pregrado. Universidad Austral de Chile, Valdivia, Chile.

¹⁰ Instituto Nacional de Derechos Humanos (2019) Informe Misión de Observación Comuna de Mariquina, Valdivia, Chile.

4. The social impacts of Chile's plantation forestry model

The plantation forestry industry in Chile causes a diverse range of social impacts. Despite the industry's important contribution to Chile's Gross Domestic Product, territories VIII, IX and X that have the highest concentration of plantations also have the lowest Human Development Indices¹¹ and the worst income distribution in Chile.¹²

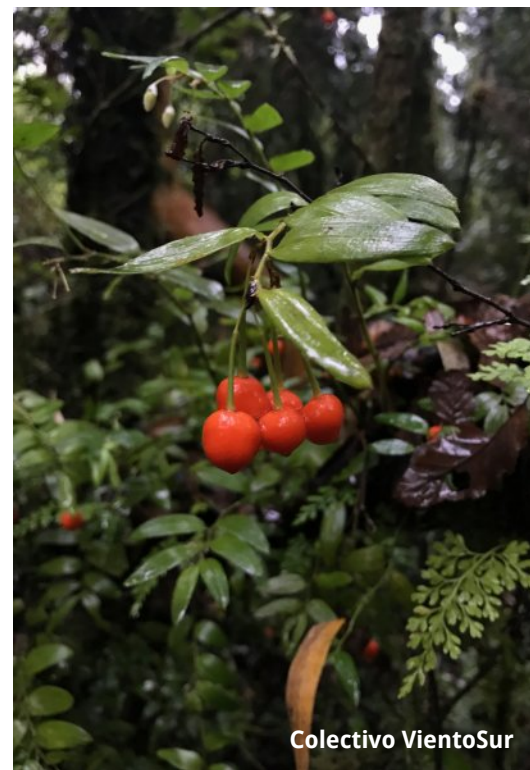
The industry's need for huge areas of land has significantly altered local economies, leading to a loss of livelihood for farming communities and in turn resulting in large reductions in rural populations and emigration to urban areas.¹³ Connected to this is a profound impact on the intercultural relations of Indigenous communities, in particular the Mapuche, where significant conflicts have deeply affected the social and cultural fabric of the area.

An example of this are conflicts over land ownership due to land-grabbing and fraudulent purchases of land for commercial tree plantations that have affected thousands of peasant farmers and Mapuche families.¹⁴ The arrival of forest industries also led to a loss of cultural and economic diversity due to impacts on land-use and biodiversity, such as a decrease in the availability of medicinal plants used by communities, which has impacted Indigenous women disproportionately. Some native plant species have disappeared as a direct result of plantation expansion.¹⁵

Another impact that this forestry model has relates to the use and availability of essential natural resources like water and healthy soil. In territories with high concentrations of plantations, water shortages during summer months are frequent, and have forced some municipalities to deliver water in tanker trucks,¹⁶ which has a high cost for many of the poorest communities in the country. Soil quality has also decreased considerably in plantation areas due to the unregulated use of pesticides and herbicides, which impacts heavily on rural farming communities.¹⁷ Further impacts involve the deterioration and damage of roads where there is heavy logging truck traffic in plantation areas, as well as the homogenization of the landscape into areas of monocultures and clear-cuts, which particularly affects local tourism opportunities.¹⁸

Finally, the links between plantations, severe drought and megafires are increasingly clear in Chile, which puts rural communities under even greater

stress. Given that current predictions for climate change in Chile indicate that drought periods will become more frequent, more intense and impact wider areas, a recent scientific paper concluded that *"...land-use planning and fire and forest management strategies must promote a more diverse and less flammable landscape mosaic limiting high load, homogenous, and continuous exotic plantations."*¹⁹



Colectivo VientoSur

¹¹ Programa de las Naciones Unidas para el desarrollo - PNUD (2004). Las Trayectorias del Desarrollo Humano en las Comunas de Chile (1994-2003). Santiago, Chile.

¹² MIDEPLAN (1998) Resultados de la VII Encuesta CASEN.

¹³ Melo O., W. Foster y G. Anriquez. (2006). Patrones de Migración Interna en Chile. Departamento de Economía Agraria. Revista Agronomía y Forestal, Universidad Católica. 4-6 p

¹⁴ Bengoa, J. (1999). Historia de un conflicto. El Estado y los Mapuches en el siglo XX. Santiago. Chile. Editorial Planeta

¹⁵ Jelves I. (2001). Intervención Externa y Medicina Mapuche. Centro de Documentación Mapuche. Araya, J.(2003). La invasión de las plantaciones forestales en Chile.Efectos de la actividad forestal en la población indígena Mapuche. Observatorio Latinoamericano de Conflictos Ambientales.

¹⁶ Torres, R., Azócar, G., Carrasco, N., Zambrano, M., Costa, T., & Bolin, B. (2016). Desarrollo forestal, escasez hídrica, y la protesta social mapuche por la justicia ambiental en Chile. Ambiente & Sociedad, 19(1), pp.121-146.

¹⁷ Montalba-Navarro, R. (2001). Transformación de los sistemas agrosistemas y degradación de los recursos naturales en el territorio mapuche: una aproximación agroecológica. CUHSO, 8 (1) pp. 19-39.

¹⁸ Ojeda, Perez (2004). Análisis de las expectativas de la población de San José de la Mariquina respecto a las instalaciones de la planta de Celulosa Arauco y su comparación con la población de constitución. Tesis de Pregrado. Universidad Austral de Chile, Valdivia. Chile.

¹⁹ Mauro E.Gonzalez, Susana Gomez Gonzalez, Antonio Lara, Rene Garreaud, and Ignacio Diaz-Hormazabal, The 2010-2015 Megadrought and its influence on the fire regime in central and south-central Chile, Ecosphere, August 2018.

5. Conclusion

This case study has analysed biomass burning at Arauco’s Valdivia pulp mill from three perspectives: the climate impacts of the “renewable” energy it produces, the local social and environmental impacts that the pulp mill is responsible for, and the wider social impacts of Chile’s industrial tree plantation model.

It is clear that the electricity Arauco is selling to the public grid is not “carbon neutral”, but could in fact be resulting in significant carbon emissions. However, Arauco’s unwillingness to respond to questions and the CDM’s flawed carbon accounting methodologies and inadequate verification procedures make it impossible to accurately assess what is being burned. The CDM is therefore providing a perverse incentive to a potentially high emissions industry, whereby certification serves to increase the profitability of Arauco’s investments and improve the company’s tarnished image, rather than reducing emissions and mitigating climate change.

Regardless of the true climate impacts of the Valdivia biomass plant, it is also the case that the operation depends entirely on the region’s vast areas of monoculture eucalyptus and pine plantations. These have had serious negative impacts on the Mapuche Indigenous People, including through landgrabbing, loss of livelihood and food sovereignty, and rural depopulation.

The pulp mill itself has also had and continues to have significant local impacts on communities and biodiversity. These began in the early days of the plant’s operation with a catastrophic discharge of effluents into the Carlos Anwandter Nature Sanctuary,

which Arauco has never been adequately sanctioned for, and continue today through poor community physical and mental health, threats to drinking water supplies, loss of income from tourism and division and conflicts that the company has sown in surrounding communities.

The conclusions drawn in this case study could also be extrapolated to the many other pulp mills in Chile and elsewhere where biomass is sourced from monoculture tree plantations and burned to generate carbon credits, offset emissions from other sectors and replace fossil fuels in the public grid.



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