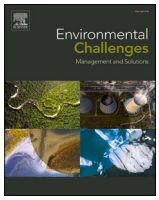
Environmental Challenges 14 (2024) 100846

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc



From a Brown to a blue economy in Chile

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ARTICLE INFO

Keywords:
Marine
Economy
Democracy
Ecology
Transitions

ABSTRACT

The Chilean brown economy continues to expand, without specific definition of sustainable limits or how to transition to an ecologically balanced future. The article first reviews marine democracy across 42 cases of mining and coastal refinery projects, port developments, aquaculture, factory contamination, wind farms, coal and property development. In depth, an industrial fish factory cluster in Arica, a coastal zone impacted by mining in Chañaral, and fjord aquaculture in Puyuhapi. Using semi structured interviews, and participatory GIS focus groups, it shows the same issues repeat, and how a new participatory marine democratic system might transition the blue economy.

Introduction

Around the planet, there is a significant increase of coastal communities interested in and achieving improved management of their marine environments (Axon, 2018; Armitage et al., 2017 and Anbleyth-Evans, 2020). Simultaneously, many coastal waters remain dominated by the brown economy, that is where pollutants ooze from ports, aquaculture, mining, and industrial fishing impacts (Anbleyth-Evans et al., 2022 and Jouffray et al., 2020). The Brown economy relies on 'extractivism', where resources in the sea and rural coast are diminished, while urban corporations based in the capital profit. Despite the brown economy being deemed fruitful by the measures of traditional Gross Domestic Product (GDP), alternative measures such as green GDP (Kouser et al., 2022), or gross environmental product (GEP) (Wang et al., 2022), can better enable coastal communities to realise the ideas found in the original theorisation of the blue economy. Conceptualised originally by the Small Island Developing States of the United Nations (UN) (Keen et al., 2018), a blue economy intends to be equitable, including gender equality, corruption, human rights, and group and economic equity (Teh et al., 2019), ecologically sustainable (Cisneros-Montemayor et al., 2021), economically viable, including stability, infrastructure, and investment risk (Shen et al., 2011), empowering cultural diversity and well-being. If clearly defined, the blue economy can also support catastrophe prevention, pollution prediction, ecologically enriching marine industries and ecological restoration (Wenhai et al., 2019 and Marin et al., 2015). Others have critiqued the paradigm for creating hegemony across spatial scales, by removing space for the discussion of the trade-offs of blue growth (Schutter et al., 2021).

To remedy this, there is a need to develop systemic Marine Democracy, where participatory marine planning works to tackle environmental impacts or blue injustices, resolved through the integration of Local Ecological knowledge (LEK) (Anbleyth-Evans, 2022). Blue injustices including mining pollution, factory point source pollution, and salmon farm contamination, resolved so that the costs and benefits of resource use and access are fairly distributed (Honneth 2001). Marine Democracy is the inclusion of actors' perspectives by institutions at a specific scale of power where people live, know each other, and their environment. This creates epistemic justice, means ensuring diverse ways of knowing, such as detecting environmental change an equal voice (Fricker, 2007). It works from the local scale to higher scales, ensuring that marginalised regions lead planning and decision making, counterbalancing typically capital city centred institutions. It is a form

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https://doi.org/10.1016/j.envc.2024.100846
Received 28 August 2023; Received in revised form 1 January 2024; Accepted 16 January 2024
Available online 3 February 2024

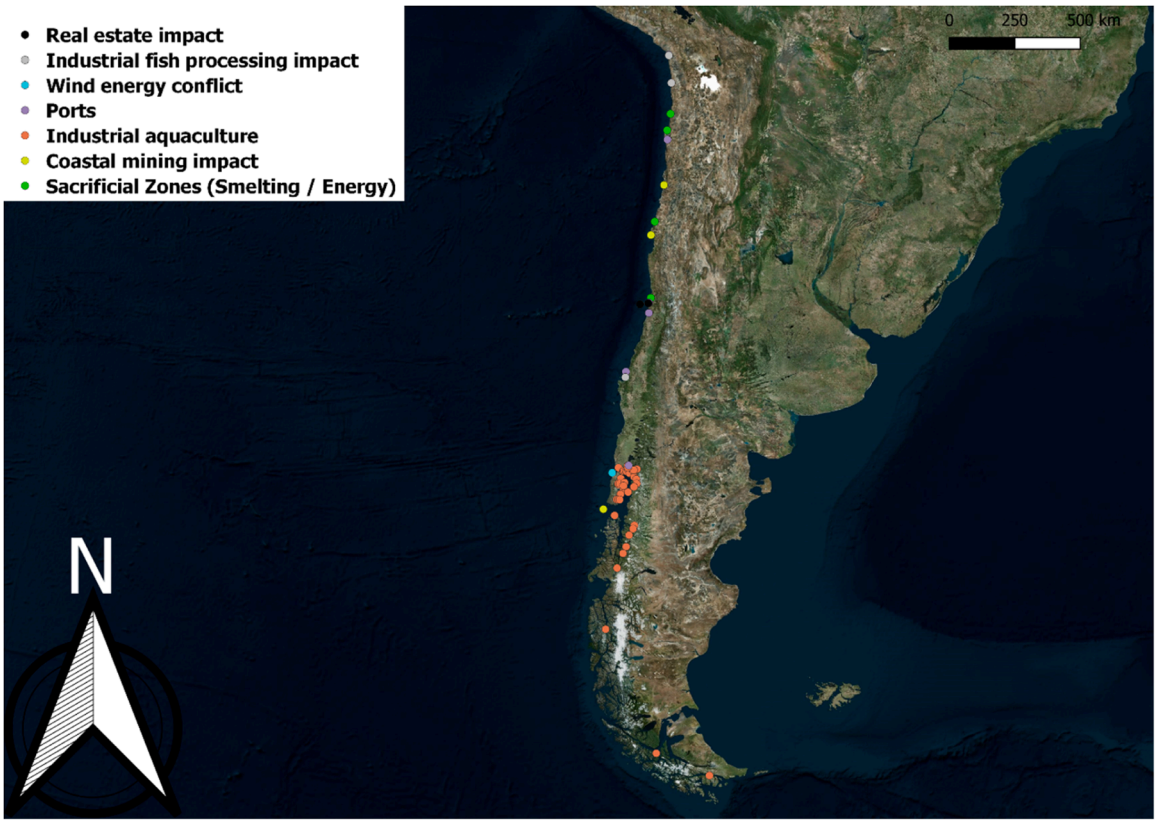

Fig. 1. Ongoing injustices in the brown economy and the key groupings of productive activities based on the review of cases below.

of subsidiarity. International precedents include elements of the Swiss system and the democratic confederalism of Rojava, north Syria and Zapatistas, Mexico (Baris, 2022).

Thus, Marine Democracy is the bi-directional feedback between socio-ecological systems and mechanisms of power. This can successfully move collaboration forward, improving human health (White, 2020) and simultaneous ecological health (Pittman et al. (2019) or socio-ecological health. Knowledge transformation into action can help confront the Marine Anthropocene (Anbleyth-Evans, 2018), the overriding era of the domination of nature by humans and markets, and local stakeholders can calculate where ecologically enriching growth can develop (Anbleyth-Evans, 2020). At the same time, enhancing the livelihoods of multiple users, aligning with debates supporting the transition to just blue economies (Germond-Duret et al., 2022 and Heidkamp et al., 2022).

Currently in Chile, there is increasing enthusiasm for participatory planning for sustainability through a comprehensive marine law to consider ecosystems (Fundacion Terram, 2022 and GEF Gobernanza Costera, S. 2022). Currently and historically, fisher LEK and other stakeholder LEK is not well integrated into Chilean planning and governance processes in Chile. Top-down brown economy developments have led to 'blue justice' issues (Bennett et al., 2021), most famously through the development of industrial copper smelter port complexes, or sacrificial zones (Anbleyth-Evans, 2022), and massive expansion of salmon farming (Anbleyth-Evans, 2020 and Tecklin, 2016) (Anbleyth-Evans et al. 2020 and Bennett et al., 2021). These ecological impacts distribute harms on certain local groups in an unjust fashion. The most common projects pushing for growth, almost inevitably result in loss of space, resource access rights and ecological impacts for coastal communities, through ocean grabbing (Barbesgaard, 2018). As the Chilean government has no definition of the blue economy currently (Subpesca, 2016), we developed a definition based on what was suggested in the proposed constitution (Convencion Constitucional, 2022).

To achieve a transition to an equitable, ecologically sustainable, and viable blue economy, the dimensions of marine democracy must be systemic and decentralized. To understand the challenges, we investigated a series of 3 in depth case studies, eliciting the stakeholder local ecological knowledge (LEK) of impacts and environmental change. We also reviewed the range of clusters that characterize today's prevailing marine economy which are: (1) submarine tailing dumping from mine processing (Coumans, 2018), (2) port construction, dumping and dredging (Anbleyth-Evans et al. 2020), (4) fish flour industrial complexes (Ambrosio and Zar, 2004), (5) refinery coal power complexes (Anbleyth-Evans et al. 2022) wind energy (Kerr et al., 2014) and aquaculture (Buschmann et al., 2006), which impact on coastal socio-ecological systems. In this context, Janßen et al. (2018) states that the Marine Spatial Planning tools of the Blue Growth / Blue Economy, do not have to have a negative impact. However, in the context of coastal communities, small-scale fisheries, and indigenous nations, this depends on if their rights and justice claims have been ignored or do not exist locally. In the discussion, we define what a blue economy can look like through the framework of Marine Democracy, considering dimensions of equity, ecological sustainability, viability, and justice. Next, we review the recent history of the brown economy of Chile and its existing marine economic clusters.

Review of the brown economy in Chile

Chile's coastline extends at least 8385 km, including the continental shelf, the archipelagos of the Patagonia and the oceanic islands of the Pacific Ocean. Her coasts support one of the world's biggest marine capture fisheries, and since the late 1970s the Chilean neoliberal economic approach, has focused on the privatization of the ocean commons and the exploitation of marine species. A boom of industrial and artisanal fisheries in the 1980s led to an ecological bust, with overexploitation of several species, including most famously the loco

Table 1
Interview numbers according to areas and sectors.

Location	fishers	Other community members	Non-governmental Organisations	Government
Arica	7	5	5	3
Chañaral	8	5	4	2
Puyuhuapi	7	5	3	3

Concholepas concholepas (Gelcich et al. 2010). Chile's fisheries are worth approximately US$ 5 billion, only behind the US and Canada in the Americas (Alagoa, 2019). Chile supports around 92,000 small scale fishers and more than 12,750 vessels (Subpesca, 2023). However, with government reporting of the 28 fisheries, 8 or 29 % are overexploited, and 8 or 28 % or 57 % of the total (Subpesca 2023).

Particularly in the southern regions, a push for salmon and mussel aquaculture has been perpetuated by the blue revolution. Chile is now the second largest exporter of salmon and mussels in the planet (FAO, 2020). Aquaculture is concentrated in Los Lagos, Aysen and Magallanes regions in southern Chile, where impacts seriously affect small scale fisheries in the region (Anbleyth-Evans et al. 2020). Furthermore, around Patagonia, industrial aquaculture continues to pollute marine ecosystems with antibiotics, decaying food and nutrient loading, producing eutrophication and anaerobic zones (Buschmann et al., 2006). Harmful algal blooms are becoming increasingly frequent in these regions (Försterra et al., 2014).

The accelerating value of brown seaweed in the last 20 years has promoted extractionism beyond the traditional collection of stranded algae on the shore. Consequently, mass direct extraction of live seaweed was exacerbated with the brutal removal of living plants occur from rocky reefs using iron rods (Vásquez et al. 2012). Subsequently, the seaweed ecosystem has collapsed, altering the structure of the benthic communities it supports such as fish spawning grounds (Vásquez 1995). In response, the Undersecretariat of Fisheries and Aquaculture (SUBPESCA) initiated a program to regulate the brown algae fishery in 2005. They attempted to implement management plans to help ecological sustainability through minimum extraction sizes and quotas (Vásquez et al., 2012). Recently, measures such as restocking, restoration of brown algae ecosystems (Westemeier et al., 2016; Campos et al., 2020; 2021) and the establishment of marine protected areas have been suggested.

In the northern and central regions, traditional fisheries (e.g., anchovy *Engraulis ringens*) are accompanied by marine sacrificial zones, where metal smelting pollution, coal power contamination, seawater desalination and related port impacts, affecting water quality and marine resources habitats (Anbleyth-Evans et al. 2022). Port developments in (Valparaíso and San Antonio) and energy/chemical companies (at Ventanas and Puchuncaví) are known to be polluting marine and terrestrial systems, affecting ecological and human health (Bolados, 2016; Fundacion Terram, 2018; Carranza et al., 2021; Anbleyth-Evans, 2022). In the same regions, the intensive growth of second homes in coastal rural zones, is limiting coastal access for traditional artisanal fishers (Araos, 2015).

Further south, several cellulose plants have taken over humid coastal bays, affecting biodiversity and fish stocks (Sepúlveda-Luque et al., 2019 and Sabatini et al., 2000). These brown economy clusters perpetuate socio-ecological conflicts, that threaten biodiversity and human well-being through pollution and habitat destruction (Carranza et al., 2020). Additionally, they create new tensions and conflicts at local subnational levels, while marine democracy through participatory spatial planning to resolve pollution and habitat impacts is not yet developed (Anbleyth-Evans et al.2020).

Methods

Macro analysis across Chile

Information was collected on blue justice issues across Chile, summarised into the results synthesis, Fig. 1 and Tables 2 and 3. Various databases from Fundación Terram (2022), ENVJUSTICE Project (2022), the map from the centre of conflict studies (COES, 2020), and the Environmental Justice Atlas (2022), and white papers which the authors contributed to, such as the International Collective in Support of Fish workers: Baffling Shades of Blue: Addressing the impacts of the Blue Economy on small-scale fisheries in Latin America (ICSF 2022), alongside academic sources and ongoing field research. This is followed by the Analysis of Blue Justice issues across Chile.

Case studies

To show the diverse range of the challenges faced on the coastal nexus, linking back to the macro-analysis in more detail, we present three case studies. i.) Industrial fish factory impacts in Arica, ii.) mining impacts in Chañaral and iii.) salmon farming in Puyuhuapi. This range was important to show how artisanal fisher LEK can better participate in decision-making and identify anthropogenic contamination through future marine democracy. The case-study approach permits the comparison of several instances of a particular phenomenon, to help explain it (Hardwick, 2009). These cases focus on the use of marine LEK examine two different community contestations of contamination in northern and southern Chile. These are based on interviews and focus groups, conducted from 2018 to 2021.

Although this evidence was ignored by responsible Government agencies, over time momentum from artisanal fisher led social movements has led to greater recognition in civil society. This fisher LEK information can serve as a basis towards marine democratisation of the system and participation of the wider coastal community.

Semi-structured interviewing

Semi-structured interviews (McIntosh and Morse 2015 and Miles and Huberman, 1994) were key to understand the experiences of those excluded from participation and the extent that community LEK could enhance ecological health. This paper builds on research indicating that marine governance currently positions LEK as less important, being anecdotal, that is not scientifically valid (Anbleyth-Evans, 2018). This work highlights LEK's value in illuminating the processes that cause ecological debilitation, which through marine planning, can lead to a blue economy.

Interviewees were recruited first based on their interest in the economic sector and environmental impact, such as small-scale fishers, NGO representatives and local governance. Those effected were typically from the economically poorer demographic, such as fishers and indigenous nations, being more resource dependent. There was a greater gender mix from interviewees from NGOs and governance. Key informants provided information, including NGOs Terram Foundation and Oceana, governance workers from local municipals, Subpesca, Sernapesca, IFOP and the Environmental Department. Contact was made first with the most prominent activists in the local social movements. After this, interviews evolved through snowballing, with 20 interviews the areas of Arica, Chañaral y Puyuhuapi. Interviews were also attempted in each case studies with the industries creating the impact when they made themselves available, the numbers are described in Table 1 below.

Interview data was analysed through an inductive approach to thematic analysis, supported by NVivo 10 (Clarke and Braun, 2013). The

Table 2
of number of those involved in focus groups from different sectors in different areas.

Location	fishers	Other community members	Non-governmental Organisations	Government
Arica	7	5	5	3
Chañaral	8	5	4	2
Puyuhuapi	7	5	3	3

themes used during interviews to develop questions were: (A) Access to decision-making and participation, (B) Impact and pollution in the marine environment, (C) Scarcity and abundance, (D) Seabed characteristics, I Seabed habitats and biodiversity, and (F) moving the blue economy. These were analysed to understand the extent of the ecological impacts and participation possible in the system. The identities of the interviewees were kept confidential; references in the text identify them by their local community and the order in which they were interviewed.

Participatory mapping focus group

Participatory mapping took place during the focus groups to understand how marine LEK could contribute to marine governance. Focus group discussions occur with an informal group with a specific theme, with open feedback, such as used in Participatory Rural Assessment in fisheries (Fitriana and Stacey, 2012). Groups were divided into two and asked to draw the ecological impacts of dumping on a local map. Coloured pens were given out with a key of different habitat types and features for groups to identify and annotate (Zambra-Alvarez et al., 2016). It was important to encourage the quieter members to take part, so that more prominent members did not dominate. Mapping with the group was the most accessible way to elicit LEK in the first instance, before consolidating the maps using the open-source Geographic Information System program QGIS (QGIS Development Team, 2018). In Arica, Chañaral y Puyuhuapi, local fishers indicated where they identified impacts to natural shellfish banks and fish breeding and spawning areas. Community activists explained where they had seen problems with pollution. The Table 2 below shows those involved the focus groups, they were predominantly the same people as those interviewed.

Results

Macro analysis of blue economy injustices across Chile

Considering the diversity of blue economy related injustice creating projects across Chile, the next section presents a macro analysis, or the breadth and extent supported by Fig. 1 and Tables 3 and 4 below.

The map of Fig. 1 above shows the main economic clusters in Chile generating widely communicated socio-environmental conflicts, where participatory approaches are urgently required. There are 3 direct mining pollution related cases in yellow, 5 metal refinery / petrochemical complex sacrificial zones in green, which cluster mainly in the north. At least 6 port related issues are dotted down the coast in purple, and at least 4 industrial fish flour processing centres in grey. Also noted are areas of significant real estate impact in Valparaisoand wind energy development conflict in Chiloe. Most relevant in terms of the brown economy, is the salmon industrial aquaculture challenges, where 39 or more key sites in the south have been identified below with orange points. This industrial aquaculture clearly coincides with the top-down government designed Area Appropriate for Aquaculture across the south. This system was zoned without any community participation or consideration of local oceanography, but rather only considering the potential for blue growth (Hadjimiachael, 2018). While these are by far the most numerous, each individual case study may not be as equally potent in footprint and social impact. Salmon aquaculture is the most important source of socio-environmental conflicts in southern Chile, as shown by Carranza et al. (2020).

Similarly, to the aquaculture, the industrial complex sacrificial zones and direct mining waste impacts have a direct impact on coastal communities and fisheries. While there are proposed plans for remediation, these have not manifested so far, with the lack of a participatory form of marine planning for conservation (Cárcamo et al., 2011). This participation is needed not simply for the planning of top-down private business expansion, but also including the wishes of fisheŕs unions and other civil society actors and organizations. The Chilean state typically over-represents the interests of the economic elite and corporations from aquaculture, alongside energy and mining corporations (Tecklin, 2011). These actors have no democratic mechanism or legal obligation to be held accountable to coastal populations. Economic elites often have disproportionate access to state resources and are disproportionately able to make policies and authorities work for them (Bavinck et al. 2018). Beyond the core 7 blue economy themes shown in Fig. 1 above and in Table 3 above, these blue injustices across the coasts of Chile also include real estate over development in Valparaiso, limiting small scale fisher access to the coast, and conflict with coastal / marine wind farm development in Chiloe.

Differently to Tables 3 and 4 above highlights examples below that do not specifically link to specific places, but wider environmental phenomena. For example, the harmful algal blooms thought to be exacerbated by a combination of salmon farm pollution and climate change are a justice and economic issue in the ecological impact and the limiting of fishers' activities once shellfish poisoning becomes a risk. Similarly, climate change broadly impacts ecosystems fishers and other coastal stakeholders, increasing El Niño effects and landslides exacerbating the vulnerability of communities and their socio-economic status.

Cases studies of marine democracy in Chile

Arica sacrificial zone

Arica is a frontier town on the border of Peru, Chile's northernmost city, being formally part of that country until 1880. It has a large fishing fleet of around 60 small scale under 14 m and 20 over 20 m vessels. It is in the Atacama eco-region, being in a desert without rain, but has one continual small river Lluta, and one seasonal river San Jose which flow down from Bolivia. While Arica is not widely reported to be a sacrificial zone in the literature and media, being without a coal power station, it has a marine zone with similar characteristics of injustice through contamination from industrial fish flour producers. A striking stench wafts over the bay area from the industry. In 2021, a mixed group of fishers, surfers and other coastal stakeholders criticised those businesses in the sacrificial zone for continuing the piped pollution, and the likely links to the increased harmful algal blooms that occurred in February and May 2021.

A fisher explained:

> They wash the pipes with sulphuric acid and then send it out to sea. They do it in the dead of night, dont tell anyone, around 2 or 3 in the morning. The tail water. There are groups of harvesters who get money from Corpesca and Golden Omega for not saying anything (Arica 1).

Fig. 4 shows the extent of the contamination spread from the waste emission pipes of the fish flour industrial complex. This industrial complex additionally closes off a substantial part of the southern part of the coast, limiting access to traditional subsistence fishers. Given the subsequent outbreak of harmful algal blooms, a community activist explained further:

Table 3
Sample of ongoing cases of brown economy injustices on small-scale fisheries in Chile.

Source	Description of injustice	Key informant / author	Main Impact	Context of injustice	Resources involved
Environmental Justice Atlas (EJA)	Plan for Coal Power Station Castilla, Chile	Barbara Galetti	Fossil Fuels and Climate / Energy Justice	Pollution of the coast decreases and affects species for commercial use and work	Employment, socioeconomic problem, poverty, impact on marine species
EJA	Ventanas Industrial complex	Jeremy Anbleyth Efren Legaspi, from Quintero Puchuncaví and Grettel Navas (ENVJustice Project)	Blue Justice	Pollution of the marine environment decreases and affects species for commercial use and work An additional effect produced by the thermoelectric plant is the constant stranding of coal. Fishers have had to adapt from the historical collection of molluscs to the current collection of coal. Coastal contamination decreasing and impacting species	Employment, socioeconomic problem, poverty, affectation of hydrobiological species
EJA	Huasco – sacrificial zone Petroleum coke, Iron mining submarine tailings impact	Patricio Chávez y Joan Martinez Alier	Fossil Fuels and Climate / Energy Justice	Pollution of the marine environment decreases and affects species for commercial use	Employment, socioeconomic problem, poverty, impact on marine ecological health and resources
EJA	Tocopilla sacrificial zone Coal power / petrochemical / mining exportation complex	Jeremy Anbleyth-Evans	Fossil Fuels and Climate / Energy Justice / biodiversity	Pollution of the marine environment coast decreases and affects species for commercial use	Employment, socioeconomic problem, poverty, impact on marine ecological health and resources
EJA	Mejillones sacrificial zone Coal power / petrochemical / mining exportation complex	Jeremy Anbleyth-Evans	Fossil Fuels and Climate / Energy Justice / biodiversity	Pollution of the marine environment coast decreases and affects species for commercial use	Employment, socioeconomic problem, poverty, impact on marine ecological health and resources
EJA	Port expansion San Antonio	Jeremy Anbleyth-Evans	Megaport expansion	Benthic ecosystems, wetlands, lagoons change of course of river, loss of beach and access	Loss of traditional chinchorro fishery, wider ecological impacts
EJA	Port dredging / expansion Arica and Valparaiso	Jeremy Anbleyth-Evans	Fossil Fuels and Climate / Energy Justice	Benthic impacts / climate change	
EJA	Plan for coal Mining at Guafo island, Chile	Patricio Chavez, Joan Martinez Alier y Denise Sinclaire	Mineral extraction and construction	Tension due to the possibility of exploiting coal mines on the island that is traditionally used by artisanal fishermen / Huichille cultural community	Socio-territorial conflict, segregation of artisanal fishermen
EJA	Wind Farm Project in Chiloe impacting Mapuche Huichille territory	Sofia Avila-Calero	Climatic and environmental justice	Wind project will affect a large coastal area in which traditional fishing and shore harvesting activities are carried out	Employment, socioeconomic problem, poverty, affectation of hydrobiological species
EJA	Dominga Cooper Mining Project, Coquimbo, Chile	Andrés Álvarez president of Modema, the Movement in Defense of the Environment	Mineral extaction and construction	Coastal contamination decreasing and impacting species	Employment, socioeconomic problem, poverty, affectation of hydrobiological species
Scientific and gray literature.	Cellulose plant pollution Mehuin, Valdivia	Sepúlveda-Luque et al., 2019, Sabatini et al., 2000	Cellulose plan	Comité de Defensa del Mar working against the polluting pipeline into the sea	Employment, socioeconomic problem, poverty, affectation of hydrobiological species
Scientific and gray literature.	Salmon farms	Gonzalo Saavedra, Marcel Claude, Jorge Oporto, Arnt Fløysand, Jonathan R. Barton, Álvaro Román, Fundación Terram Foundation, NGO Ecoceanos, Superación Pobreza Foundation	Aquaculture concessions and hatcheries	Salmonid farming in the south of the country has involved the capture of marine areas for the installation of this industry (areas that were historically used by artisanal fishermen and local communities), and generated a socio-environmental crisis that has caused the eutrophication of the sea, with macro-scale scopes that have jeopardized local economies	Employment, socioeconomic problem, poverty, affectation of hydrobiological species
Scientific and gray literature.	Real estate speculation	Hidalgo, Arenas, Santana	Replacement of traditional living spaces shelter and work of artisanal fishing by large real estate projects	Real estate pressure (mainly on the central coast) has displaced and / or precarious the historical / traditional spaces of residence, shelter and work of artisanal fishermen, both at the scale of coves and of shore harvesters	Employment, socioeconomic problem, poverty, affectation of hydrobiological species

(*continued on next page*)

Table 3 (*continued*)

Source	Description of injustice	Key informant / author	Main Impact	Context of injustice	Resources involved
Scientific literature	Kelp overexploitation	LC and collaborators	Kelp populations, benthic communities.	High international demand of brown algae has led to their intensive exploitation in northern Chile.	Fisherman monthly income, Benthic biodiversity Other marine fisheries associated to kelp

Table 4
showing non placed based injustices.

Source	Description of injustice	Key informant / author	Main Impact	Context	Resources involved
Scientific and gray literature.	Harmful algal blooms	Marine toxins Laboratory/ Universidad de Chile, Terram Foundation, Universidad de LL	Harmful algal blooms	Harmful algal blooms prevent artisanal fishermen linked to benthic species from extracting and marketing their products. Since the blooms do not have a predictable pattern of emergence or duration, the fishermen enter a socio-economic crisis and depend on the State for assistance	Work, socioeconomic problem, poverty, impacting species
Scientific and gray literature.	Climate Change, policy trap	Andrés Marín, Terram Foundation, Superación Pobreza Foundation	Regulatory restrictions prevent artisanal fishermen from reacting freely to environmental disasters and global climate change	Catastrophic events (such as tsunamis or landslides of coastal hills) and global climate change itself, generate ecosystem alterations that artisanal fishers cannot face by appealing to their cultural background and traditional skills since the fishing regulations (and other national regulations) prevent it. This aggravates their vulnerability and reduces the scope of their historical resilience (adaptation, transformation, learning, etc.)	Work, socioeconomic problem, poverty, impacting species

We carried out two testing points, one dredging the sediment, one testing the water quality because it was rockier near the pool. Golden Omega sends out the greatest concentration of heavy metals and nutrients at the northern point.

Harmful algal blooms can be toxic outbreaks of micro algae, impacting a range of species, and changing the colour of waters with their biomass, with their spores waiting on the seabed for the right conditions. Internationally, literature links nutrient loading, eutrophication, and Harmful algal blooms (Collos et al. 2007; Heisler et al. 2008, and Park et al. 2013).

Whether the impact of the pollution from the fish flour producers is directly responsible for the harmful algal blooms or not is not clear, however literature widely indicates that nutrient balance and eutrophication can be supporting factors for species such as the *Heterocapsa* spp. and *Psuedo-nitzschia* (Flynn, 2010 and Parsons and Dortch 2002). Additionally, another community activist described the potential influence of the port.

We also think the port is spilling various chemicals spilling in the sea from the unloading of the fertiliser. Like Ulexita, boron, sulfer, zinc. It's the Quiborax business that's doing it. There's a huge pile of it blowing into the sea.

Again, these different in combination impacts are not considered as a whole, something important in developing a strategy for the improved ecological health of the bay.

Chañaral

With a population of 13,143, Chañaral was one of the first places to export copper in Chile. Not known as a coastal resort, notorious Chañaral in the Atacama region is famously one of the most contaminated coastal areas of Chile, through the impacts from the El Salvador mine, run by national corporation Codelco. Daily tailing dumpings of 29,000 tonnes were deposited continually from 1938- 1974. Nearly 150 million tons of fine mining concentrates of molybdenum, zinc copper and arsenic have accumulated (Castilla and Nealler, 1978). Today, the bay remains one of the most contaminated in Chile, as the untreated mining tailings that were discharged through a semi-artificial canal, also called the Salado River. This flows to the coast from east to west via the dunes and lagoons as can be seen in Fig. 3. The liquid from the lagoons visibly dribble round into the sea. It continues to result in chronic or sub-lethal effects, reducing fecundity, with direct impacts on benthic ecosystems, such as the group marine copepods Harpacticoida, which are the primary consumers in the meiofaunal assemblage (Lee et al., 2006).

A local artisanal fisher explained more:

Yes, the whole bay is still dead, 70 years ago they first started it, the waste still seeps out where it was buried in the lagoons and dunes. You must go out as far as El Barquito to see any seaweeds. The state won't do anything about it.

The fishers described that still after 70 years, they still needed to go outside of the red contaminated zone to catch any fish. But there were no controls or local laws over this. The loss of fishing access was difficult to calculate over time but was in the region of millions of pesos every year.

Similarly, a seaweed harvester explained:

Yes, you can't find any seaweed anymore unless you go right out west round the coast. I fell into the mud once, and my feet and legs stayed green for days.

Indeed, as this quote shows from a seaweed harvester, the environmental problems of Chañaral Bay by no means ended with the symbolic bathing of previous president Ricardo Lagos in 2003, who controversially announced that the water quality problems were over whilst swimming.

However, the stakeholders say that the municipality or the state in general still don't take responsibility for the action of what was then a state owned mine and disposal scheme, and their perspectives continue to be ignored. With over 7,125,000 m3 of contaminated soil on the landward side, and an unknown quantity of benthic sediments, the costs

Fig. 2. Map showing from north to south case studies Arica, Chañaral and Puyuhuapi.

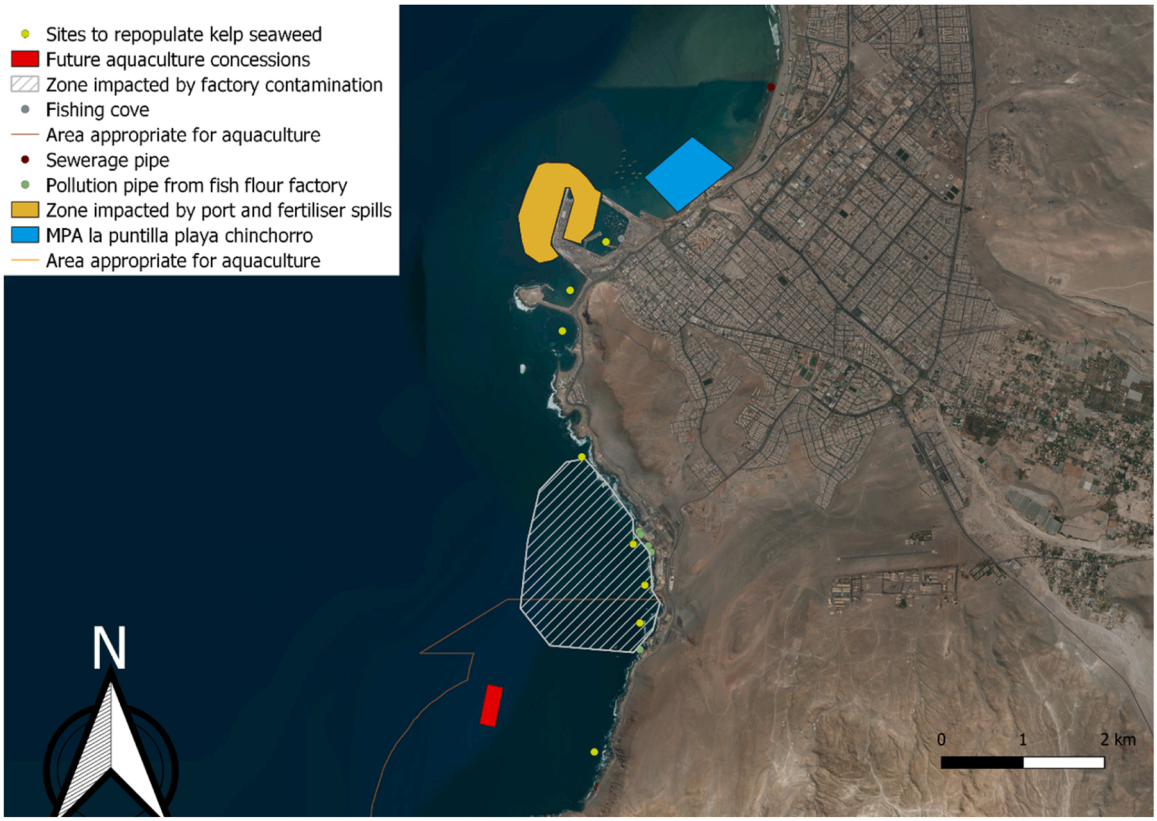

Fig. 3. showing the site of the contamination from the fish flour producers and the zone around it thought to continue to have polluted benthic sediments and water column (White hash). Additionally of interest is the sewerage outfall affecting the northern bay (brown dot), and the area around the port influenced by spills from fertilisers (yellow).

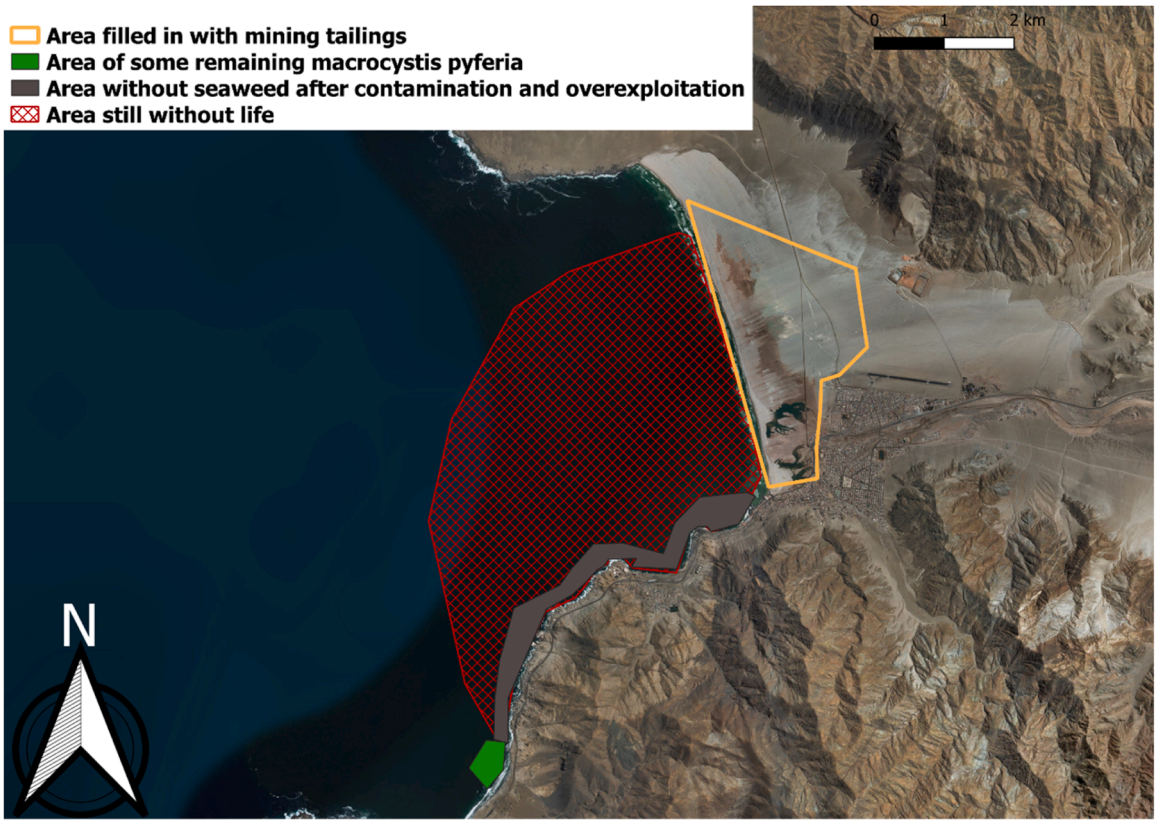

Fig. 4. showing the extent of the continued dead zone still without life from heavy metal mining tailings impact in hashed red. Also highlighted is the area where seaweed disappeared from the combined contamination and overexploitation and in green where some patches continue.

of possible confinement, bioremediation, biological treatment, Microbial bioremediation, or phyto-remediation are considerable. However, there has been discussion of an "Environmental Recovery Plan", paid for by Codelco by parliamentarians in 2016 which has potential.

Puyuhuapi

Puyuhuapi caletas pesqueras artesanales and observations of contamination

The village of Puyuhuapi, is the Patagonian region of Aysen, on the Puyuhuapi fjord, founded less than 150 years ago by government invited german settlers, and Mapuche people from Chiloe, leading to a mixed culture. The dispersed population of artisanal fishers and people is less dense than in Chiloe or Los Lagos region further north, with few hamlets scattered around the fiords and channels. Puyuhapi's complex network of fiords and islands has made it popular with industrial aquaculture, however the rate of circulation is particularly slow. The average velocities of the water flow into the fjord are one of the slowest within this system and after Comau fjord, the one that takes the longest to renew its water. Additionally, Puyuhuapi Channel is the fjord with the most severe hypoxic conditions in all Chilean Patagonia (Schneider et al., 2014). It has been affected by increasingly intense industrial salmon aquaculture over the last 20 years with subsequent outbreaks of harmful algae blooms (Seguel et al., 2005).

According to the fisher LEK, certain locations are unsuitable for aquaculture as the nutrients and other contaminants do not flush out, as the circulatory regime is too slow, such as the area in the north of Puyuhuapi fiord. This has meant that many of the natural shellfish banks have died off, and fish species have become less common than the past as can be seen in Fig. 4- 6 below.

Fig. 6, from the participatory mapping above, shows the former feeding grounds of *Basilichthys australis* "Pejerrey" in orange and *Merluccius gayi* "Merluza" in purple, the dead natural shellfish bank areas in blue, and the linked proximity to the salmon aquaculture footprints in brown and their concessions in red, as well as the fishing community coves in yellow, and benthic management areas in green identified during the participatory mapping workshop. A fisher explained.

> We've had to go further out of the fjord. In the past, 20 years ago, there were banks of mussels, oysters, razors clams. There have been more harmful algal blooms flourishing, each year is worse. All the contamination from the aquaculture keeps building up, and it doesn't flush out here. No, the AAA zone doesn't consider that (Puyuhuapi, 1).

Additionally, a community campaign group has developed, Puyuhuapi Sin Salmoneras. This group, embedded with Council of Culture of Puyuhuapi has arisen with multi-sectoral stakeholders including council workers, teachers and school students. The first demonstration in rejection of the installation of salmon cages by the company Salmones de Chile S.A, belonging to the Errázuriz group, was held. They explained that:

> The cages were placed less than 500 m from the town's waterfront, and without a public consultation and without an environmental impact investigation, in what should be a protected area.

The community thus demanded the immediate relocation of these salmon farms, outside of the Puyuhuapi fjord. Like many other areas of Patagonian Chile, the area deemed appropriate for aquaculture does not include the community perspective nor the oceanographic conditions, such as the highly stratified watershed of the fjord north of Puerto Cisnes.

Table 5
showing the extent these industries are equitable, ecologically sustainable, economically viable, democratic, and just.

Industries	Equitable	Ecologically sustainable	Economically viable	Democratic
Wind farms	currently only benefiting corporations, potential for community scale	Potential to decarbonise energy	Viable as corporations, as well as for community ownership	Currently undemocratically realised
Salmon farms	currently only benefiting corporations	Not currently, potential with seaweed	Viable as corporations	Currently undemocratically realised
Sacrificial zones	currently only benefiting corporations	Polluting heavy metals	Viable as corporations	Currently undemocratically realised
Port expansions	currently only benefiting corporations	Disturbs benthic and other ecosystems	Viable as corporations, as well as for community ownership	Currently undemocratically realised
Fish factories	currently only benefiting corporations	Point source pollution from pipes	Viable as corporations	Currently undemocratically realised
Coastal real estate	currently only benefiting corporations	Potential future impacts from construction	Viable as corporations	Currently undemocratically realised
Small scale fishing	Small businesses / communities	Impact where there is too much fishing pressure	Viable at any organisational scale	Currently undemocratically realised
Mussels and Multi-trophic aquaculture	Small businesses for mussel farms	Potentially at huge scale	Viable at any organisational scale	Currently undemocratically realised
Blue biotech	currently only benefiting corporations	No current risk	Viable at any organisational scale	Currently undemocratically realised

Table 6
Showing the spread of different laws across different authorities that need to be brought together.

Case study	Law	Authority
Arica – point source pollution from fish flour factories and sewerage Chañaral – mining waste pollution	the Supreme Decree No. 90/2000 to "*regulate the discharge of pollutants into surface marine and continental water courses by setting maximum permissible limits for the discharge of liquid waste, thus preventing contamination of said bodies of water*"	SMA Ministry of the environment
Arica – point source pollution	Law of navigation Title IX on contamination No. 95/01 of the Directemar law environmental competence in the marine environment Under the Organic Law of the General Directorate of Maritime Territory and Merchant Marine	Directemar
Puyuhuapi - in context of aquaculture production	Fisheries and aquaculture law	Subpesca
Puyuhuapi – in context of aquaculture production	INFA the aquaculture environmental report	Subpesca

Discussion

Opportunities for a blue economy through marine democracy

While there are diverse opportunities for realizing a sustainable blue economy through marine democracy, the multiple economic clusters of the brown economy currently don't manifest these characteristics. Rural marine ecosystems and resources continue to be exhausted, for the benefit of urban corporations creating conflict with coastal communities. As shown in the results in Section 4.1, Fig. 1 and 2, Tables 3 and 4, show the problems is systemic. A new participatory system is needed with new measures of success. As reviewed in the introduction, to show how the transition from brown to blue can develop, the dimensions of equity, equality in the economy, ecological sustainability, economic viability are discussed, and highlighted in Table 5 below, and how they can be realized through a system of marine democracy.

Equity

As seen through Table 5 below, research suggested that equity is limited, with profits and taxes concentrated with corporations headquartered in the capital of Chile or other cities, such as with salmon businesses and sacrificial zone copper industrial complexes. In the case of the seaweeds, after harvesting the resource is exported raw, through a trade structure based on formal and informal relationships and with a large presence of intermediaries. Consequently, the distribution of profits from this activity is very unequal, marked by a speculation and subcontracting (Porras & Vasquez 2020). Differently, for mussel farming and small-scale fishing local autonomy continues. Interviews suggested that the singular wind farm case, that while currently only benefiting corporations, has significant potential for community scale, such as community ownership or cooperatives (Kerr et al., 2014). The social dimension of participatory planning with coastal communities needs to be emphasised, to realise the many potential benefits. Similarly, the small business ownership of many mussel farms shows the potential for equitable benefits, where profit is maintained in the communities, maintaining livelihoods, and with small scale fisheries. A good option is fishermen's marketing cooperatives that can improve the quality of the products and consequently can generate lasting benefits for the producers (Jardine et al., 2014). Fishing management rights should be decentralized to cooperatives, which should determine where and when to fish, how much to fish and what resources to devote to fishing, generating greater efficiency and consequently greater economic benefits (Wielgus et al., 2014).

Ecologically sustainable

There is huge potential for a low carbon transition, through planning across Chilean regions for offshore wind. In the context of the 3 direct mining pollution related cases, while there are now major benthic and terrestrial impacts, there is potential for the restoration of ecosystem services through bioremediation. The recovery of these ecosystem services can be added to the calculation of Blue GEP. Similarly important is bioremediation for the 5-copper refinery / petrochemical complex sacrificial zones. Considering the 6 port related cases, there are other opportunities for habitat creation, and the decentralization of shipping to smaller ports. Additionally, the footprint of artificial structures, such as port infrastructure, is proliferating in the marine environment. In the context of what has been termed "ocean sprawl" there is not yet consideration of the 'green ports' paradigm, to integrate ecological design (Evans et al., 2019).

Ecologically and energetically, it is difficult to justify industrial trawling for salmon flour fish feed. Present in the case of the industrial fish feed factories, and their point source pollution impacts. Relatedly, the extent of the direct ecological impacts from the 39 industrial salmon farms reported to be polluting on the benthos, are not ecologically in balance. These may be an underrepresentation, as discussed in more detail in the Puyuhuapi case study These feature examples of the throughput, or waste that is not calculated by GDP (Jackson and Senker, 2018).

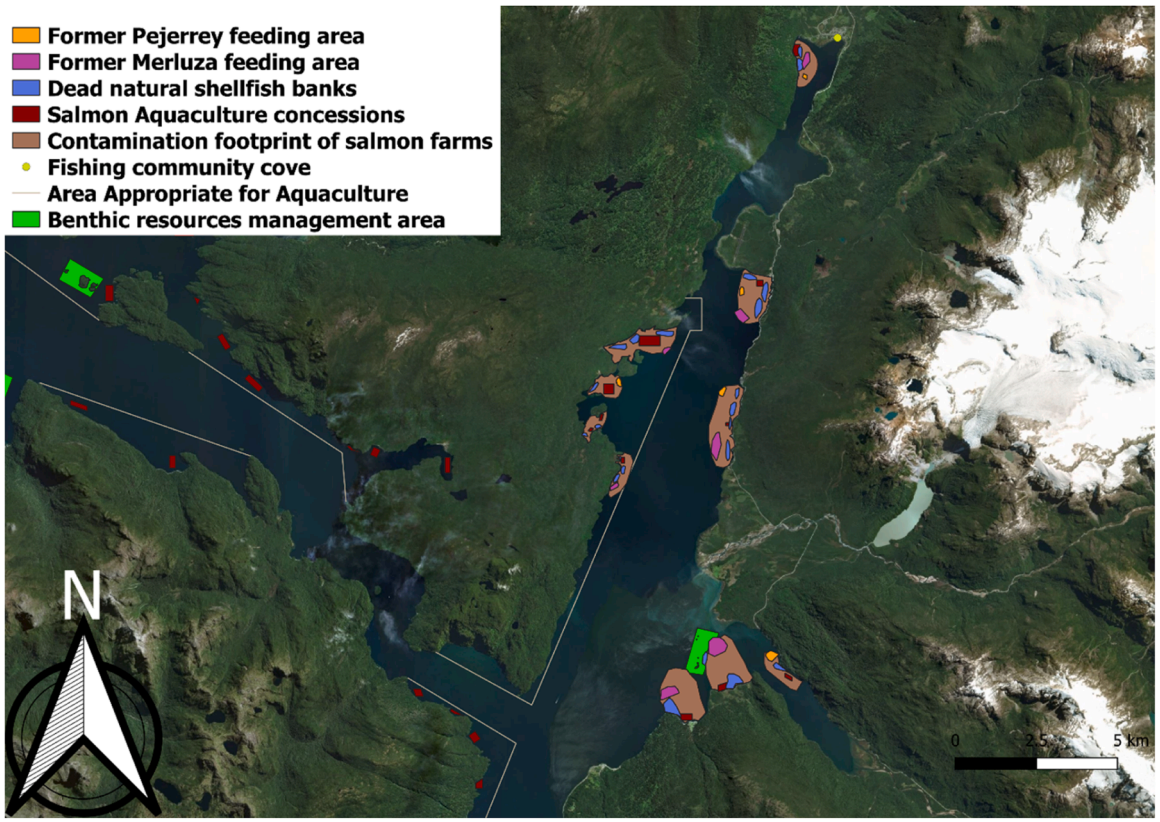

Fig. 5. Extent of the aquaculture contamination in the Puyuhapi fjord, the former feeding areas of fish, and the associated loss of natural shellfish banks from the participatory mapping.

The contribution of seaweed in the move towards multi-trophic aquaculture (Neori, 2007) and the importance of growing omnivorous native species which are less impacting if escaping (Ross et al., 2008), will be important in the blue transition. The mussel farm industry, which has arguably not realized sustainability through overexpansion of shellfish banks, can develop in collaboration with the seaweed for ecological benefits, and possibly be attached to windfarms through co-location, as mentioned in Table 5 above.

Economically viable

Wider viability considerations include political stability, infrastructure, and investment risk (Shen et al., 2011). Nevertheless, while most of these industries are economically viable under traditional GDP measures in the short term, the overwhelming impacts of salmon farming and copper producing sacrificial zones continue benthically. This may put other clusters such as small-scale fishing out of business. Under the neoliberal, or neoclassical economics paradigm, the government does not calculate ecological impacts. Being designated as an externality, this does not account for currently or future collapsing ecosystems. Alternative measures such as green GDP (Kouser et al. S. 2022), here distinguished as 'Blue GEP' can calculate a more holistic suite of measures to ensure marine coastal resources are not exhausted for the benefit of urban corporations. An indicator that measures positive ecosystem services was well received in Guangxi Province; the sum of total ecosystem services produced and showed that compared with GDP, natural capital was 50 % higher (Wang et al., 2022). This system has gained traction through the UN's System of Environmental and Economic Accounts (Dasgupta, 2021).

In terms of ecotourism, (Fennell, 2020) highlighted access to the coast is often more difficult with private development. Burgeoning property development and brown economy industries, such as fish flour factories and copper refinery complexes, limit access privatizing swathes of the coast for neoliberal extractivism. As mentioned in the Arica case study, and the privatization of the coast by real estate seen in Puertecillo or Topocalme near Pichilemu (Araos, 2015). Rights to access the coast, such as a legal right to a coastal walking path, need to be guaranteed across regions.

Furthermore, the benefits of blue carbon and ecosystem services have yet to be calculated in most locations in Chile, meaning coastal ecosystems remain undervalued outside of the few coastal conservation zones (Carranza et al., 2020). Even though Chile has made great advances in marine protected area creation, 89 % of the area protected is found in remote oceanic islands, 10 % south of Cape Horn and 1 % in continental Chile, meaning most of the coast remains exposed to industrial development (Paredes et al., 2019; Friedlander and Gaymer 2021). The cultural efforts of Mapuche-Williche groups in developing their Indigenous Marine Areas may prove to be a way forward (Anbleyth-Evans et al. 2022). Blue biotechnology may play an increasing role in the future, currently most discussed in developing salmon farming immunity (Pulgar et al., 2015). Under a system which encourages ecological health through participatory marine democracy, these indicators can be better evaluated. This is discussed in more detail through the case studies in Arica, Chañaral and Puyuhuapi, examining how marine democracy can be operationalised.

Developing marine democracy through the case studies

The Arica fish flour and oil industrial complex and urban pollution

The complicated environmental impact of four pipes polluting the sea from Arica from the fish flour industrial complex, means the area to the south continues to be heavily polluted with heavy metals, sulphides, and nutrients. Furthermore, it remains unknown the extent the sewerage system is functional or is in fact degenerated as key informants suggested. Additionally, the port area remains heavily contaminated with

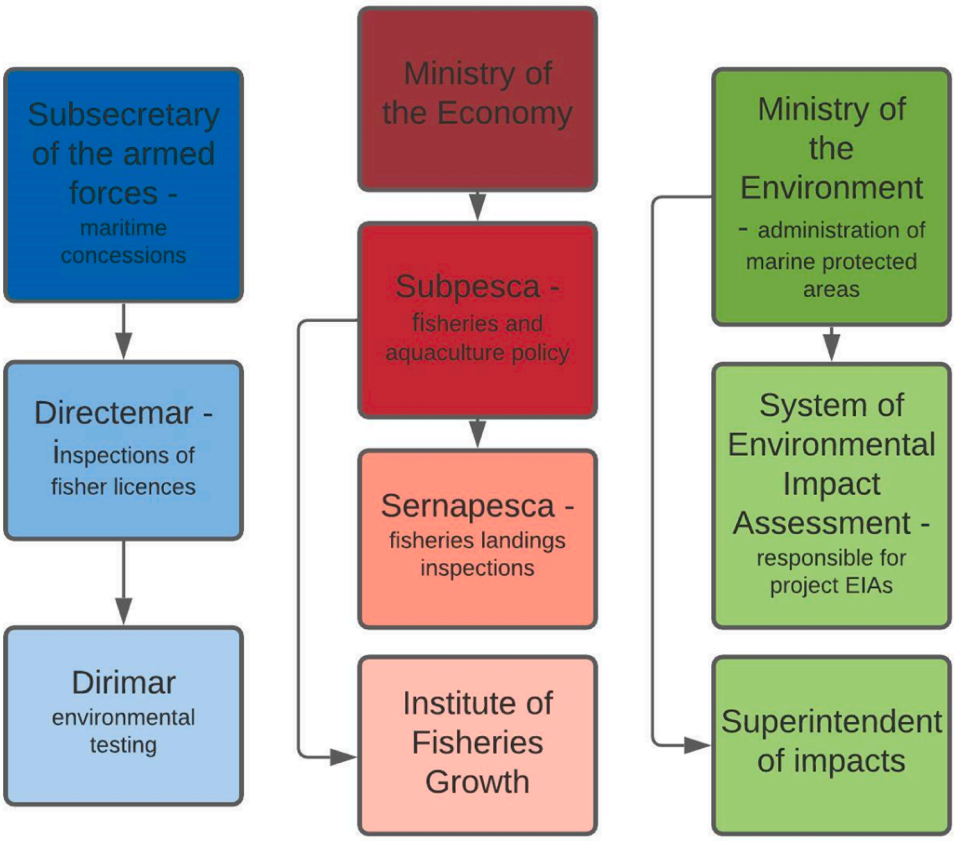

Fig. 6. showing the diversity of institutions involved in marine management and policy. There are three overlapping ministries, the Naval Armed forces, Ministry of Economy and those linked in the Ministry of Environment.

metals according to Naval inspectors, and local stakeholders report that commercial fertiliser on the port dock continues to blow into the sea. These elements together need a joint marine strategy to understand how they interact cumulatively and in combination with each other. For example, while a valiant attempt was made by the Tortu Arica organisation to save the migratory turtles, they have disappeared since 2018, which maybe through a combination of factors including the point source pollution and local fishing practices. Also, universally fishers report the disappearance of Macha shellfish from overharvesting, as well as fishes *Semicossyphus darwini* "Pejeperros", *Paralichthys adspersus* "Lenguados", *Medialuna ancietae* "Achas", *Cynoscion analis* "Ayanques", *Paralabrax humeralis* "Cabrillas" among others (Godoy et al., 2010). In order to understand the level of losses bibliographic reviews of the historical landings of these species and studies of their current state can develop. Studies of environmental variables such as concentrations of heavy metals, organic matter, fertilizers of the entire bay t and estimate community descriptors of diversity, richness, dominance and equitability of benthic and pelagic species would also be useful. A cohesive marine conservation strategy is needed for the bay, such as a partnership to examine these elements in combination. A marine protected area could be co-designed with the community. Such strategies were visualised for the local government using participatory GIS with the fishing community and local NGOs. In the future an ecological baseline can be determined, so the regrowth of ecosystems services can be planned together.

Chañaral

In Chañaral fishers continue to report the loss of benthic marine life and other fish species in the bay area, and must continue to fish further out, and that the government refuses to take responsibility for the remediation. Other community stakeholders including such as seaweed harvesters and the public enjoying coastal tourism agree that there has been a lack of state interest in creating a strategy to resolve the issue. While flash floods are still rare, they occurred in 2015 and 2017, sending more of the mining tailings into the bay (Bonnail et al., 2020). Recently a study warned that exposure to high concentrations of heavy metals, contained in sediments and respirable particulate material from mining tailings in the bay may have a possible future effect on the health of children, especially transported by the wind from the beach to the town. Also, those children exposed to fine particulate material from tailings deposited in the Chañaral Bay can have their lung development affected, increasing the risk of chronic respiratory diseases (Yohannessen et al., 2015). The implementation of "Environmental Recovery Plan", paid for by Codelco, has been mentioned in the media and by the municipality, however meetings haven't continued since 2016 (OCMAL, 2016). A strategy such as the development of seaweed farms to increase heavy metal absorption was also proposed (Westemeier, 2013). This could work with associated bioremediation with plants in the dunes (Lam et al., 2017). In these cases, the law needs to create a special permission for bioremediation in the sea, as the project was heavily delayed by lack of special permission.

Puyuhuapi

The case of Puyuhuapi similarly shows that the system of areas apt for aquaculture, a top-down planning system, ignores the participation of coastal communities, even while fishers attempt to show that natural shellfish banks and fish species are negatively impacted by their contamination. Additionally, there remains a lack of consideration of the ecological ramifications of the oceanographic processes, as the fjord is particularly stratified in the northern section past Puerto Cisnes, creating conditions which perpetuate plankton including harmful algal bloom phytoplankton species at the lower – upper interface (Schnieder,

2014). Moreover, the oceanography of Puyuhuapi supports the most severe hypoxic conditions <2 mL L^{-1} of all fjords, making it unsuitable for the accelerating number of salmon farms in the channel. This means greater participatory monitoring of dissolved oxygen state is needed. Indeed, such ecologically sensitive areas should be distinguished from those which are apt, for aquaculture. Historically the zoning of 80 % of the coast as apt for aquaculture, has been often against the marine democratic wishes of the community with the salmon cage placement. The testing of impacts through the aquaculture environmental report (commonly called an INFA) can be similarly criticised, as it doesn't consider all the different salmon farm projects in combination and cumulatively. The updated policy also needs testing for sulfides, which can indicate redox changes. A participatory plan can be developed to relocate the salmon farms and co-produce regrowth strategies.

Legal evolution towards a blue economy

As was seen in the detailed case studies, to consider ecosystems and realise participatory planning for sustainability there is need for comprehensive policy or marine law (Martinez et al. 2020) leading to regional participatory mapping through marine democracy. This was identified in the proposed rejected constitution, in section 145.- article 4 states that:

It is the duty of the State to protect marine and marine-coastal spaces and ecosystems, favouring the various vocations and uses associated with them, and ensuring, in all cases, their preservation, conservation and ecological restoration. The law shall establish their spatial planning and integrated management, through differentiated, autonomous, and decentralised treatment, as appropriate, based on territorial equity and justice (Convencion Constitucional, 2022).

Currently, The National Policy on the Use of the Coastal Edge (PNUBC), approved in 1994, is today the only existing coastal planning and management instrument (Fundacion Terram, 2022). A major problem has been, too many overlapping legislations from different organisations (As seen in Table 6 below) when defining access, use and occupation of the coastal zone, limiting adequate and effective planning of this space.

To move towards an equitable, sustainable, and viable blue economy, through blue democracy, local or regional participatory marine plans can be developed. Marine planning where impacts from contamination, construction, multiple interactions of species, fisheries, projects, and stakeholder groups can be understood together. The overlapping blue democracy issues are exacerbated by institutional overlap of responsibilities, as they are dealt with across three ministries and several departments as shown in Fig. 6 below.

Permissions for built projects constructions are with the Subsecretary of the Armed Forces, Directemar, environmental impact assessment of projects with Service of Environmental Impact Assessment (SEIA), fish population assessments with Institute of Fisheries Growth or IFOP, led by Subpesca in the Ministry of the Economy, and enforced by Sernapesca. A classic example of this overlap is that to enforce environmental issues regarding fisheries or aquaculture, Sernapesca need to ask Directemar to go on their boats, while environmental impact is assessed by SEIA and enforced by the environmental superintendent. An even more complex system is evidenced for protection of marine biodiversity, where, apart from the Ministry of the Environment, SUBPESCA, SERNAPESCA and the Navy, the Ministry of Education oversees Marine Sanctuaries, and the National Forestry Service oversees marine birds such as penguins while they are nesting or resting on land (Cárcamo and Gaymer 2013). Amazingly, all the institutions may be acting simultaneously in certain portions of the coast making management and conservation extremely inefficient (Cárcamo et al., 2013).

Thus, to understand how an equitable, sustainable, and viable blue economy can be developed through marine democracy, we assessed the case studies and sectors according to these characteristics in Table 5. In each of the case studies, participatory GIS was used to elicit a participatory plan towards a local transition. Additionally, the information provided by the interview participants could be meaningfully included within these participatory plans, through further workshops in the case studies, to address the injustice concerns identified.

Policy for participatory planning through marine democracy

These more in-depth case studies show the importance of seeing impacts holistically through participatory marine planning to transition from brown towards the blue economy. A single law of the marine environment could pull together all the different legal regimes responsible for marine pollution, fisheries, and planning, with policy for decentralised conservation and planning authorities. For instance, in Britain, the institutional confusion was remedied with a Marine and Coastal Access Act (2011) (Boyes and Elliott 2015). The Marine and Coastal Access Act 2011, which created the Marine Management Organization and the Inshore Fisheries and Conservation Authorities in England, coordinates the law of fisheries and aquaculture with the law that establish comprehensive protection of ecosystems (Appleby and Jones, 2012). They also coordinate marine licences for construction and aquaculture projects, coordinated through marine planning. However, there is a lack of local oversight over the permissions and planning of projects, and co-evaluation of EIAs. Marine democratic rights are firstly having participatory rights to decision making. This is then epistemic justice, having the way you know what you know, such as through the lived experience of fishing or diving, taken seriously as a form of evidence (Anbleyth-Evans, 2018). Simultaneously this is a right to research, ensuring feedback between different knowledge systems (Appadurai, 2006). It secondly means the right to take part in public or governmental / testing, by having training, to widen the influence of their evidence, where their evidence is described as anecdotal (Anbleyth-Evans, 2022).

In Chile, the creation of a Biodiversity and Protected Areas Service seems to be the way for solving the overlap between multiple agencies in biodiversity protection (Squeo et al., 2012; Paredes et al., 2019), however this initiative that started 12 years ago is still in the parliament. This can support a structure allowing for interaction with municipal councils, whilst on a local level to be seen together whilst planning for sustainability and conservation. Locally situated participatory planning can be a response to the challenges of the increasingly crowded coastal zones, which are often ridden with stakeholder conflicts (Stepanova 2015) and balance the necessities of the emerging blue economy. The concept of 'interactive governance', which emphasizes solving problems by creating societal opportunities by fostering interactions between civil, public, and private actors is relevant here (Kooiman and Bavinck, 2005).

Blue GEP and marine democracy

Marine democracy enables the local scale where regrowth can develop and be determined. The simplistic calculation of goods and services of traditional GDP, as shown in this article, perpetuate environmental injustices in rural areas and accelerate the degradation of the marine environment and the creation of throughput which remains uncalculated. Blue GEP, through the co-production of regrowth strategies, can see socio-ecological health develop. With the co-evaluation of ecosystem services through Participatory GIS, the economic inclusion and regrowth of habitats and species can be participatorily determined. Wellbeing, equality, viability, and ecological sustainability indexes can provide a richer perspective. Economic structures such as small businesses / cooperatives / halocracies have the local multiplier effect, can be supported (Wuisman and Mannan, 2016), with local taxes recirculated in regions. The co-production of regional marine maps working from the municipal level upwards, can link together the opportunities for blue economy clusters, where multi-trophic aquaculture, wind wave and tidal renewable energy can grow with the ecosystem regeneration. This includes supporting carbon sequestration, coastal protection, energy cycling and species repopulation. The marine environment can finally be given equal status, as marine protected areas and Indigenous

Marine Areas replenish ecosystems.

Conclusion

To transition towards a Blue Economy in Chile from a browning of the benthos, this article showed that a deeper critical understanding of the current sustainability of marine economy in Chile is needed. It evidenced that while most economic clusters continue to reflect the business-as-usual neoliberal approach, there are opportunities to grow equitable, ecologically sustainable, viable clusters through a Chilean interpretation of what a new blue economy could be in the future. The urban hegemonic calculation of GDP exhausting marine ecosystems for the benefit of city corporations can be overcome through blue GEP.

By using interdisciplinary methods to integrate empirical stakeholder LEK with theoretical analyses, it advanced why and how new policy is needed. It reframes the blue economy transition through the framework of marine democracy, with marine environmental rights recognised marine planning can be participatory, and with co-construction of local marine plans. It can generate greater legitimacy for a transition where sustainable activities such as multi-trophic aquaculture, seaweed farms for remediation, offshore wind energy and tide, are the new normal across self-sufficient decentralised regions. Where a circular understanding of impacts, throughput and energy is matched by the local multiplier effect, and taxation stays in the region. The new marine framework can holistically integrate the needs of those who live and depend on the coast and the sea to survive, whilst creating new jobs and livelihoods for those that want regrow ecosystems and biodiversity. Rather than increasing hegemony across scales for existing economic power relations, a marine democracy approach can realise the blue economy, with power flowing up from municipals towards a flourishing of regrowthism (Fig. 5).

Project t CONICYT/FONDECYT N. 3190473 “Marine Democracy in Chile, Cultural Ecosystem Services of Knowledge and Participation in Fisheries, Aquaculture and Conservation Governance”. PI: Dr. Jeremy Evans.

CRediT authorship contribution statement

Jeremy Anbleyth-Evans: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Francisco Araos Leiva:** Writing – review & editing. **Carlos F. Gaymer:** Writing – review & editing. **Ricardo R. Alvarez Abel:** Writing – review & editing. **Leonardo Campos:** Writing – review & editing. **Carlos Hidalgo:** Writing – review & editing.

Declaration of competing interest

The authors confirm that there is no conflict of interest

Data availability

Data will be made available on request.

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