Climate Change, Cod Production and Consumption

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1. Introduction

The repercussions of climate change will have drastic effects on the four pillars of food security which are defined by the Food and Agricultural Organization as availability, accessibility, utilization and food systems stability (FAO, 2016). Even though our globalized economy is highly sophisticated, it provides consumers with availability and accessibility to food but it does not guarantee food security for all. It is expected that food sovereignty which empowers the local community to utilise their local resources will better ensure food security.

The food system of a country is not dependent only on local or internal changes, they are also affected by external forces (Hossain et al., 2018). Such forces include climate change. Coastal communities will be affected by climate change and their subsistence dependence on traditional foods such as fishing will be affected. In the Lofoten islands of Norway, fishing especially the Arctic cod has played an important role in ensuring food security for the local communities. At the recently held SKREI Convention Conference in October 2019, the convention sets out to re-imagine the historic trade routes of stockfish from the North of Norway to the Baltic Sea as far as Germany, Italy and Portugal. The project is supported by the European Year of Cultural Heritage 2018, Creative Europe cooperation projects. Partners in the project are CERS Italia, the Ílhavo Maritime Museum, Portugal and Museum Nord, Norway as lead partner of this two-year project. In the project, a body of knowledge is created and shared through a new digital archive and through an engagement programme for local communities. It explores the cultural heritage of stockfish from the Iron Age to today. Additionally, an international artists' residency programme investigates stockfish as a natural resource and a valuable food stuff for the future within its social, economic, political and historical context. More on this at Museum Nord projects (www.skrei.net).

In this short review, we present the discussion around the Arctic cod following the multi-disciplinary inputs at the 'Skrei Convention Conference' on the theme of cod. The next section is on the production and consumption of cod. Section 3 highlights the impacts of climate change on cod, section 4

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discusses governance issues and section 5 looks at the future possibilities.

2. Production and consumption

Arctic cod can be trophically linked to sea-ice algae and pelagic primary producers. According to Steiner et al. (2019), they act as key vectors for energy transfers from plankton to higher trophic levels (e.g. ringed seals, beluga). The availability of Arctic cod will be affected by predators such as seabirds and mammal. A better understanding of the cod farming system that will encourage a more sustainable means of production will be very relevant in the nearest future. A good balance to ensure sustainability and avoid loss of biodiversity in the ocean need to be developed. For instance, the Nordic Cod Farming Network as a cooperative project with representatives from Faeroes, Denmark, Sweden, Iceland and Norway. The main goal of the network is to create a forum for research and development that will develop the cod farming business in Nordic countries.

Cod farming has a rich history in supporting the economic pillar of Norway. During the fourteenth century, the Hanseatic league[1] monopolised the distribution of stockfish. The Norwegian-Arctic cod has been the cornerstone of the Norwegian fishing industry. Unlike the coastal cod, the Norwegian-Arctic cod travels far out to sea to the north for much of its life – but when it returns, it returns in numbers. Stockfish is cod that are gutted and immediately dried whole or split along the back. Fish drying techniques in northern Norway date back to the Iron Age (ca. 500 BC). Commercial fishery using traditional methods started approximately 1150-1200 AD. Lofoten and Vesterålen islands provided cured fish to urban and rural populations. After three months outside, cod matures indoors in a dry and airy environment for an additional 4 -12 months[2]. A perfect drying takes a delicate balance of wind, rain, sun and temperatures just above freezing. Traditionally, the drying or hanging period takes place form early March to the middle of April in southern parts of Norway and March until May in the northern part of Norway.

The lean, white meat of the Arctic cod fish has an excellent taste, the cod also contains a number of important nutrients. There is still much to be

[1] The Hanseatic League (also known as Hansa, Hanse, 1356-1862 CE) was a federation of north German towns and cities formed in the 12th century CE to facilitate trade and protect mutual interests. The league was centered in the German town of Lübeck and included other German principalities which established trade centers ranging from Kievan Rus through the Netherlands, Scandinavia, and Britain (https://www.ancient.eu/Hanseatic_League/)

[2] https://seafoodfromnorway.us/norwegian-seafood/products/norwegian-cod/

learned about exact nutritional requirements for different age groups of cod. Along with omega-3 fatty acids, vitamins, and proteins, the cod is rich in iodine, an important nutrient. These nutrients are very important for the metabolism and are essential for brain growth and development in children. The roe and the liver from the skrei are used to make "mølje", which is regarded as a delicacy. The mølje[3] is a Norwegian traditional food regarded as a 'proper vitamin bomb', with enough D-vitamins to keep Norwegians healthy through the dark, cold winter. This is probably why the cod has a special place in Norwegian food-culture and history. At the Skrei conference, a variety of food with stockfish with other ingredients were explored an served to participants.

3. Climate change and the Arctic cod

Arctic cod (*Boreogadus saida*) is the dominant pelagic fish in Arctic seas and a staple food of many arctic predators including several seabird species (LeBlanc et al., 2019). Climate change can lead to a reduction in the production of Arctic cod. The decrease will be caused by increased temperature, acidification and northward migration. Other important drivers that result from climate change are the presence of predators, e.g. seabirds and mammal's migration.

However, with climate change, it was estimated that there will be a 17 % decrease in Arctic cod population at the end of this century in a high emission scenario without considering the devastating effects of ocean acidification Steiner et al. (2019).

Generally, the drying technique in cod processing depends greatly on the cold weather, warmer temperature will favour microbial growth leading to devastating consequences on the quality and safety of stockfish.

Microbial spoilage can cause economic losses in cod production. Infectious pancreatic necrosis (IPN) virus and nodavirus causing viral neural necrosis (VNN) are ranked as highly significant (Santi et al., 2005). These viruses are detected in many marine fish species, and are especially lethal to their larval and juvenile stages. IPN-virus caused heavy losses among farmed cod juveniles, both in Denmark and Faroe Islands, several years ago, and there are recent reports of serious nodavirus outbreaks in juvenile cod in USA & Canada (Samuelsen et al., 2006). Nodavirus outbreaks have also been reported from Scotland. In Norway one of the most significant pathogens of cod larvae and juveniles is the bacterium

[3] http://fishonfriday.org.uk/traditional-norwegian-skrei-molje/

Listonella (Vibrio) *anguillarum* (Samuelsen et al., 2006).

The export market of stockfish is also a function of the storage and distribution facilities to ensure the quality of the fish is maintained over long distances. For instance, Nigeria is the biggest market for Norwegian stockfish in volume, and more or less the only market for dried heads.

In 2018, exports reached 6,100 metric tons of dried heads, at a value of NOK 143 million ($16.3m). The reduction of the tax from 20 % to 10 % is a big boost for the Norwegian stockfish producers, a good example of soft diplomacy from the Norwegian Seafood Council. According to Trond Kostveit, the Norwegian Seafood Council (NSC) representative in central and western Africa remarked on the reduction of tax as something that was worked on and dialogued with the Nigerian authorities for a long time.

4. Governance: Global, EU and Norway

There is a link between management, governance and ecosystem health in the fishing sector that requires an ecosystem-based approach (FAO, 2003). The impacts of climate change in the fishing sector can be minimised by ensuring less greenhouse gas emission in the value chain. A key to mitigation is the requirement of Parties to submit nationally determined contributions (NDCs) that set out planned domestic mitigation measures (UNFCC, 2019). Under the Paris Agreement, adopted in December 2015, the INDC will become the first Nationally Determined Contribution (NDC) when a country ratifies the agreement unless it decides to submit a new NDC at the same time. Once the Paris Agreement is ratified, the NDC will become the first greenhouse gas targets under the UNFCCC that applied equally to both developed and developing countries (WRI, 2014)

The European Union has three fisheries agreements with Norway, namely the bilateral, the trilateral and the neighbouring agreements. The bilateral arrangement covers the North Sea and the Atlantic, the trilateral agreement covers Skagerrak and Kattegat (Denmark, Sweden and Norway) and the neighbourhood arrangement covers the Swedish fishery in Norwegian waters of the North Sea. The agreements are implemented in the form of annual fisheries arrangements. The bilateral and the trilateral arrangements allow for the setting of total allowable catch TACs for joint stocks, transfers of fishing possibilities, joint technical measures and issues related to control and enforcement.

The European Union (EU) and Norway have agreed on quotas for the jointly-managed fish stocks in the North Sea (cod, haddock, plaice, whiting, herring,

and saithe) and Skagerrak (cod, haddock, whiting, plaice, shrimp, herring and sprat), as well as exchange of reciprocal fishing possibilities.

In the North Sea, for two of the shared stocks, namely saithe and plaice, the jointly agreed total allowable catch (TAC) increased compared to last year. For four other shared stocks (i.e. haddock, whiting, cod, herring), a reduction was necessary to protect the stocks.

The EU and Norway also reached an agreement on quota exchanges. In particular, the EU received over 21,500 tonnes of Arctic cod.

These agreed arrangements will ensure continuation of fishing operations for both parties in each other's waters from 1 January 2019[4].

The International Panel of Experts on Sustainable Food Systems (IPES-Food) was established in 2015 to shape debates on food system reform through policy-oriented research and direct engagement with policy processes around the world. Governance reforms are the first building block of a Common Food Policy. The report also puts forward proposals for reforming and realigning policies under five key objectives:

1. Ensuring access to land, water and healthy soils

2. Rebuilding climate-resilient, healthy agro-ecosystems

3. Promoting sufficient, healthy and sustainable diets for all

4. Building fairer, shorter and cleaner supply chains

5. Putting trade in the service of sustainable development

Reforming our food systems in line with the above objectives will provide an opportunity for the EU and its Member States to address the concerns of many citizens, and is the key to meeting the UN Sustainable Development Goals (SDGs), the Paris Agreement on climate change, and many other commitments to protect people and the planet.

5. Future possibilities

As part of finding new solutions to improve food security at local levels in the Arctic, there is a need to ensure that local terrestrial or aquatic resources are developed in ensuring sovereignty. This can be achieved by creating innovative novel foods that are nutritious from research and technology from a multi-disciplinary lens as promoted by the SKREI Convention Conference.

Digitalisation as a tool can be used to enhance consumer experience, marketing and future export-oriented

[4]https://ec.europa.eu/fisheries/cfp/international/agreements/norway

opportunities for cod. Part of the discussion of SKREI Convention was dedicated to exploring the future possibilities of Arctic cod. The session held on October 14th Monday afternoon was centred around the provocation of thinking if the cod can feed the world. Guri Hjallen Eriksen, the first contributor, looked at the future development of Cod fisheries and Law, with attention paid to the connection with the Sustainable Development Goals number 14 and 16 (SDGs), of the 2030 Agenda for Sustainable Development. The discussion continued with the contribution of Rune Stokvold, from Torrfisk fra Lofoten, who positively showed the efforts made by local Stockfish producers to value the quality of the product as well as to adapt it to the current market's needs. Andreas Santi Flach described the biochemical processes that happen within the Arctic cod, which define its distinctive taste and how this can be reproduced and kept in the future. Finally, Kunt Korsbrekke from the Institute of Marine Research, described how the fish stocks are currently kept sustainable, whether sustainable is intended as the "limitation of damage" for future generations. In his words, it is necessary to think about other measures aimed to improve the conditions of the fish stock and the number of catches.

During the conversation, the Arctic cod emerged as a unique product which can be relevant for the future, but attention should be paid to regulations, laws and management of the fish catches and stocks. These ideas weaved into the October 15th Tuesday morning session dedicated to the governance and geographies of Food. Thanks to the presentation of Dr. Bamidele Raheem (first-author), the curators Torill Østby Haaland and Dani Burrows, emerged the need to think about alternatives to the Arctic cod production and consumption. This session was chaired by Camilla Crosta (co-author). The contemporary art field, as shown by the projects developed both by Lofoten International Art Festival (Norway) and the Delfina Foundation (UK), has opened a strand of enquiry into the food production system. In the art projects presented at the conference, such as the Kelp Congress (LIAF 2019) and Climavore Skye (Scotland) by Cooking Sections, lies the opportunity to create a vision for alternative forms of food production, questioning the relationship between fishing communities, the environment and the fish stocks. In these terms, the Arctic cod and its future are topics that can be addressed by different sectors and it is in this multidisciplinary exchange and collaboration that there is potential for innovation and improvement of the fishing, the processing and the eating of Arctic cod.

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