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# How to achieve the sustainability of the seafood sector in the European Atlantic Area?

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**Abstract.** Climate change, globalization or marine debris are on the spot of concerns for the most society. Particularly, fisheries are impacted by these and other issues. On the framework of the European Atlantic area, NEPTUNUS project (EAPA\_576\_2018) tries to provide opportunities for the transition to the circular economy of the seafood and aquaculture sectors by means of a consistent methodology for products eco-labelling and defining eco-innovation strategies. Furthermore, this project will provide key actions for resource efficiency based on life cycle thinking and the nexus water-energy-food, incorporating producers, policy makers and consumers in the decision-making process. This review addresses, therefore, the threats and challenges of the current Atlantic fisheries, the methodologies and actions to be face them and the expected results of the NEPTUNUS project

**Keywords:** sustainability, life cycle assessment, eco-label, seafood, climate change.

## 1. Introduction

Atlantic countries share commercial alliances and common interests in the production and consumption of food and product safety, transparency and the protection of consumer health must be guaranteed [1]. Particularly, in the case of seafood, the Atlantic area has abundant natural resources, which places it among the main exporters of seafood resources serving the European market. Indeed, ‘Blue economy’, in which fisheries and related activities are included, was directly employing over 4 million people in the European Union (EU) in 2017, generating €180 billion of gross value added [2]. The enormous contribution of this sector to the EU and global economy implies a high responsibility that needs to be articulated through tangible midland long-term actions. It jointly addresses a global concern and interest in terms of policies and strategies aimed at climate change mitigation, energy or food security. Recently, global institutions, such as the United Nations, highlighted the responsible consumption and production as one of the seventeen Sustainable Development Goal (SDG) [3]. Furthermore, the FAO is largely concerned about the state of the world seafood sector [4] or the specific impacts of climate change in Atlantic fisheries [5]. At European scale, the EU is working on the implementation of the Circular Economy [6] by means of specific regulation in fisheries [7]) or facilitating better information on the environmental performance of products and organisations [8], among others.



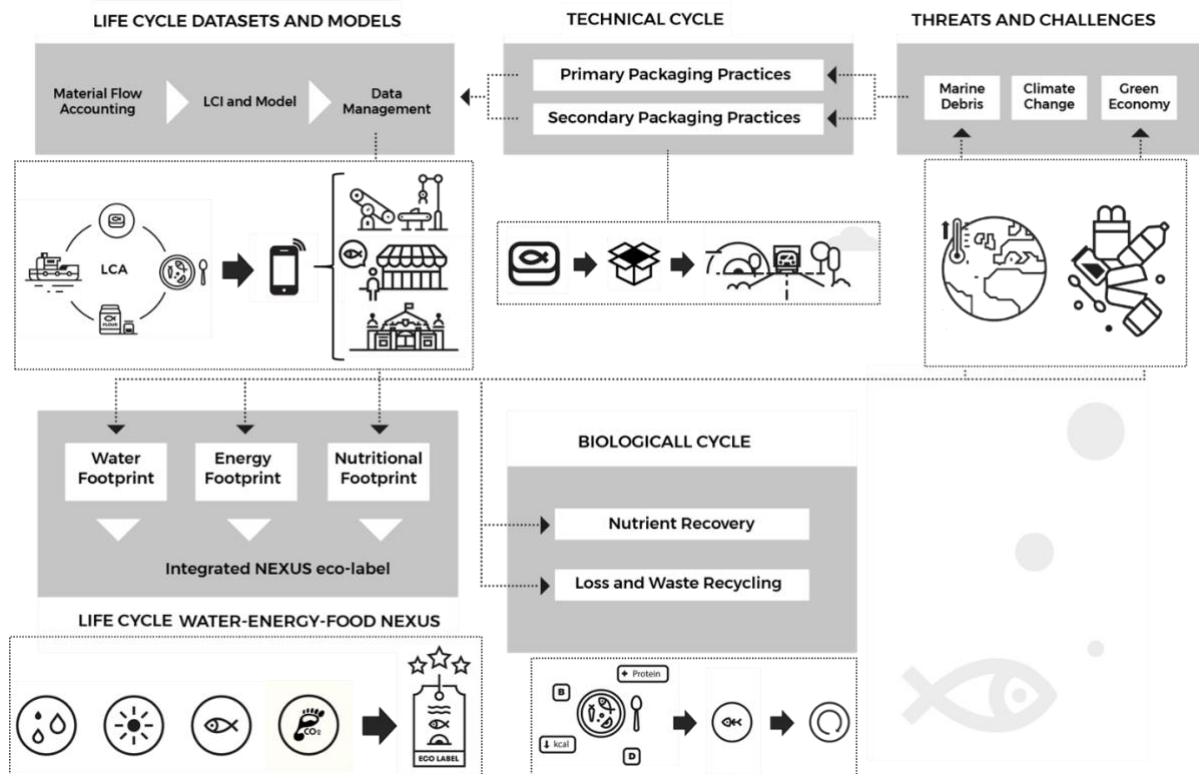
Although the vast majority of national and regional studies in these domains generate significant technical data, yet they fail to define weaknesses and strengths of transnational synergies (nexus or model) in infrastructure, innovation and skills that promote and maximise regional development and relevance to commensurate cross-jurisdiction needs from policy maker, industry and consumer approaches.

To address the challenges, sustainable and multilateral research cooperation is needed to define integrated methodologies and strategies. As part of the European Union's Cohesion Policy, some funding programmes, such as INTERREG Atlantic Area [9], promotes transnational cooperation among almost forty European Atlantic regions leading to support the development of renewable sources of energy, especially those deriving from the sea and fostering the transition to a resource-efficient society. Under the umbrella of this programme, NEPTUNUS project (EAPA\_576/2018) [10] focuses on the idea of providing opportunities for a transition to the circular economy of the seafood sector in the Atlantic Area.

This review addresses the scope and the methodological framework of NEPTUNUS to face the current status of the seafood and aquaculture sectors in the European Atlantic region: environmental threats, e.g. marine litter [11] or climate change [12]; social aspects, e.g. people's awareness about public services and the planet [13] or worker's rights protection [14]; and economic perspectives, e.g. globalization [15] or quality of products [16].

## **2. Research methodology**

Clustering and knowledge transferring require specific and coordinated actions in order to obtain applicable and useful outputs in terms of sustainability. To make this, "nexus thinking" is applied to fisheries and activities related to transitioning from a linear economy to a circular one. The methodological framework implies, therefore, (i) the integration of environmental, nutritional and economic variables that meet regional needs through transnational strategies, and (ii) synergies in knowledge and experiences at the local level to help overcome challenges at a global level. Figure 1 illustrates the five interconnected research lines to be developed in NEPTUNUS:



**Figure 1.** Methodological framework of NEPTUNUS project.

### 2.1. Life cycle inventory

Life cycle assessment (LCA) [17, 18] will be applied to the seafood sector to quantify main inputs and outputs of the product system in a life cycle inventory (LCI) according to European Life Cycle Database [8]. The model has to be as flexible as possible in order to create a user-friendly tool for assisting seafood produced, municipalities, communities and regions of the Atlantic area to easily obtaining LCA results on seafood production and consumption. Moreover, the tool has to integrate the imports/exports of seafood from/to other areas that will have an important environmental impact. The analysis of this variable can be conducted by material flow accounting (MFA) [19]. MFA will allow to address interactions between socioeconomics and biophysical systems. Thus, materials and energy inputs can be accounted in order to determine sustainability from an urban metabolic approach, as well as waste flows can be assessed, and therefore, sustainability by means of closing materials flows. Regarding the species, both marine captures –demersal fish, pelagic fish and molluscs- and aquaculture production – diadromous and mollusks- of the Atlantic region are considered.

### 2.2. Lifecycle Water-Energy-Food Nexus

Demanding transformations and the policy tools required, including behavioural change interventions that go beyond mere education to influence how people make decisions about buying and consuming marine products are also part of the research. A new approach to assess seafood lifecycle is proposed based on the nexus of water-energy-food systems. “Nexus” means that the action in one of the systems has impacts on the others and, therefore, any strategy that focuses on one system without considering its connections with other systems may lead to acute unpremeditated consequences. This concept allows assessing the life cycle of seafood products under a holistic manner considering the whole supply chain. Currently, there is no universally recognised methodology for nexus analysis. However, LCA is

particularly important for understanding the interconnections in the nexus, as it enables the consideration of entire supply chains.

Four footprints [20] and an eco-label will be calculated and designed. Firstly, the impact of the water use, based on the Footprint Category Rules Guidance [21], covering the blue water, i.e. the amount of surface and groundwater required to produce seafood products, green water, i.e. the amount of rainwater, and grey water, i.e. the amount of fresh water required diluting the wastewater generated in manufacturing, in order to maintain water quality determined by European standards. Secondly, the energy is the largest overhead cost associated with seafood processing. In this sense, FAO has recently recognised the need to reduce energy consumption and efficiency in food processes with a large demand of fossil fuels for use, transportation, storage and refrigeration [22]. The challenge is to identify bottlenecks to target actions for energy improvements, which can result in huge cost savings. Thirdly, the Carbon Footprint can be used to target hotspots in seafood supply chain establishing a link among fossil fuel consumption, carbon sequestration and greenhouse gas releases. Fourthly, the nutritional aspects. This action will conduct a global nutritional assessment, estimating the Protein Footprint based on the protein content of each ingredient involved in the seafood supply chain. Finally, the definition of an integrated nexus eco-label is considered, leading to facilitate the decision-making process to stakeholders and to allow the development of strategies based on the circular economy concept.

### *2.3. Eco-design and packaging*

Better product design is key to facilitate recycling and to increase products' lifetime, while saving resources. Source reduction, recycling and reuse are the ways to implement practically the eco-design of packaging without sacrificing product safety [23, 24]. In this sense, the importance of applying a holistic approach to packaging eco-design clearly has been emerged. Recyclability is highly desirable, but other packaging features should also be considered. One of the most important of these is ensuring that products reach consumers undamaged and in good condition, and hence that the raw materials and energy required for their production are not wasted. Moreover, the packaging of a product is often the best way to visually engage and attract potential consumers. Consequently, by infusing eco-friendly methods into the design, retailers are able to creatively distinguish themselves apart from other less eco-conscious brands and promote innovative products from the Atlantic region. Since seafood is highly perishable and sensitive to harmful microbial growth, effective primary and secondary packaging is critical. Therefore, eco-design applied to the packaging is a source of added value for the Atlantic seafood food products.

The need and development of packaging is caused by the delocalisation between production and the consumption, and the required distribution and transportation of the produced goods. In the future, innovation and new packaging technologies will play a key role in the prevention of food waste [25]. Primary packaging eco-design strategies will be defined to mitigate climate change and to adapt the current type of containers validating their effectiveness preserving seafood. In the current level of global market, food distribution is crucial and the role of packaging is enormous. There are a number of factors to consider in choosing the appropriate secondary packaging solution. In addition to protective features, economic feasibility and ease of transport, environmental variable should be balancing these interests.

### *2.4. Circular economy strategies*

A circular economy approach must be managed from a holistic point of view, i.e. from natural resources consumption to waste management. For the transition to a circular economy, the reuse of natural resources should be favoured. An approach in which residue streams are prevented as much as possible, and where unavoidable residues are viewed as useful resources, could provide a new impulse for tackling the old issue of seafood waste.

In this regard, it is necessary to link the potential high value use of residue streams with food safety. Therefore, in addition to nutrients identification, a full nutritional characterisation should be introduced. Based on LCA, techniques that produce several nutrient rich products (used to replace synthetic fertilisers) reducing CO<sub>2</sub> and N<sub>2</sub>O emissions and increasing the economic revenue will be assessed. For

instance, anaerobic digestion has further benefits in terms of providing by-products such as biogas [26]. The objective is to complement the reference European Best Available Techniques document [27] with recommendations based on food circular economy and the analysis will include the prevention and reuse options.

On the other hand, the European Energy Policy [28] aims at encouraging sustainable energy use and, consequently, waste to energy options should be considered. These residue streams, however, could be used more profitably as food, animal feed [29] or as resources for biorefining [30], depending on the raw material that is fermented. Waste management is often overlooked in seafood processing as a potential area for resources savings. The simplest way to foster an efficient use of resources is to reduce the amount of waste. Innovative reuse and recycling can transform wastes into valuable by-products. Three categories including biological digestion, non-biological volume/weight reduction, and thermal processing, are considered.

### *2.5. Threats and challenges fisheries in the Atlantic area*

The main challenges of the fisheries in the Atlantic area are related to European circular economy transition, the adaptation to the climate change, and the growing threats of the marine debris. Climate change impacts in general on fisheries, including operational aspects at the harvesting stage [31], the likely impact along the supply chain and particularly at the production stage [5, 32] but also at structure levels and policy development. Therefore, to mitigate climate effects on fisheries, actions are needed along the supply chain. The Atlantic area could be an adequate framework to apply this approach in order to propose regional strategies of climate change adaptation.

Furthermore, the seafood sector has to lead with the threat of marine debris. From interfering with food webs, ghost fishing and transferring toxins up the food chain, this marine debris significantly interferes in ecosystems and human health [33], and it has many socioeconomic impacts. The eradication of marine debris is essential to the wellbeing of our current and future generations, and the characteristics of marine debris as an environmental problem require an innovative approach to its eradication. Derelict fishing gear is particularly harmful as it often results in ghost fishing [34]. Therefore, a number of strategies or policies for tackling the problem of ghost nets are necessary to introduce in the Atlantic area.

### **3. Expected outputs**

Expected results of NEPTUNUS project will be a reality if the nexus approach and the specific methodology and actions are correctly carried out, opening the opportunity to contribute from an environmental, economic and social point of view to a Europe Circular Economy Strategy. With the upcoming “circularity revolution” in the European and global arena, it is of vital importance to establish new methodologies and strategies, which will promote sustainable seafood production and consumption:

(i) Environmental point of view: The integrated approach of the project as a bidirectional challenge, considering production and consumption, will allow a better understanding of flows, obstacles and innovations that would seem to be necessary to promote the minimisation and recovery of food waste, contributing to the sustainable use of natural resources. The achievement of reduction targets in Atlantic Area needs an integrated approach based on circular economy. This perspective, in which residue streams are prevented as much as possible and where unavoidable residues are viewed as useful resources, will provide a new impulse for tackling the old issue of waste. Some expected effects from the environmental point of view include: an eco-efficiency gain, and the mitigation of climate change.

(ii) Economical point of view: The seafood value chains are of significant importance in many areas of the European Atlantic Area. A noteworthy socioeconomic benefit of a sound seafood value chain ensures employment security in less populated maritime areas. The focus in the present proposal could contribute to novel interests for new fishery production, important employment opportunities and value creation. The «closing the loop» initiatives of seafood will enable to address the economic needs of some specific seafood sectors, contributing to strengthen the fishery industry in the Atlantic Area. The consideration of the economic perspective will make possible to trigger investments; to increase

business activity/capacity (new products, processes or services based on the pilots); to save cost and improve services (% savings and increasing users' satisfaction); and to rise jobs/employability (jobs and employment opportunities created).

(iii) Social point of view: Within a global context of increase population growth, reducing food losses and waste is necessary to meet forecasted nutritional needs. Therefore, the transition to a food circular economy will have significant societal relevance, being the central drivers: 1) the need for an environmentally, economically and societally sustainable development, in which foods and food waste take a central place; 2) the global issue linked to climate change and the need to reduce atmospheric greenhouse gases emissions; 3) the need to stimulate small regional maritime areas; and, 4) the main challenge of addressing food security on a global scale. This is especially noticeable under the seafood perspective, and taking into account healthy considerations. Specifically, throughout the NEPTUNUS project is expected a cluster development (increasing the durability of cluster connections, increasing the cluster size, and increasing the integration of activities among the partners).

#### 4. Conclusions

The success of a cluster network under the umbrella of NEPTUNUS is expected but it strongly depends on the increment of the awareness and public acceptance based on the undoubtable positive aspects of collaboration and common development, among others. Nevertheless, there are some limitations to take into account for near future.

As a reminder, individual regions or countries working on their own cannot efficiently solve the environmental problems of the seafood supply chain in the Atlantic area. This could be either an issue affecting a clearly defined transnational geographical area or a common issue of interest, which transnational cooperation leads to more innovative and efficient solutions. Thus, in a global food economy, investments and new alliances between regions will be necessary, as well as balancing environmental influences with social and economic gain in policy and decision making for regional and global food flow. Therefore, the association requires including stakeholders from the whole society: from policy-makers and public bodies to citizens and not-for-profit organizations, as well as private companies.

However, the clustering beyond frontiers still results insufficient because only gives an answer from an administrative or technical point of view. But, what about the content and how to effectively deal with the environmental threats? Transitioning to a circular economy in a seafood context requires the "nexus thinking" aforementioned. This is essentially a transformative approach to governance, and also requires substantial changes in the way people behave. Of course, government policy informed by stakeholder engagement will be necessary to overcome obstacles that includes influencing consumer behaviour and change to embrace the importance of natural resources.

Accordingly, NEPTUNUS project addresses several overarching yet interrelated innovation actions, including the seafood flows, methodologies and tasks for a circular economy on a larger transnational scale that has not been pursued previously, this is, a robust framework that unites stakeholders and addresses gaps and barriers in terms of managing important interacting forces regionally and transnationally. Nevertheless, despite the pioneering scope of the project and the opportunity to extrapolate future results to other regions, seafood flows and related actions are limited from a territorial point of view that should be overcome in further researches.

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