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RESEARCH

Unravelling sustainable salmon aquaculture: an historical political ecology of a business responsibility discourse, 1970–2020

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Abstract
How sustainable is salmon aquaculture? The criteria for responding to this question are set by different organisations, since the concept of sustainable aquaculture is a social construction and there are no agreed criteria for establishing this sustainability condition and its evolution. Using an historical political ecology perspective, this paper unravels the evolution of this social construction over the past 50 years in order to establish how sustainability, responsibility, and sustainable development have been (re)constructed over time in response to changing demands. These constructions are traced through scientific publications, business reports, international organisation literature, and in terms of regulatory and consumer pressures. The documents provide evidence of the ways in which the sector evolved a particular conception of sustainability alongside the emerging global agenda set in motion by the Stockholm Conference of 1972, precisely at a time when the collapse of many capture fisheries became evident and aquaculture was presented as a more sustainable alternative. The conclusions point to the importance, for the sector, of restricting the sustainability concept to a narrow definition of business responsibility based on eco-efficiency, bio-security, and innovation, and separating this responsibility from the broader-based concept of sustainable development promoted by most UN agencies, governments, and NGOs.

Keywords Aquaculture · Sustainability · Responsibility · Sustainable development · Historical political ecology

Introduction

Overfishing during the late twentieth century led to a crisis for global fisheries and markets as well as for subsistence livelihoods. In response, new commercial systems of aquaculture were designed for large-scale intensive production (e.g. shrimp and salmon in particular) focused on international market consumption (Coull 1993; Naylor et al. 2021).

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While aquaculture has continued to provide additional protein supply for low-income communities through targeted technical assistance programmes throughout the Global South, the 'boom' in aquaculture is also related to the emergence of new actors developing substantial export capacity, as in the case of Chilean salmon production (Barton and Fløysand 2010).

The crisis of capture fisheries was one of the many socio-ecological crises in the global economy highlighted in the first international conference on sustainable development (more specifically, the Conference on the Human Environment) in Stockholm in 1972, and later in the IUCN-UNEP-WWF *World Conservation Strategy* report of 1980 (IUCN 1980). Consequently, the rise of aquaculture emerged almost in parallel with the rise of this new development paradigm. This article compares the evolution of both trajectories: sustainable aquaculture against sustainable development (as a broader agenda of transformation), and how different organisations and institutions socially constructed them for different purposes.

Theoretically, the article is informed by political ecology. Consequently, the changes in discourse and practice

are regarded as political rather than environmental issues per se (Leff 2006; Robbins 2012). From a political ecology standpoint, sustainability and sustainable development are regarded as social constructions that emerge from particular relations of power. There is, therefore, a constellation of power relations at work in the definition and redefinition of concepts, content, and boundaries. This power struggle is continuous, and the discourses that redefine these elements through time need to be deconstructed to establish what different actors seek to achieve in the process. Since the research covers 50 years of discursive evolution in the sector, it is historical and falls within the sub-field of historical political ecology (Davis 2015; Offen 2004). In this particular case, the article is interested in the ways in which the salmon aquaculture sector was able to create its own discourse, how this differed from the dominant sustainable development agenda of the UN, and the implications of this differentiation in practice.

The specific framework used here for analysing the evolution in these narratives, based on an historical political ecology perspective, is Erik Swyngedouw's (2004a) glocalisation theory. Rather than the global and the local being different scales for thinking and acting, Swyngedouw focuses on how different actors seek to regulate and deregulate at different scales, within the complexity of trans-scalar processes. These processes reveal that power relations generate tensions, conflicts, and transformations, and these can be seen in the impacts in different territories at different scales, as a consequence of these globalisation trends (Swyngedouw 2004b).

In Swyngedouw's work, he refers to 'scales of regulation', for attempts to increase regulation and 'scales of networks', for efforts towards deregulation. This theory is relevant to this case since these forces work against each other, producing continuous tension. In Swyngedouw's words (2004a, 4):

> I conceive scalar configurations as the outcome of socio-spatial processes that regulate and organise social power relations. As a geographical construction, scales become arenas around which socio-spatial power choreographies are enacted and performed.

The 'glocalisation' process therefore implies a transformation of the local scales of regulation and the emergence of global forces that irrupt through scales of networks. However, these antagonistic forces are not necessarily constructed in such a stark form, but rather as a process that operates across inter-firm networks and scalar levels of governance. For instance, many multinational corporations and territories, such as 'global cities' or valleys for wine production, internationalise their production and profiles to compete in the global market. This process requires the articulation between local scales of regulation and cooperation and competition between global scales of networks. Swyngedouw explains that 'the nesting and articulation of geographical scales becomes internalised in firm and inter-firm networks that reach from the local to the global and back again' (2004a, 38), manifesting the necessary relations across scales.

Control over the narratives of sustainability and sustainable development is an example of this de- and re-regulation process or tension. Firms stress the advantages of voluntarism and self-regulation versus state agencies and NGOs that emphasise the need for stricter controls to reduce externalities and ensure sound labour and environmental practices. Narratives are a crucial feature of this performance or power choreography. Effectively, the tension surrounds the state's regulatory role and capacity at different scales, from local government, through regional and nation-state institutions to multilateral intergovernmental arrangements and the nature of public–private relationships. This tension is relevant in the period in question since the timeline follows the rise of neoliberalism as a dominant political economy form of globalisation, producing a wide range of variegated forms of capitalism in the process (Brenner et al. 2010; Jessop 1997, 2013; Peck and Theodore 2012). Firms often argue that more regulation increases costs and generates uneven playing fields, also leading to higher prices for consumers. Public sector and civil society organisations, on the other hand, often argue that environmental externalities, low wages, and poor working conditions lead to the need for higher public spending on housing, health, education, and other services, or simply contamination and the socialisation of vulnerability. How narratives evolve and fit into this struggle over regulation should be recognised and understood.

This article engages in a literature review process to generate evidence for, and to reflect on different narratives that have emerged over time. Using a semi-systematic approach (Snyder 2019), we focused on incorporating narratives of sustainable development across several decades, with a critical position for evaluating the scope of definitions of sustainable development in the sector, or related concepts. We selected four temporal periods, beginning in the 1980s which is when the sector began its globalisation process, and when the Stockholm Declaration began to generate policy responses. The periods mirror important shifts in international public policy relating to sustainable development, with the release of key documents and the organisation of influential further conferences that shaped the sustainable development debate. In addition, we incorporated documents from different sources (academic literature, non-academic sources, official supranational organisations reports, and company-related reports) to provide examples of narratives across different groups of actors, since the semi-systematic approach requires that positions and multiple

perspectives within the same topic of interest are compared and contrasted.

In the first section, the article establishes the history of the sustainable development agenda from Stockholm to the present, as the context from which the concept of sustainable aquaculture emerged. The ways in which the business sector sought to establish a more partial, sustainability path through the World Business Council on Sustainable Development (WBCSD) is highlighted, giving rise to the construction of a 'responsibility' approach, as opposed to the language of sustainability and sustainable development. This is followed by a discussion of the social construction of sustainable salmon aquaculture in each of the four decades from 1980 to 2020, following the early emergence of the sector in the 1970s in Norway, to show how this evolved in response to different drivers and demands.

The conclusions point to three main themes that run through this period, which was characterised by an increasing emphasis on business sustainability within the overarching framework of global sustainable development. The first is a social construction as opposed to fixed, universal criteria. The sector responded rapidly to increased demands for sustainable development by creating and controlling its own discourse on the limits of these demands, which proved to be flexible and versatile, adapting over time. The second is a productive focus, that limited the reach of sustainability to firm operations on-site and through the value chain, but with little influence in terms of local development responsibilities. The third is the emphasis on voluntarism, with responsibility becoming a key discursive mechanism to subvert attempts to increase regulation of the sector or to use market (dis)incentives. Each of these themes is developed further in the sections that follow. Salmon aquaculture has evolved since the 1970s alongside the evolving concepts of sustainability and sustainable development. However, the sector has carefully managed its own narrative of responsibility to limit the regulatory impacts of the more mainstream multilateral sustainable development agenda.

The hybridity of sustainable development

There are two observations in relation to sustainable development that seem to be commonplace. The first is that sustainable development has become a metanarrative of our times, promoting a paradigm shift in how development is understood and enacted. The second is that it is hybrid. Definitions abound, and there is considerable flexibility in the use of terms such as sustainability, sustainable development, and responsibility. The roots of modern sustainable development, as opposed to classical or seventeenth-century German sustainability practice (Caradonna 2014; Grober and Cunningham 2012), emerged in the uncertainty of the postwar period. These roots were based on the reflections of William Vogt (1948), Fairfield Osborn (1948), and Aldo Leopold (1949), among others, who all pointed to the crisis in intensive agricultural and forestry production, and the evidence of it in the Badlands and the Great Depression in the USA. They all advocated for a new paradigm of development in tune with human livelihoods and ecosystem limits. For example, Aldo Leopold highlighted, in *The Sand County Almanac,* the importance of greater cooperation in order for there to be something left to compete for. The threat of the Cold War and the rise of the international 'Third World' development agenda announced in the Truman Doctrine of 1947, compounded these concerns and placed democracy, development, trade, and environment in the same broad agenda, in which capitalism pitted itself against communism. Simultaneously, advances in science and technology also led to major international collaborations and conferences, and concerns for the state of the planet were also voiced in these meetings (Warde et al. 2018).

In these debates on natural resource provision, population growth, science and technology, and international security, concerns over degradation, ecosystem collapse, and threats to humanity emerged most strongly. While specific texts influenced public opinion, such as Rachel Carson's (1962) *Silent Spring*, Paul Ehrlich's (1968) *Population Bomb*, and the Club of Rome's *Limits to Growth* report of 1972, there was a general mobilisation of scientific and public support for critical reflection on the excesses of capitalist modernisation. By the time the IUCN report in 1980 had documented the critical state of most of the world's biomes and ecosystems, the need for concerted action was clear. While the 1972 Stockholm Conference on the Human Environment had been more focused on 'first world' issues such as acid rain and urban environments, leading to the creation of UN Habitat in 1976, it was the work of the World Commission on Environment and Development led by Gro Harlem Brundtland (1983–87) that broadened this agenda and also the depth of the required response, as set out in the *Our Common Future* report in 1987.

To this point, the business sector had been largely marginal to this debate. However, the impacts on the business sector from the creation of the US Environmental Protection Agency in 1970, and similar agencies in other countries at this time, with new regulatory capacities and instruments (e.g. Superfund, and Environmental Impact Assessment) were highly influential and led to additional costs for firms. For this reason, by the time that the sustainable development debate arrived on the world stage at the Rio de Janeiro Conference on Environment and Development in 1992, firms and their associations were more organised and had been working on economy and environment issues for several years, as a way of engaging with and reducing increasing regulatory pressures. Rather than wait for international commitments

and regulations to be enforced on business, a counter-strategy was planned.

While governments met in Rio, and NGOs and community organisations conferred in the Global Village outside the official event, the business community prepared its own sustainability strategy in Switzerland under the leadership of the industrialist Stefan Schmidheiny. Consequently, as the nation-states agreed on the Rio Principles, the UN Framework Convention on Climate Change, the Forest Principles, the Convention on Biodiversity, and Agenda 21, the business community established its World Business Council for Sustainable Development (WBCSD).

The WBCSD worked enthusiastically to ensure that sustainable development, and more specifically, firm sustainability (defined by themselves), would be based on voluntary codes and the self-interested responsibility of the firms themselves. This was an apparent attempt to establish scales of networks (Swyngedouw 2004a, b), through which voluntarism and self-regulation would be promoted in order to reduce state regulation and associated costs. Since the UN was keen to establish widespread support for sustainable development, the specific mechanisms for stimulating this model were not defined, in line with the autonomy of nation-states to define their own economic strategies. Consequently, voluntarism became the leitmotif, including certifications and ISO standards, as opposed to clear national and international regulations based on restrictions and prohibitions.

The term *business social and environmental responsibility*, which emerged in the 1990s, gave way to corporate social responsibility, and then corporate responsibility as the emerging paradigm of this business commitment to the global development agenda (Bulkeley 2005; Elkington 2002; Ponte 2019). Each sector tended to manage the challenge in different ways, according to the degree of public, consumer, or regulatory pressures. The earliest example, preceding Rio'92, was the chemicals sector, which initiated its Responsible Care programme as a reaction to criticisms following the Union Carbide Bhopal disaster in 1985. The choice of the name of the programme, put in place while the World Commission on Environment and Development (1983–87) was still building its sustainable development agenda, is highly significant. It juxtaposed competing narratives of sustainability: a private sector focus on responsible production, to reduce risks and externalities, and a public sector focus on sustainable development that highlighted the economy-environment nexus but was much wider in scope, including integrated local and regional development processes and planning. At precisely the same moment in time, salmon aquaculture was beginning its journey from small-scale, localised production to becoming a major player in the global food supply system.

The growth and globalisation of salmon aquaculture

The conversion of aquaculture into the intensive production of salmonids and shrimp, in particular, is a recent innovation in comparison with the long historical experiences of permaculture (Lindbergh 1993). Perversely, it emerged as a response to a crisis in fisheries. Due to overfishing in the latter decades of the twentieth century, the collapse of many fisheries led to innovation in more controlled marine protein production methods. This response can be divided into: small-scale aquaculture for subsistence, poverty alleviation, and with limited local commercialisation, heavily backed by multilateral, and bilateral development banks and institutions; and large-scale commercial aquaculture of high-value products.

Both options were regarded as a positive response to the crisis in capture fisheries and enhanced food security, a consistent theme over the decades, even in more recent reports (FAO 2017). However, the production of salmonids was paradoxically dependent on the industry that it was purportedly trying to replace. Capture fish converted into fishmeal was essential for fish farms, which surprisingly was not an issue at the centre of the discussion (Chamberlain 1993); several more kilogrammes of captured fish were required for each kilo of farmed fish (Tacon et al. 2011). This, along with other practices, like the indiscriminate use of pharmaceuticals such as antibiotics (Bustos 2015), marked the unsustainable birth of modern, intensive aquaculture.

In the early decades of the 1970s and 1980s, salmon aquaculture was a national-scale activity. Geographically, it emerged swiftly in Norway, Canada, Scotland, and Chile due to their coastal geographies that provided secure, protected locations with deep water columns and suitable temperature ranges (Beveridge 1987; Heen et al. 1993). Respective governments were the principal promoters until private companies became profitable (Phyne 2010), and different political regimes and ideological contexts led to different productive configurations. In the Chilean case, a public–private partnership facilitated experimentation at each stage of the process, from eggs to exports, intending to place Chilean salmon in global markets by the early 1980s (Combs et al. 1978; UNCTAD 2006). However, privatisation under the Pinochet dictatorship led to a concentration of capital and multinational involvement, including British Petroleum (BP). Norway created a different model, with economic and environmental controls to encourage competition between firms and ensure a broad coverage along the coastline to encourage local and regional development. In this case, the sector was closed to

foreign investors (Phyne 2010). This proximity between public and private agencies in the promotion of the sector led to limited regulation. The aim was to promote the sector rather than control its impacts in this early phase of development.

Sectoral development went hand in hand with inputs from scientific and technological entities to deal with emergent social and biological problems (Herke 1978; Shepherd et al. 1975). Since both state and firms were invested in the future growth of the sector, the negative externalities generated by it were viewed as obstacles that would be overcome with time, linked to better science and management techniques. The costs of this regulatory antipathy were persistent problems with diseases and high mortality, issues of biosecurity in product commercialisation and, later, labour and community conflicts.

In this stage of the evolution of salmon aquaculture, both governments and private companies tried to secure significant capital flows for the sector (Herke 1978; Pullin 1977). Discourses on the emerging 'Blue Revolution' were common, supported by academic work highlighting rapid industry growth and benefits for economies, society, and the environment (Anderson 1975; Young 1976). However, this revolution did not emerge spontaneously. It resulted from numerous initiatives in different parts of the world to supply marine foodstuffs in a more controlled, predictable way (in contrast with the uncertainties of capture fisheries).

For this same reason, salmon aquaculture was encouraged by the FAO as part of its wider aquaculture promotion, using 'food security' as a term that highlighted the relevance of sustainable development at a global scale. The sector's sustainability considerations were mainly regarded as industrial challenges to be solved internally, whether in terms of environmental issues, social protection, or community impacts. For example, Isaksson (1988), Lindbergh (1993), and Bailey (2014), all provide lists of the environmental impacts generated by salmon aquaculture, including 'escaped' fish, lice, and other diseases, problems with sea lions and seals damaging cages or feeding around the sites, and eutrophication of the benthic layer under the cages, as examples of practices with high environmental impacts. These same concerns had been raised during the sector´s earliest development stage (McNeil 1975). The persistence of these impacts, from the 1970s to the present reveals how difficult it has been to devise adequate scientific and management responses. Nevertheless, there was a fervent belief from the outset that each of these challenges could be solved with better medication, new technologies, and improved genetics (Shepherd et al. 1975; Beveridge 1987).

On the social front, the provision of employment opportunities in remote locations was key to promotion by national and regional governments, with multiplier effects being regarded as positive community externalities (Iizuka et al. 2016). Consequently, these positive externalities also led to weak regulation of the sector. The FAO enthusiastically supported aquaculture more generally, given its potential role in contributing to food security and nutritional well-being, poverty reduction, and economic growth (Subasinghe et al. 2009). At the same time, companies and some researchers called for reduced environmental and administrative regulation of the sector, with both sets of regulations identified as major barriers to private investment (McAnuff 1979).

The new growth trajectory led to the salmon industry establishing itself in multiple locations, and eventually new countries and markets outside Europe. Global salmon production expansion followed the global trend in salmon consumption. This trend required more processed products adapted to retail distribution chains, requiring less space and less refrigeration. Consequently, salmon consumption was influenced by new locational opportunities in retail (Asche et al. 2014). The expectation was that demand would increase mainly in higher-income countries. It is these markets that have experienced the most significant shift from traditional capture fish markets to aquaculture products distributed through supermarket chains (Asche et al. 2014; Straume et al. 2020). This rapid expansion reflects on private companies' efforts to secure higher production levels, reduce investors' risk and demonstrate the power that these organisations are able to exert at various scales (Aarset 1998; Phyne 1997). It also demonstrates the role of supranational organisation impacts on the more general development discourse (FAO and United Nations in general). For instance, the Kyoto Conference on Aquaculture held in 1976 revealed the growing relevance of the sector globally and rising governmental interest beyond the industrialised western economies. The global roll-out of the industry was, however, limited by the environmental conditions required for intensive production.

Salmon production sites depend on specific environmental conditions (Iizuka 2004; Montero 2004), which leads to geographical concentration in six major production areas in high latitudes, with diverse climates and ecosystems. This diversity enables the coexistence of different trends in growth and differentiated productive cycles (Ørnholt-Johansson et al. 2017), creating an inevitable interdependence among countries to ensure a continuous supply, principally for egg imports. Each country's social and economic particularities have also reinforced the global expansion of the sector, and economies of scale, consolidating networks for 'growing on', processing, and packing (Asche et al. 2013; Newton and Little 2018). Additionally, this has generated concentration among firms to guarantee larger contracts of larger volumes (Asche et al. 2013; Irarrázaval and Bustos-Gallardo 2019; Straume et al. 2020). In this process of concentration, smaller firms have been sold or merged, often accelerated by critical events such as disease outbreaks.

Today, salmon farming operations and their interconnections are global in scope. Multiple companies interact to

develop joint farming projects and develop new technologies and innovations. The so-called Blue Revolution has led to an extensive expansion across multiple locations, involving governments, communities, and companies. Most relevant for the purposes of this article are the discourses of regulation and deregulation, alongside private and public initiatives, such as certification, that have facilitated this growth, and lie at the heart of this ongoing tension. This discursive promotion from the 1980s was characterised by narratives of food security, innovation, and technology, and ultimately a 'responsibility'-oriented, voluntaristic approach to sustainable development (see Fig. 1).

1980s: Globalisation and the rise of business responsibility

The slow rise of salmon aquaculture as a response to the global capture fisheries crisis took place in the 1980s. While the dominant environmental critiques were directed at deforestation, wood-based products, and biodiversity, including concerns with the 'hamburger connection' of forest cover loss for livestock production (Myers 1981), aquaculture was viewed by many as a sustainable alternative rather than a problem. This juxtaposition with the capture fisheries crisis generated a positive image of the Blue Revolution. Consequently, it was not considered alongside intensive livestock production as a problematic sector, despite similarities that included high-intensity production, high levels of medication, and associated impacts from feed supply and waste management.

In the flagship report, the *World Conservation Strategy* produced by IUCN, WWF, and UNEP in 1980, some of the potential impacts from aquaculture were raised, although obliquely since the term itself was not used despite the concerns expressed regarding overfishing, including the 15% rise in trade in fish and fish products from 1977 to 1978. In terms of threats to wild species, the report noted the risks from introduced species, such as trout and bass in the USA. The concerns raised in the *World Conservation Strategy* on overfishing were echoed in *Our Common Future*, following the work of the WCED. However, the WCED understood aquaculture to be the sustainable alternative (1980, 138): 'A five- to tenfold increase is projected by the year 2000, given the necessary scientific, financial and organizational support. (…) The expansion of aquaculture should be given high priority in developed and developing countries.'

This positive assessment led to considerable support from the FAO and multilateral development agencies for aquaculture development. However, subsistence aquaculture and commercial, export-oriented aquaculture were considered in the same light. In many ways, the language of the Blue Revolution was that of the Green Revolution. It was presented as a high- or appropriate technology, scientifically-robust 'solution' to food security across the board. Since the capture crisis had placed many fisheries in such a critical condition, it was easily constructed as a positive revolution in comparative terms. This dominant narrative of a sound contribution to global development and poverty reduction was accompanied by low regulation, with the FAO also playing a role as a promoter of voluntary initiatives rather than state regulation.

Given other concerns on the environmental agenda and the Blue Revolution's positive light, salmon aquaculture grew rapidly in Norway and Scotland in particular and was introduced commercially in Chile; average growth was 10% each year from 1980 to 2000 (Tveterås and Bjørndal 2001). However, the *World Conservation Strategy*'s concern over

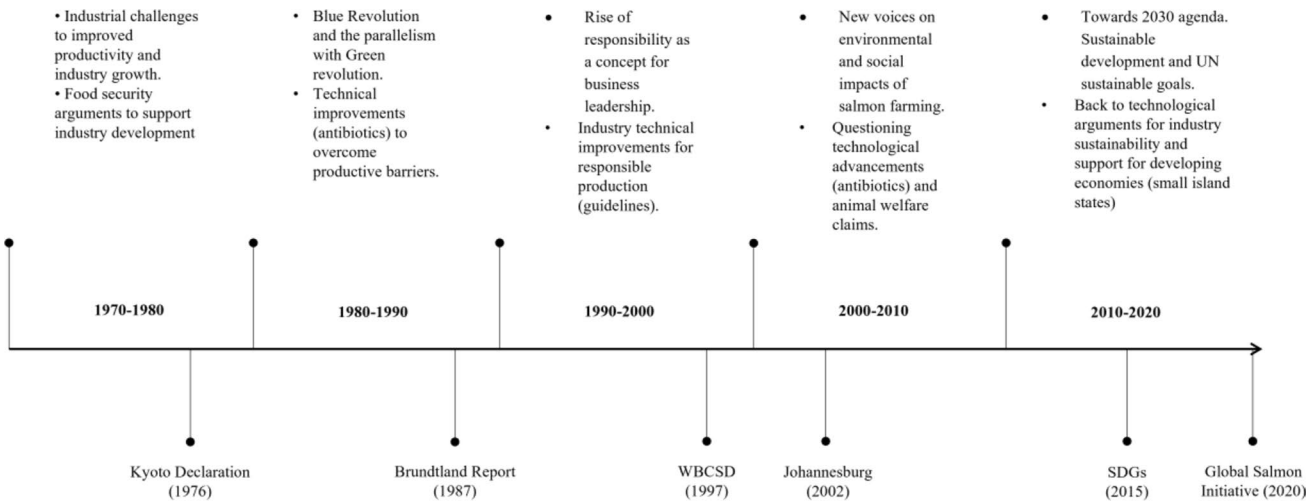

Fig. 1 Timeline of principal discourses and events relating to the aquaculture sector

introduced species, or potential escapees from cages, was not part of this Blue Revolution discourse, neither was the primary concern: the use of wild fish to feed salmon (49% of operating costs in 1995 from 35% in 1982 in Norway, according to Tveterås and Bjørndal 2001). Since food security, protein and employment were the main arguments of the UN promoters of aquaculture, the use of wild fish-based fishmeal to feed caged fish was incongruent.

Another rising issue in the 1980s, alongside the industry's rapid emergence, was the use of antibiotics for disease control. It was evident from the outset that high pen densities led to various fish health issues, from salmon rickettsia to infectious salmon anemia and sea lice. Consequently, biosecurity became the Achilles' heel of the sector as it evolved. By the early 1990s, it was evident that the intensity of the growth in the sector was problematic, similar to the experience of industrial livestock production.

Folke and Kautsky (1992, 21) criticised this intensive production logic versus one based on ecological engineering principles: 'The management of sectorial aquaculture for short-term profits does not recognise the interrelations between resource use, environmental impacts, and the workings of ecosystems.' As with the Green Revolution, salmon aquaculture was highlighted to meet rising food demand. Since most of this demand was in high-income households and on restaurant tables in East Asia, North America, and Western Europe, it was quite distinct from the UN food security agenda. Rather than defend intensive aquaculture systems per se, the sector aimed its attention at the product itself, with its mortality rates and diseases. Although not yet presented as such, responsible salmon aquaculture involved producing fish that met phytosanitary standards. A consumer-oriented narrative of biosafety shifted attention away from the production process to the system's retail end. The ecological engineering principles of salmon aquaculture were fragile at best, demonstrating a high level of confidence in adopting technical solutions to environmental problems, despite the evident natural barriers that limited the sector's expansion (Hilborn 1992; Meffe 1992).

1990s: WBSCD and the sustainability imperative

It was only later, from the 1990s, that regulations began to affect the growth rates in global aquaculture more generally (Abate et al. 2016; Bjørndal and Aarland 1999; Maroni 2000). In salmon aquaculture, the lack of early regulations may have contributed to what Asche et al. (2009) refer to as technical and allocative inefficiencies relating to the overuse of inputs, with high variations between farms. Against this, however, production costs fell to a quarter of their mid-1980s value by 2004, with technical progress, e.g. in feed conversion ratios, revealing that some of these inefficiencies were ironed out over time as the sector developed its Research & Development (R&D) capabilities, particularly among input suppliers, and including links to public funding and universities (Asche et al. 2009; Bergesen and Tveterås 2019). Moreover, during this period, we see the irruption of major supranational organisations, namely FAO and the WBCSD, shaping discourses of sustainable development and introducing guidelines for standard practices within the industry (Bulkeley 2005). The following section unpacks these discourses and practices for understanding the scales of regulation in different territories.

The FAO's *The State of Food and Agriculture* (FAO 1991) publication established significant economic and political concerns for food security and the sustainability of food supply worldwide, repeatedly using this argument to support the aquaculture industry. Similar reports on aquaculture highlighted the environmental and social concerns at this time, focusing on the need to secure food supply for developing regions and the positive economic outputs of such activities. Additionally, these reports also captured the environmental concerns of the time. The Rio de Janeiro Conference of 1992 and the statements on aquaculture and fisheries presented arguments on aquaculture's benefits compared with the environmental impacts of capture fisheries (i.e. overfishing). In the years following the Rio de Janeiro Conference, further UN meetings discussed the role of aquaculture (including salmon farming) in tackling the significant sustainability challenges of fisheries and world food security. The Rio Declaration settled the discussion broadly over marine resources, but this was refined by the FAO Cancun Declaration in 1992 (Caddy and Griffiths 1995), the Kyoto International Conference on the Sustainable Contribution of Fisheries to Food Security in 1995 (FAO 1995), the Holmenkollen guidelines for Sustainable Fish Farming in 1994, and the subsequent document on Sustainable Fish Farming in 1997 (Norwegian Academy of Technological Sciences 1997). The emphasis of these meetings and documents was on self-regulation and codes of conduct for the industry, highlighting that firm responsibility was sufficient, without the heavy hand of state regulation.

Alongside the efforts of the supranational organisations, whether WBCSD or FAO, companies also developed a common narrative in the face of environmental and societal challenges, with the term *business responsibility* emerging as a tool to guide sustainable global production. The use of this concept, which has been retained, reflects the influence of the WBCSD in the sustainable development agenda from the mid-1990s. By the end of the decade, Corporate Social Responsibility (CSR) had become a widely accepted concept framed by the codes of conduct for businesses under the WBCSD guidelines in multiple economic sectors. The message was embraced by corporations and created a new

language of how companies would interpret sustainable development, anchored ultimately in business leadership, with responsible businesses capable of self-regulation for mutual benefits (Najam 1999). These ideas were embraced by the FAO, and responsibility became embedded in the narrative of global salmon aquaculture.

Guidelines and protocols became central to the development and expansion of the sector. Given the support of the UN, countries acquiesced to these voluntary codes for the development of local salmon farms (Hopkins et al. 1996). This undoubtedly represented a hybrid form of environmental governance, in which non-governmental groups defined an imperative discursive agenda that permeated local regulatory frameworks and which translated those intentions into scales of networks, a dynamic seen in developed and developing economies (Bailey and Maresh 2009; Bulkeley 2005; Buschmann et al. 1996). This discursive agenda implies scalar configurations of nature that revolve around access to the natural resource (e.g. ocean or coastal space), how it is managed, and by whom (Swyngedouw 2004b). Discourses of self-regulation and this hybrid form of governance (supranational governance and private organisations) emerged as a glocalised alternative to manage access in the future to resources that might become controversial as the environmental impacts increased. Consequently, codes of conduct and guidelines became an early tool for self-governance initiatives.

For example, the Federation of European Aquaculture Producers (FEAP) developed guidelines and principles for *responsible and sustainable* aquaculture. These guidelines were aligned with the UN and FAO propositions on sustainable fish farming. They placed particular attention on aspects of *responsible production*, which in general terms meant the development of technical practices that would not impact the long-term productivity of the sector, while minimising the environmental impacts through the use of technology (a reductivist sustainability approach). Most of the documents proposed responsibility as a concept that entailed applying techniques that reduced fish mortality alongside genetic technologies for improving aquatic species. Another example emerged in the 1994 proceedings of a seminar on Aquaculture Development in Southeast Asia, where sustainability was defined in terms of conservation and technological improvement, alongside a code of conduct for companies and governments (Csavas 1995).

In the FAO's objectives for aquaculture development (FAO 1997), a code of conduct was proposed in which responsibility implied applying best practices and following particular standards for aquaculture. However, in this document, a definition of sustainable development is also provided. This definition is strictly limited to the conservation and management of the natural resource base. The emphasis on technological and institutional change (self-regulation) is regarded as being the mechanism for the satisfaction of human needs in the present and future generations (FAO 2000). Similarly, the Holmenkollen Guidelines for Industrial Fish Farming (Norwegian Academy of Technological Sciences 1994) highlighted technical and scientific practices for sustainable fish farming, covering significant issues on planning, operations, genetics, research, and education, but also limited to firm operations rather than local or regional sustainable development more widely.

The proposals of best practices for the industry led to a generalised focus on technological capabilities in the sector. This situation derived from a scientific search to maximise production, and to overcome the biological and environmental constraints in the sector. By the end of the decade, researchers and other voices, such as NGOs, were raising concerns for the industry's social and environmental impacts, questioning the efficacy of the responsibility discourse. One of the criticisms was that the sector had focused on 'development and research' rather than 'research and development', resulting in adverse environmental outcomes in many cases, the antithesis of the precautionary principle (Frankic and Hershner 2003). Certainly, technological advancements in the industry have been widely beneficial for particular economic and environmental dimensions of the activity. The industry's impacts have been reduced mainly by the development of pharmaceutical technologies to control diseases, accompanied by environmental management and planning within companies. However, this ability to reduce mortalities and raise profit margins does not equate with a broader sustainable development agenda that has ecological engineering principles and social equity firmly within its scope.

As the aquaculture industry intensified during the decade, major environmental and sustainability critiques were also raised elsewhere, beyond the mainstream business agenda (Barton 1997; Folke and Kautsky 1992). Despite the efforts to position a sustainable development agenda that sought to solve problems of overexploitation of marine resources, the emerging narratives took different positions. If *sustainability* was territorial in focus and physical in terms of local ecologies, local labour, and local development, *responsibility* was global, voluntaristic, self-interested, and somewhat abstract. The former was based on how to regulate impacts in situ, and the latter on unregulated intentions and commitments.

2000s: Continuous growth and further environmental concerns

At the beginning of the decade, the Bangkok Declaration (FAO 2000) provided a shift in orientation for the sustainable challenges of the global aquaculture industry. Following the 1976 Kyoto Conference and Declaration on Aquaculture,

this second major meeting in Bangkok focused much more on developing strategies to make the aquaculture industry more environmentally sustainable on the one hand and effective in tackling poverty and hunger on the other, particularly in developing economies (South East Asia and Africa). In many ways, it echoed many of the tenets of the 1980s Blue Revolution. Despite the relevance of this particular conference, the sustainable development discussion was strictly limited to environmental concerns, without any mention of the multiple dimensions of sustainable development raised in the Rio de Janeiro Conference in 1992, including the Rio Principles and Agenda 21, and its precursor, *Our Common Future*. This intrinsic technocratic focus in the meetings of the FAO and other supranational organisations highlighted the relevance of aquaculture development as a solution for global food problems. The strategy was aimed at maintaining steady growth in the sector, with the hope that this would become more sustainable over time with increased technological development (de Silva 2001; Tveterås 2002).

As a case in point, much of this discourse has permeated the salmon industry in Chile (one of the world's largest salmon exporters). In 2007, the World Bank report on Aquaculture and Sustainability (2007) described Chile as a successful case for the Latin American region, illustrating the economic benefits in the southern Chilean regions, but without discussing the environmental constraints, despite the continuous calls to address those issues (Barton 1997; Barton and Staniford 1998; McDaniels et al. 2005; Naylor et al. 2003; Olson and Criddle 2008; Phyne 1996).

After a decade of planning and proposing measures to develop a more responsible and sustainable industry during the 2000s, most of the efforts focused on limited quantitative measures to analyse progress towards an economically sustainable industry, as opposed to a sector in tune with local, regional, national and global sustainable development objectives. National efforts pointed in this direction, evidencing the strong interconnection between global agendas and local decision-making and the focus on environmental controls. An example is the 2009 Strategy for an Environmentally Sustainable Norwegian Aquaculture Industry (Norwegian Ministry of Fisheries and Coastal Affairs 2009), which set multiple variables and standardised measures to evaluate sustainability. Focusing on environmental impacts, the policy focus was on issues such as genetic interaction and escapees, pollution, diseases, area utilisation, and feed. As in the past, these efforts were focused on developing technologies to secure sustainable productivity levels, with little attention to the systemic environmental-economic-societal relations relevant to achieving a sustainable aquaculture industry.

Despite the identified problems, the solutions proposed by supranational and other organisations were limited, generating an important debate between opposing narratives that highlighted the benefits of a globally mature industry on the other hand, and the environmental and societal impacts of this expansion on the other. To counteract the latter, companies tackled the criticisms using the terminology of social and environmental responsibility in their reports (Marine Harvest 2009). However, the critical voices emerged strongly in this decade and became rapidly globalised also (Barton and Fløysand 2010). Reports and articles provided evidence to support the statements made concerning the industry's potential (environmental, social, and economic) and its impacts (both positive and negative) in the main producing areas. As the industry evolved into a more complex global production network, researchers and activists raised their voices against the intensive nature of aquaculture production, particularly regarding the environmental impacts that fish farming (including salmon) brings to coastal ecosystems and communities (Hume et al. 2005; Naylor et al. 2003; Staniford 2002; Thorstad et al. 2008; Whitmarsh and Wattage 2006). Although these problems had been present in previous decades, as the scale of production increased and aquaculture impacts were more publicised, the expansion and scope of the larger transnational corporations were more intensively questioned, as in-house responsibility was set against a broader narrative of local and global sustainable development. This questioning has done little to affect production levels however. Even following the disastrous environmental impacts of the ISA virus outbreak in the south of Chile in the late 2000s, companies still reported on the necessity to build back quickly and increase production in those same regions (CERMAQ 2010).

Economic concentration in the sector, global interdependence, and opportunities to increase production at other latitudes have led to an increasingly competitive sector. However, this development process is often disconnected from local socio-ecological contexts and processes and operates across various scales of influence between global capital and local sovereignty (Sud 2017). The counter argument of the responsibility narrative highlights the increasing use of technology to maximise production and improve environmental sustainability, limiting negative local impacts. The narrative demonstrates that the rhetoric of technological improvement for maximising production rests in the imaginary of global capital and its networks, hierarchically nested in selected territories (Swyngedouw 2004a, b). For instance, firms have driven innovation in the sector with vertically integrated productive structures (Asche et al. 2016; Guimón et al. 2018; Irarrázaval and Bustos-Gallardo 2019); however, there is little space for negotiating or encouraging innovations in situ, which exposes a weak flank for enabling local sustainability.

While the sector expanded globally, technological advances were insufficient to reduce concerns over the intensity of modern salmon farming. The virus ISA outbreak in Chile represented a pivotal moment for expanding the

industry, changing some of the country's regulatory framework (Bustos 2017), as it had done in Scotland in the late 1990s. However, companies and supranational organisations maintained a discourse of innovation for overcoming those difficulties, accentuating the importance of technological innovation for local production areas. This decade of expansion and crisis exposed the weaknesses of the production model; however, these had been evident since the 1970s. The responsibility narrative had also been exposed since the sector had been unable to control its vulnerability to disease outbreaks (whether rickettsia, sea lice, or the ISA virus) and their effects on salmon mortality and on other fish species in local areas. When these risks became socialised locally through employment loss in the sector, and local environmental impacts beyond the cages and the processing plants, the differences between a technologically-framed responsibility agenda and a more holistic local and regional sustainable development agenda were also exposed.

2010s: Competing sustainabilities in Agenda 2030

Much of the discussion in the 2000s was maintained during the 2010s. The concerns over the environmental impacts of aquaculture, and the salmon industry in particular, grew as the Chilean ISA virus crisis impacted the regional economy of the south of the country in 2008 (Asche et al. 2009; Asche et al. 2009; Bustos 2017, 2015; Quiñones et al. 2019). Despite these impacts, however, the discussion at the global level remained relatively stagnant. The idea that technological innovations are essential for confronting global sustainability challenges is a discourse that remained, and was linked to governance practices at various geographic scales (Barton and Fløysand 2010). Similarly, sustainability and responsibility have been used interchangeably by different organisations, particularly when referring to the environmental impacts of the industry (Boyd et al. 2020). The narratives of sustainability and technological innovation remain linked to food security in the case of the capture crisis. However, these technological 'solutions' to maintain growth in production may improve certain conditions, e.g. feed conversion ratios or reduced antibiotic use, but the principal concerns over the negative externalities of the sector and the local sustainable development of the activity remain (Fløysand et al. 2016). This includes concerns with parasite and pathogen control and their effects on process sustainability, as well as new challenges such as climate change (Global Salmon Initiative 2020; Naylor et al. 2021). Twenty years earlier, the concerns had focused on the risks from wild fish inputs into aquaculture and the gap between ecologically-sound technologies 'on the shelf and those actually implemented in the field' (Naylor et al. 2000).

For example, FAO has maintained the concept of *responsible aquaculture* to define practices and codes of conduct for sustainability in the sector. This language is mainly used for technical reports and policy guidelines advocating good governance, which is described as essential to 'fully realize its potential for growth' (FAO 2017, 1). Likewise, the industry has generated an overwhelming focus on economic indicators to measure a sectorally-defined construction of sustainability (Milewski and Smith 2019), and to policies that promote sectoral growth over developing alternatives for more sustainable production (Bailey and Eggereide 2020). It is undeniable that better standards and technological advancements have led to more sustainable practices in the sector, in terms of eco-efficiencies and reduced impact per kilo of product. However, it is also relevant to bear in mind that strict regulatory measures have been applied following critical environmental impacts, such as disease outbreaks or negative media campaigns that have affected sales (Asche et al. 2009); the recent traffic-light system for monitoring and regulation of sea lice prevalence in Norwegian production is a case in point. In this regard, the responsibility narrative is a defensive one, designed by the sector and aligned with the messages of the FAO, to reduce negative publicity and limit state regulation. Limiting the scope of firm actions to their own on-site operations, rather than their wider contributions (including negative externalities) to local and regional sustainable development, has been an exercise in damage limitation that has been established with a careful delimitation of responsibilities and liabilities.

In recent years, the UN´s Agenda 2030 has provided a further opportunity to link salmon aquaculture to broader development objectives. Since the agenda is voluntary and follows the 'green economy' orientation outlined in the Rio + 20 Summit on Sustainable Development of 2012, the sector has been able to promote its credentials in particular goals, particularly those concerned with marine environments (SGD 14) and food security (SDG 2). The links to the FAO are once again prevalent. In *The State of World Fisheries and Aquaculture* (FAO 2020, 2016), the FAO set out the necessary activities to achieve the targets of Agenda 2030, which includes themes such as marine assessment, sustainable management, and marine area conservation, but also nutrition, food security, and artisanal fisheries, e.g. as part of the UN Decade of Action on Nutrition (2016–25) and The International Year of Artisanal Fisheries and Aquaculture in 2022.

Since the SDGs are wide-ranging, with 169 indicators, they are inclusive in ambition. For the same reason, productive sectors are able to select which goals they would prefer to highlight (Hai et al. 2018). While this approach is aligned with the 'green economy' and a focus on technology and innovation in creating more sustainable businesses for a more circular economy (Sachs 2015; Simpson et al. 2011),

it fails to engage with the structural issues of salmon farming in relation to feed, disease control and pharmaceutical use, marine environment impacts, labour, and local sustainable development. While this situation is not particular to the salmon industry and the SDGs (Fleming et al. 2017), it reveals how the voluntaristic, responsibility agenda initiated by the WBCSD has gained traction within the sustainable development agenda over the past 30 years, in this case in alliance with the FAO.

Most global salmon firms now have explicit references to the 2030 Agenda and actions to meet those sustainability goals. References to SDG 2 (food security) stand out as the most relevant. Alongside highlighting the importance of fish as a protein source, company reports focus on climate change (SDG 13) and the reduction of CO_2 and other greenhouse emissions (CERMAQ 2019; MOWI 2019). The strategies that are adopted point towards technological development in the industry, with 'efficiency' providing a common theme in international documents and industry reports for targeting productivity challenges due to increasing global consumption (Kobayashi et al. 2015). However, selecting some goals over others can indicate a predilection for those that can secure industry expansion rather than concrete strategies for shifting to more sustainable production modes. The Norwegian firm Lerøy indicates that it is committed to an integral approach to production, without necessarily committing to actions in line with Agenda 2030 (Lerøy Seafood Group 2019). However, it is the only one of the three main producers to have joined the Global Reporting Initiative, designed to encourage full disclosure on company activities.

Undoubtedly, the impact of the 2030 SDGs is relevant to the salmon aquaculture industry. The alignment of the largest companies to these goals is unprecedented. However, it is necessary to bear in mind the post-Rio process in the 1990s as context. Past discourses on sustainability in the industry were easily diluted in responsibility arguments that encouraged increased production and expansion of the sector, which in turn led to further disease problems. The sector has established that its responsibility lies in more efficient production, which includes biosecurity and lower mortalities linked to technological innovation. However, any discussion of how the sector contributes to marine conservation and protection, and local and regional socio-economic development (beyond employment per se) is presented as beyond compliance, and beyond voluntary commitments, and therefore beyond the remit of the firm, except for some exceptions that confront these concerns through business-friendly, firm-funded NGOs (O'Shea et al. 2019). It is precisely this compartmentalisation of obligations and responsibilities that has led to a vibrant opposition to salmon aquaculture, in local community conflicts, and in global media campaigns promoted by NGOs. In this regard, responsibility for integrated development transcends firm operations and requires cooperation and collaboration at different scales.

Local regulatory frameworks are essential to tackle these wider local and regional sustainable development challenges, operating beyond the scope of the 'scales of networks' of corporate responsibility. Despite the influence of those scales of networks, states are still the main drivers of local sustainable development with the obligation to ensure minimum guarantees, whether labour conditions and wages, local environmental quality, or infrastructure development (Bailey 2007; Swyngedouw 2000). This regulatory framework for local and regional sustainable development—'scales of regulation'—is in constant tension with the demands of scales of networks, with their emphasis on voluntary, operational responsibilities for more efficient production. Ultimately, what is responsible for a firm, its market value and its shareholders may not equate with what is sustainable for local socio-ecological systems and livelihoods. It is in this tension that these diverging positions in responsibility, sustainability, and sustainable development became incongruent and, in terms of the ensuing conflicts between positions and social constructions, unsustainable.

The end of sustainable salmon aquaculture?

The history of salmon aquaculture, from its incipient, experimental introduction in the 1970s and its rapid globalisation from the 1980s onwards, is synchronous with the history of modern sustainable development, following the Stockholm Conference in 1972, the WCED *Our Common Future* report of 1987, and the 1992 Rio Conference on Environment and Development. Almost 50 years after Stockholm, how sustainable is salmon aquaculture? The answer: it depends. It depends on the narrative or social construction of the concept of sustainability that you find most acceptable. Rather than establish whether a particular narrative is better than another in describing the nature of salmon aquaculture, the point of this article is to track the emergence of the dominant narrative of the sector in the face of increasing regulatory, consumer, and local community pressures. It focuses on the continuous tension over the regulation and deregulation of activities, understood as scales of regulation competing with scales of networks (Swyngedouw 2004a, b): the former demands best practice, and the latter encourages best practice. Regulation follows along the lines of the intergovernmental agenda for *sustainability*, promoting participation, equitable outcomes and welfare alongside the protection and conservation of the resource base, for current and future generations. However, the approach of the sector has been to promote voluntarism, 'trickle down' benefits from investment, employment and multiplier effects, and self-regulation understood as *responsibility*. This approach

highlights short-term viability and accumulation, aligned with technological optimism.

There are cogent arguments to support each of these positions, and they co-exist in practice. However, the sustainable development that is produced by each approach is intrinsically different, to the extent that corporate responsibility should not be confused with more integrated sustainable development. Where corporate responsibility enables a sector to select two or three of the SDGs as its focus, the wider implications of the indivisibility of the 17 SDGs and the 169 indicators have to be managed and regulated through alliances, with the state most often acting as the 'guarantor of last resort'. Certification and similar schemes also show similar paths, as the definition of sustainable development within aquaculture is instrumentalised to reinforce governance and environmental indicators and justify definitions of categories through a narrow understanding of sustainable development (Osmundsen et al. 2020). Therefore, certification does not add to significant reflections on sustainable development practises as a systemic proposition, but rather they serve to evaluate risks in the face of publicly-debated concerns. In Norwegian salmon aquaculture, certification serves mainly as an instrument for public market image and potential reputational gains (Olsen et al. 2021). Furthermore, in Chilean salmon aquaculture, certification supports companies in their pursuit of self-governance and legitimacy against state regulation and other global actors in a multiscalar process involving territorialised local production, global stakeholders, and other interest groups (Cid Aguayo and Barriga 2016).

The salmon aquaculture sector has been subject to criticism since the 1970s, initially from scientists concerned with the scaling-up of production, and then from regulatory authorities, NGOs, other economic sectors (such as tourism and artisanal fishers), labor organisations, and affected local communities. The principal themes persist: intensive production that involves captured fish in feed, disease management problems and related high mortality rates, the impacts of escaped fish, and benthic layer impacts from waste. While these themes focused on environmental impacts and environmental management evolved as a response in the 1980s, other sustainable development issues began to emerge in the 1990s, such as how the sector benefited workers and local communities, particularly in Chile where the sector had grown most rapidly and was without the public welfare safeguards present in regional development in Norway, Scotland, and Canada. This diversity of related issues raised the question of what should be understood by sustainability and sustainable development: of the product, the firm, the locality, or the whole production network? By delimiting the narrative to firm responsibility in situ, complying with regulations for operations, and supporting communities through employment and voluntaristic outreach gestures, the nature of salmon aquaculture sustainability was defined, and then promoted by the FAO.

This approach to curbing regulations and promoting voluntarism had been put in place by the chemical industry's Responsible Care programme in the mid-1980s and this orientation became the central feature of the WBCSD approach from the mid-1990s: responsible business based on voluntary codes. In this sense, the experience of the promotion of sectoral responsibility is not specific to salmon aquaculture and fits within the broader concepts of ecological modernisation and the 'triple bottom line' that emerged strongly in the 1990s (Christoff 1996; Elkington 2002). The narrative of responsibility places emphasis on the ethics of best practice, of compliance, accountability, and efficiency. In the same way, the limits of this best practice are also clearly defined. The firm is responsible for its operations, but any extended activities beyond the operating space are voluntary and a sign of goodwill; they are not its responsibility per se. Improving the efficiency of productive systems to reduce feed waste, to substitute captured fish with plant-based feed, improving cages to avoid escapees, and to apply labour regulations, are all within the remit of a firm's operations and an intrinsic part of their internal strategies (Vormedal 2017).

Rather than a singular notion of what sustainability and sustainable development have come to represent from Stockholm and *Our Common Future*, to Agenda 2030 and the SDGs, this article points to the coexistence of narratives that highlight different elements and dimensions, and different approaches, as political ecologists have observed in other fields since its emergence as an analytical framework, e.g. in land use (Blaikie and Brookfield 1987) and forestry (Bryant 1997). To conflate them is to oversimplify the issue and the possible responses.

Given that this sector emerged alongside the sustainable development debates of the 1980s, it had to incorporate these concerns into its position. It did so by delimiting the concept, defining its own responsibility (efficient, technology-driven production) and its contribution to global development (biosecure food security), and ensuring the effective promotion of voluntary codes of conduct alongside the FAO. This was achieved through the mobilisation of scales of networks, with a view to curbing regulation and appeasing consumer concerns. However, it should be recognised that scales of networks that pursue deregulation and voluntarism act against scales of regulation that seek to increase standards and obligations for local and regional sustainable development. This approach – of scales of regulation – denotes a different sustainable development narrative, in which more integrated planning is required that transcends short-term horizons, the maximisation of resource yields with increasingly intensive inputs, and the ongoing risks of

negative externalities. Without a more critical reading of what is construed and communicated as responsible aquaculture, sustainable aquaculture and local, sustainable development, it is likely that the completion of the Agenda 2030 cycle will be marked by more rather than less controversy surrounding intensive salmon farming.

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