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Sustainability Assessment of the Societal Costs of Fishing Activities in a Deliberative Perspective

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Abstract: Assessing the social cost of fisheries is generally seen as a matter of how to monetize the components of fisheries. This paper presents an assessment of the societal cost of fishing activities, seen as a social process that is expected to contribute to the better management of aquatic resources, affecting sustainable development in coastal areas around the world. The originality of this article lies in considering the sustainability assessment from a deliberative perspective. It aims at defining the types of guiding concepts, frameworks, and information sets that might be appropriate for decision support, as we enlarge our scope of concern from fisheries to the ecosystems of eco-regions in the long term. In defining the societal cost of fisheries, through interviews, the objective is, first of all, to identify the social effects (positive and negative) of fishing métiers. By comparing fishing activities in a multi-criteria and multi-actor analysis, this evaluation is intended as a means for the actors to express in different ways (scientific indicators, institutional objectives, etc.) their judgment regarding the sustainability of the fishing profession. This analysis is the basis for defining the methods of monetizing these effects in different eco-regions (West African coastal upwelling and the deltas of Southeast Asia).

Keywords: societal cost; fishery; sustainability; assessment; deliberation; social choice; evaluation; monetization

Citation: Douguet, J.-M.; Failler, P.; Ferraro, G. Sustainability Assessment of the Societal Costs of Fishing Activities in a Deliberative Perspective. *Sustainability* **2022**, *14*, 6191. https://doi.org/10.3390/su14106191

Academic Editor: Tim Gray

Received: 13 March 2022
Accepted: 10 May 2022
Published: 19 May 2022

1. Introduction

As the fishing industry is a complex system characterized by the interactions of the people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, and the purpose for fishing, it is difficult to define the effects of such activities on society. Worldwide, fishery resources continue to drift on the fringes of unsustainability, despite considerable efforts in terms of management and policy [1]. Fisheries management is characterized by governance practices where multiple actors, interests, and institutions and by processes at various administrative scales, in different territorial entities, and across sectoral policies. In the past, biology, economics, and sociology have each followed their own paths in analyzing and advising fisheries management and policy but have failed to be effective and helpful to define sustainable fisheries management trade-offs. Surely, multi-dimensional parameters characterize these situations, and the issues involved are themselves multiple, and cannot be reduced to one aspect, neither can the views of the actors on these issues.

Acknowledging the past failures and the complexity of fishery resource management, this research has endeavored to introduce an integrated assessment method to the fisheries industry. Adopting the stance of the UN 2030 Agenda for Sustainable Development to protect the marine ecosystems and biodiversity upon which our health and marine-related economic and social activities depend (Sustainable Development Goal 14), this research aims at developing a new approach for the assessment of fishing activities to contribute

to the better management of aquatic resources. This assessment must be seen within the broader context of providing public decision-makers and society in general with the appropriate tools and methods not only to consider the immediate economic and social benefits but also in terms of defining the types of vulnerability in the activities of fishing and as a social process involving the knowledge of the actors.

Keeping the focus on sustainable development, fishing activities are considered to be a métier. The métier concept characterizes the multi-dimensionality of fishing activities. When several fishing fleets are present, with several fishing methods being used that have different impacts on resources, a classification of fishing actions is needed according to these impacts. Classes of this typology are usually called "métiers" or "tactics" (see [2–4]).

The societal cost can be considered as the expression of a variety of vulnerability types related to fishing activities. In this article, the various forms of this vulnerability will be studied as part of the assessment process, through the identification of the performance issues of fisheries. A generic framework of the forms of vulnerability is proposed by Douguet et al. [5]. It was built as part of a synthesis, carried out based on an analysis of the literature in various fields, such as philosophy, political science, economics, law, etc. There are several dimensions in this regard:

- Subsistence—that is to say, the health, survival, and security of an organism.
- Goods and services in the commercial context. In both cases, we can be invested either positively or negatively in the distribution of capacities, opportunities, risks, and costs, either for individuals or groups. Ultimately, all sectors of society are concerned.
- Political dimension—the distribution within a society of the means of being part of a political process or of governance, which can be at any institutional level.
- Social link—the capacities of individuals to relate to other individuals and act according to the status and recognition of each person within the group, referencing communities, wealth, and issues of belonging, collective identity, and prestige; or, conversely, marginalization and exclusion.
- Ecological experience—the access or lack thereof to the various "environmental services" (natural resources, reception of waste, cognitive qualities, and support of life) and the symbolic meaning of such services.
- Autonomy and creation—the capacity of an individual or group to express freely and, by extension, to contribute to the capacities and opportunities of others, and to organize the life of society and the political process.

Sustainability assessment is a complex endeavor. It is conducted to support decision-making and policymaking in a broad environmental, economic, and social context, and is not merely a technical/scientific evaluation [6–8]. Two approaches for a sustainability assessment of societal costs could be considered. The first approach is based on a cost accounting model. In the economic tradition, this approach is often associated with the concept of social cost. It aims at identifying additional costs that are not supported by private agents, which are qualified as "externalities". Externalities are defined, in the strictest sense, as damages caused by one agent (or a group of agents) to another agent (or to another group of agents), either positively or negatively (see, notably, [9]). Social cost is then defined as the sum of all the costs assumed for a given economic activity to be exercised. Considering sustainability dimensions, in the context of this study, the societal cost is defined as the societal costs and benefits of fishing activities at the métier level, calculated by aggregating the economic, social, and ecological cost and benefits of a specific métier [10,11].

The second approach proposes the contextualization of sustainability issues from a deliberative perspective. The aim is to socially define those issues and indicators related to the effects of fishing activities. Actors, which can be considered to include knowledge carriers and/or stakeholders, are part of the process to identify key issues and pertinent indicators to frame the sustainability assessment. Due to the complexity of the fishing industry, the information cannot easily be calculated using a single unit of measurement (as proposed in a cost-benefit analysis). Sustainability assessment procedures must incorporate

other methods for identifying the nature of the choices and trade-offs in question. A great variety of multiple criteria analysis methods have indeed been developed and applied in recent years, in an effort to help organize scientific as well as economic information as a basis for a multi-perspective representation of the effects of sustainability issues [12,13].

Two steps in this second approach should be distinguished. The first step is the identification of the relevant indicators (in monetary, quantitative, and qualitative terms) by knowledge-carriers (scientists, institutions, NGOs, etc.) to represent each of the sustainability issues for every situation studied. The second step is the opportunity for a deliberative process to build up a shared understanding for the purposes of producing meaningful evaluations for public decision-makers [14–19]. From a deliberative perspective, we propose to develop a social choice approach (see, notably, [20]) by (1) starting with a problem definition (identifying key issues), then (2) framing the assessment process for stakeholders to identify the positive and negative externalities of fishing across the value chain in different eco-regions [21,22].

Section 2 proposes to frame a sustainability assessment of fishing activities within a deliberative perspective. In Section 3, the societal cost of métiers is represented from multiple perspectives, using the KerBabel representation rack tool. Section 4 aims to assess the societal cost of fisheries using a multi-actor and multicriteria analysis (using the KerBabel deliberation matrix). It is essential to make explicit the evaluation question to be answered. In this article, four types of evaluation will be proposed:

- Evaluation of the performance of fishing activity from a sustainability perspective;
- Comparison of the societal cost of fishing activities at the eco-region level;
- Comparison of the societal cost of fishing activities at the level of multiple eco-regions;
- A proposal of an economic evaluation of the societal cost of a fishing activity (in monetary terms).

Sections 5 and 6 present the outputs of the application of the deliberation matrix to compare fishing activities (1) within an eco-region (Southeast Asia eco-regions) and (2) in the West Africa and South Asia eco-regions. Finally, Section 6 offers a discussion of the resulting sustainability assessment of the societal cost of fishing activities in monetary terms and the complementary nature of the two societal cost-calculation approaches toward fishing activities.

2. Toward a New Approach for the Sustainability Assessment of Fisheries from a Deliberative Perspective

The first works on sustainability assessment were published in the literature on environmental impact assessment and strategic environmental assessment. Pope et al. [23] identify a diversity of sustainability assessment types over time and in different domains (water quality, waste management, etc.), including environmental impact assessments, evaluations related to the pragmatic integration of developmental and environmental goals, limitations imposed on human activities, a process of directed change/transition, and the promotion of resilience and justice.

Sustainability assessment (SA), as utilized in this article, does not mean the process of developing and applying measurement tools and indicators to assess the dimensions of sustainability [24–26]. It is defined as the types of guiding concepts, frameworks, and information sets that might be appropriate for decision support as we enlarge our scope of concern from fisheries to the ecosystems of eco-regions and the long term. To allow SA to be framed, the issue of sustainability should address certain commitments to be upheld and ask: "Sustainability of what, why, and for whom?" Following the arguments presented by Frame and O'Connor [25], we propose to obtain a SA by embedding multi-criteria representation and evaluation methods in a multi-stakeholder deliberative evaluation process. We adopt the view of "sustainable development" as a challenge of coexistence across multiple key questions concerning fishery activities, informed by a diversity of knowledge. The role of the SA is, thus, to provide guidance.

Since 1950, the bio-economic modeling of fisheries has permitted significant theoretical advances in the practice of fishery management. The maximization of individual profit and the fishery rent under technical and resource-scarcity constraints, and the adjustment of supply and demand through the mechanism of pricing, had seemed to offer insight into effective fisheries management. The development of the concepts of resource and market equilibrium ("maximum sustainable yield" and "maximum economic yield") were applied to the management of commercial species and, in most cases, helped to explain the decline in fish stocks. However, their actual application failed. Considering the external effects associated with a fishing activity requires a change in our understanding of the operational dynamics of fisheries.

The complex systems approach to sustainability, as proposed, for example, by Passet [26,27], highlights the interdependence of four "spheres" or classes of system organization. These are the economic, social, and environmental spheres—usually recognized as the "three dimensions of sustainability"—complemented by a fourth category of organization, the political sphere of conventions, rules, and institutional frameworks for the regulation of the economic and social spheres. This leads to a systems model of "four spheres", named by O'Connor [21] as the tetrahedral model of sustainability (Figure 1).

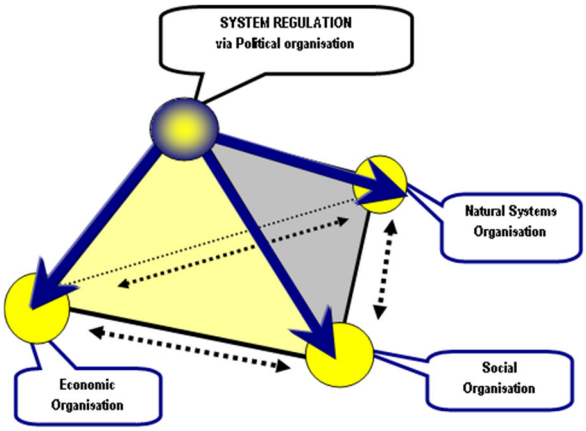

Figure 1. The tetrahedral model of sustainability.

Analyses for sustainability must focus their attention on the interactions between the economic, social, and environmental spheres ("triple bottom line"), on the characterization of the principles of performance in each sphere, and on the principles of the interdependency of one sphere in relation to another. The political sphere has the role of the "referee" that arbitrates matters in relation to the different—and often incompatible—claims made by the actors of the social and economic spheres for their own interests and about the other spheres (including the environmental sphere).

Achieving sustainability would mean a process of co-evolution respecting a "triple bottom line", that is, a simultaneous respect for the performance goals pertaining to each of the three spheres. To frame this process, the "social choice" problem or, as rephrased in our context, the problem of "Sustainability of what, why, and for whom?" led to the development of a framework for analysis combining individual preferences, interests, or welfare to reach a collective decision [20].

It is difficult to formulate a commitment to sustainability without embracing, firstly, a complex view of the challenges of the governance of fisheries with a view to enhancing the prospects of coexistence and, secondly, the requirement of a commitment to deliberation. The fundamental scientific and normative preoccupations of SA would then have to be established along two axes:

- Firstly, when the sustainability goal is affirmed, from which point of view the different dimensions of system feasibility and opportunity costs can be explored; and

- Secondly, when attention is given to the question of how to reconcile the diversity of sustainability concerns expressed by the spectrum of stakeholders in sustainability.

The INTEGRAAL meta-method can be mobilized to carry out an assessment of sustainability in fisheries from a deliberative perspective [28]. INTEGRAAL is an approach that aims, through 6 main steps (that are not necessarily linear), to engage experts and stakeholders in an integrated sustainability assessment process (Table 1). The objective of this meta-method is to establish a process of reflection and public dialog around institutional objectives, scientific knowledge, and the concerns that are expressed locally. It is about exploring ways of reconciling the diversity of fisheries performance issues to inform policies and decision-making processes.

Table 1. Application of the meta-method INTEGRAAL to SA and the tools mobilized.

Integraal Steps	Description	Tools Mobilized
Step 1: What is the common problem?	Identification of key questions about the effects of fishing activities in different eco-regions	
Step 2: Make the framing of the sustainability assessment explicit	In which ways do fishing activities constitute a problem of "social choice"? Who are the actors? What are the categories of performance issues to consider (e.g., sustainability of environmental services, economic viability, institutional feasibility)? What are the eco-regions within which fishing activities should be compared? (This step is based both on a more in-depth field study (including interviews) and on the literature.)	
Step 3: Inform and represent the societal cost of the métier, in different eco-regions, using scientific and vernacular knowledge.	The actors, in this step, are knowledge-carriers. Through the identification of pertinent indicators, they contribute to the representation of the societal costs of fishing activities, according to different perspectives.	KerBabel Representation Rack
Step 4: Evaluation by a multicriteria and multi-actor analysis of the societal cost of métiers in different eco-regions.	The actors, in this step, are stakeholders. They participate in the evaluation of fishing activities through the formulation of judgments to express, from their point of view, the variety of effects and societal costs of métiers. Part of this information can be expressed in monetary terms.	KerBabel Deliberation Matrix Monetary Assessment approach
Step 5: Recommendations and communication	Recommendations and communication of the results of the study, not only to participants but also to the wider public. Then, the process moves from research to decision-making.	
Step 6: Feedback on the experience	Feedback on the experience and on how the evaluation approach occurred.	

A sustainability commitment, even if affirmed individually, must find collective expression, and be accommodated along with other stakeholders' concerns [29]. More specifically, it is asserted that actors in deliberation can build up and exercise a judgment capacity concerning social choice dilemmas in ways that are inaccessible by analytical procedures alone (i.e., the measurement of costs). Accepting the plurality of justification principles as irreducible in SA portrays again the "classic" multi-criteria situation, where no single option "dominates" all the others for all criteria. The originality of the INTEGRAAL application is to develop a monetary assessment of societal costs based on a multicriteria and multi-actor analysis.

3. Sustainability Assessment of Métiers Using the KerBabel Representation Rack

Profiling each métier requires considering a range of knowledge, to represent their positive and negative effects from a sustainability perspective. The eco-regions studied are characterized by the ecosystems of coastal upwelling (West Africa) and deltas (Southeast

Asia), wherein a set of major métiers has been identified. The KerBabel representation rack aims at representing a situation from a multi-perspective approach. Its use requires, firstly, defining the four axes of representation of the situation. They are of two orders. The first series of axes relate to the supply of knowledge: What or who are the knowledge-carriers? What is the conceptual framework? The second series of axes relate to the need for knowledge to characterize the performance issues (i.e., socially defined criteria) and for the situations to be compared (different métiers within the same eco-region or the comparison of métiers in different eco-regions). These four axes are defined as follows:

- Knowledge-carriers' axis: scientists (in EU, West Africa, Southeast Asia), institutions (FAO, OECD, WorldFish Center, Sub-Regional Fisheries Commission (Senegal), the Secretariat of the Pacific Community);
- Conceptual framework axis: the Ecopath/Ecosim model [30,31], economic ECOST model [10], discursive analysis, the Johannesburg plan of implementation and the Code of Conduct for Responsible Fisheries (CCRF), etc.;
- Performance issues axis: the analysis of the texts of the Johannesburg plan of implementation and the Code of Conduct for Responsible Fisheries (CCRF) and the interviews leads to the identification of six categories of criteria expressing preoccupations at the international level [32–34]. These performance issues of fisheries express the types of vulnerability and should help in guiding actions (see Table 2):
- Situation to be compared axis: eco-regions characterized by ecosystems of coastal upwelling (West Africa) and deltas (Southeast Asia).

Table 2. Presentation of the performance issues of fisheries and their types of vulnerability.

Performance Issues of Fisheries	Description	Vulnerability Dimensions
Ecosystem health	Emphasizing the impact of fishing activities on the conservation and restoration of species and ecosystems.	Ecological experience
Sustainable livelihoods (employment, income, job satisfaction, and gender)	Focusing on poverty reduction, the creation of opportunities, access to assets, and the developing of an enabling environment.	Goods and services in the commercial context, social links
Social justice (income distribution and equity)	Referring to the distribution and use of income and resources. This is highly dependent on the fisheries' national and international economic structure and is closely related to the next issue (food security and sovereignty).	Social links, political dimension
Food (security, safety, and sovereignty)	Referring to the availability of food to people in sufficient quantity and quality; food sovereignty being the right of people to define their own food consumption.	Autonomy and creation, political dimension
Profitability	Measuring the capacity of fishing equipment, techniques, and people to generate enough profit to economically sustain their activities.	Goods and services in the commercial context
Regulations and policies	Referring to the elaboration, implementation, and enforcement of legal rules, as well as voluntary mechanisms.	Political dimension

The second step is deciding the pertinence of indicators or "fitness" for the model's evaluation function [35]. During this stage, the knowledge-carriers assess the pertinence of their knowledge, as related to the conceptual framework, by positioning the indicators that they deem most pertinent to inform the intersections of the axes of the performance issues and the situations to be compared. The representation thus obtained constitutes a patchwork image of the situation. More technically, the KerBabel representation rack could be considered as the integrated modeling of a socio-ecological economic system, in a

multi-perspective approach and as an innovative and experimental participatory approach to representing a situation using pertinent knowledge.

Knowledge-carriers must assess the pertinence of the indicators they propose to represent the situation studied. This pertinence can be strong (a relevance of 4), weak (a relevance of 1) or null (a relevance of 0). An indicator can be used by one or more knowledge-carriers, for one or more performance issues, and for one or more eco-regions. An indicator can have different levels of pertinence, depending on the knowledge-carriers who offer it. It is, therefore, possible to have the first level of deliberation around the relevance of the indicators for representing the situation studied. In this context, there will generally be uncertainties and controversies; and these fundamental issues of knowledge quality assessment are, thus, mentioned plainly within the context of the representation of the situation studied [35].

In the preparation phase, the facilitation team first gathered the indicators used within the ECOST project, through the production of the ECOST model [10,36] and the existing ECOPATH model [33,37]. Performance issues were chosen as one of the criteria for classifying the pertinence of a particular indicator. As most of the indicators were specific to one performance issue (ecosystem health, sustainable livelihoods, social justice, food (security, safety, and sovereignty), profitability, regulations, and policies), they were labeled as E01 to E22 for environmental health (see Table 3), S01 to S22 for social justice, and so forth. A complete description of each indicator is accessible in the KerBabel Indicator Kiosk. However, this did not preclude the possibility of an indicator across issues. A total of 128 indicators were produced.

Table 3. Slice of the KerBabel representation rack for the crossing—knowledge-carriers (scientist), conceptual framework (Ecopath/EcoSim model), performance issue (ecosystem health), for different eco-regions (the situation to be compared).

	Knowledge Carriers Axis: Scientist
	Conceptual Framework Axis: Ecopath/Ecosim model
Eco-regions axis	Performance Issue Axis: Ecosystem Health
Southeast Asia eco-region	*Ind. E01: Fishing resource biomass* *Ind. E02: Ecosystem richness* *Ind. E03: Gross efficiency of the catch (catch/net P.P.)* *Ind. E04: Mean trophic level of the catch.* *Ind. E05: Impact of fishing on other trophic levels*
West Africa eco-region	*Ind. E01: Fishing resource biomass* *Ind. E02: Ecosystem richness* *Ind. E14: Capacity to maintain support services (primary production)* *Ind. E15: Capacity to maintain provisioning services (food, other)*

Among the array of 128 indicators suggested, almost half seemed meaningful to the country-based teams for the evaluation of métiers. Others did not seem meaningful to them, often because they appeared too technical.

4. Assessing the Societal Cost of Fishing Activities Using a Multi-Actor and Multicriteria Analysis

Linking the four spheres of the tetrahedral model of sustainability makes explicit the complexity of métiers that exert pressures on marine resources, and which is directly related to the organization of the fisheries supply chain (production, processing, transportation, final market). The comparison of societal costs for different métiers in a deliberative perspective would allow us to compare the different forms of fishing practices, considering performance issues not only related to the economic sphere (profitability of the métier) but also to the interaction of the social and economic spheres (sustainable livelihoods) and so on. The development of such an approach is a way to differentiate between responsible fishing practices and risky ones using multi-criteria analysis.

Sustainability is a multi-faceted challenge; hence, there is a certain naturalness to a multi-criteria indicator-based approach to SA. Using the 3-dimensional KerBabel deliberation matrix, the problem is framed for different eco-regions for the assessment of the effects of a spectrum of performance issues, as perceived by the different stakeholders of each category of métiers under evaluation. The three axes are as below:

- Métiers axis: small ships (canoes and salans) and light gear, such as the different types of gillnets or hand lines, or the industrial export-oriented sector, equipped with trawlers, etc.;
- Performance issues axis: ecosystem health, sustainable livelihoods, social justice, food (security, safety, and sovereignty), profitability, regulations, and policies;
- Situation to be compared axis: eco-regions characterized by the ecosystems of coastal upwelling (West Africa) and the delta (Southeast Asia).

The logic of this 3-dimensional KerBabel deliberation matrix (KerDST) is to allow a didactic presentation of the process and outcomes of judgments offered by each eco-region for each category of métier under evaluation, with reference to a spectrum of performance issues. The assessment approach of the métier from a deliberative perspective is not purely analytical. Rather, it is a social process that may have strong interactive and inter-subjective dimensions, opening the possibility of "emergent" properties. In this context, a social process of the comparative evaluation of métiers can readily become a framework for assessing societal costs. The KerDST provides a framework to carry out an indicator-supported, multi-stakeholder, multi-criteria assessment. With this evaluation tool, the basic idea is that for each eco-region, a group of stakeholders will make a judgment (good, fair, bad, etc.) about each métier, with reference to each performance issue (Figure 2).

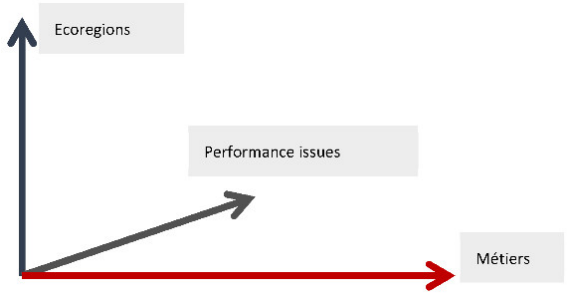

Figure 2. The three axes of a KerBabel deliberation matrix.

These judgments produce a composite picture, visualized on a screen as a 3-D array of "cells", somewhat akin to the well-known Rubik's cube. For example, from one angle of observation, the observer sees rectangular arrays of cells, each being a layer of the matrix, within which each row represents the evaluations (issue by issue) provided for a given class of métier for successive eco-regions. Looked at from another angle, the matrix establishes the evaluations according to each eco-region of a given métier.

Several ways to use the KerDST are available, with increasingly complex structures. The first and simplest variation is simply to color the cells (stakeholder x métier x performance issue) using an intuitive code such as [red = bad], [green = good]. A more "objective" basis or motivation for the judgment (color) suggested in each cell can be constructed through the selection, for each cell of the deliberation matrix, of a "basket" of indicators that are chosen to specify relevant attributes of the métier under scrutiny. With this procedure, the judgment at cell level in the matrix is obtained not by a simple choice of color for the cell, but instead as a weighted "amalgam" of the qualitative judgments assigned to each indicator in the "basket" (in the scenario shown below in Table 4, only one indicator has so far been put into the "basket", its color code being yellow). In general, the color (or composite) of each matrix cell is a function of the relative weight and significance attributed to each indicator in the corresponding basket.

Table 4. Example of the construction of an indicator basket in KerDST.

Eco-Region 1/Performance Issue 1/Métier 1				
Name of the Indicator	**Value**	**Subjective Weight**	**Comment**	**Summary Conclusion**
Conservation of species	Bad	15%		
Conservation of ecosystem	Good	15%		Good
Trophic level of the catch	Good	15%		
Impact on ecosystem services	Good	20%		
Existence of juveniles in sufficient proportion	Good	35%		

The multicriteria and multi-actors' evaluation process and outcome are, thus, built on several layers of judgments. As described in the KerBabel representation rack, the first selection of indicators is based on their relevance to the situation studied. In the KerDST, the pertinent indicators are the "candidate indicators" that can be mobilized to express a judgment for a specific crossing. To establish a judgment, an individual or a group of individuals is asked to state their opinion concerning the performance of métiers in a specific eco-region. None of the métiers, performance issues, or eco-regions are weighted. The judgment for each crossing is composed of 1 to 5 indicators that come either from the "candidate indicators" list or from those indicators proposed directly by the stakeholders themselves. For each of the indicators selected, a value should be proposed that is established by the choice of color:

- [red = very bad];
- [dark red = bad];
- [white = medium];
- [green = good];
- [dark green = very good].

For each of the indicators, it is possible to provide a commentary to justify the choice of color and to attribute a subjective weight, to assign the importance of the argument in the global judgment. The weight of each indicator in the judgment may be relativized by using a subjective weight (defined by the stakeholder).

This process will not produce a conclusion about the "best" option but might allow a partial ranking. However, what is seen to be most important is the role of the 3-D array as a deliberation matrix, providing all participants in the SA process with an opportunity for "collaborative learning". It is based on the hypothesis that individual reflection and/or exchanges of views between stakeholders in a deliberation process may lead to modifications in any or all of the steps of the choices and judgments leading up to an entry in a cell of the matrix table. Those "representing" stakeholders of one particular type may try to persuade the stakeholders of another type to modify their criteria or relative weighting, and so on.

5. Comparing Métiers Profiles within the Southeast Asian Estuaries Eco-Region

As in many other parts of the world, fishing is a very popular and ancient activity in the South Asian estuaries. The fishing métiers are diverse (see Table 5). The métier profiles were built for the Southeast Asia deltas eco-region, gathering the case studies in China (CH), Vietnam (VN), and Thailand (TH) in 2009. In this case, the métiers were small ships (purse seiners or canoes) and light gear (CH3 to CH5, TH2, VN2), as well as an industrial sector equipped with trawlers (CH1 and CH2, TH1, VN1, and VN3).

Table 5. Métiers in the Southeast Asian estuaries eco-region.

Code	Vessel	Gears	Target Species
TH1	Trawler	Otter board trawl	Trash fish and demersal catches
TH2	Purse seiner	Anchovy purse seine	Anchovy
CH1	Trawler	Single and pair trawl	Blie scad, golden threadfin bream, big-eye perch, mullet, cutlassfish, jack mackerel, Pacific mackerel, conger eel, black scraper, squid, prawn
CH2	Trawler	Single and pair trawl	Crevalle jack, threadfish, large-head hairtail, shrimps, squid
CH3	Seine Boat	Purse seine	Shrimps
CH4	Canoe	Gill net	Golden threadfin bream, large yellow croaker, conger eel, black pomfret, cutlassfish, banded, tuna, tunny, big-eye perch, deep-sea bass, squid
CH5	Canoe	Hook and line	Golden threadfin bream, deep-sea bass, squid
VN1	Trawler	Trawl net	Demersal fish
VN2	Gill Boat	Gill net	Demersal fish
VN3	Trawler	Trawl net	Shrimps

The evaluation in this region makes two groups of métiers stand out: the small-scale sector, with small ships (purse seiners or canoes) and light gear (CH3 to CH5, TH2, and VN2); and an industrial sector equipped with trawlers (CH1 and CH2, TH1, VN1, and VN3). Using the deliberation matrix to evaluate the societal cost of métiers, the spheres in lines correspond to the judgments for a given performance issue of all the métiers, and to the judgments for a given métier of all performance issues (Figure 3).

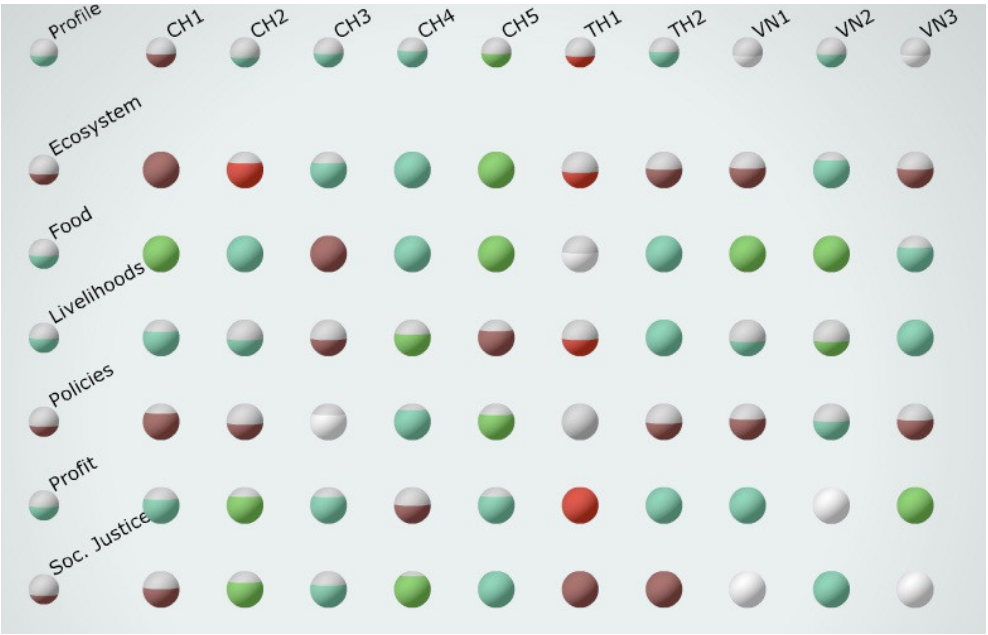

Figure 3. Profile of métiers in South Asian estuaries.

The discussion on the societal cost conducted with the country experts allowed them to specify its meaning for their region, and to suggest other specific means of measuring ecosystem health, food security, livelihood, policies, profit, and social justice. As shown in Appendix A, the indicators using performance issues to define the societal cost of different métiers are different within the eco-region. In "ecosystem issues", indicators that are systematically included are the conservation of the ecosystem and the conservation of species. The "food issue" includes food security and safety, as well as food sovereignty. The

"livelihoods issue" is in terms of the employment provided by the fishing chain and income provided by the fishing chain. In "gender balance and equity", this included opportunities for women. In the "policies issue" are the legal and institutional activities regarding the fishery sector, the existence of illegal fishing activities, the efficiency of existing regulations, and the enforcement of law and regulations. In the field of "profit issue" is the economical profitability of fishing. Finally, in the "social justice issue", the distribution of income within the fishery sector and the distribution of income along the chain are used. Other indicators are specific to a particular métier: for example, the indicator "Existence of juveniles in sufficient proportion" is used only for métier CH4, and "The species is in a position to reproduce itself", is only included for métier CH1.

Small-scale boats focus not only on species that contribute to food security but also on exports, such as anchovies. Pressures on several resources are high as captures, despite legislation, also target juveniles. In China, the legislation is better enforced, and in Vietnam, the same is the case, particularly for open-sea shrimps. Overall, fishing provides overall good employment, but the distribution of revenue is often evaluated as being unfair in the case of larger vessels, such as trawlers, or wherever fishermen receive wages rather than being independent. Here, also, trawlers are poorly evaluated in terms of the environmental sphere. As in West Africa, women are involved in the processing of local species to a variable extent, depending mainly on the country in question.

With regard to the policy performance of the fishery sector in the two eco-regions that provided results (i.e., Southeast Asia and West Africa), the overall picture is that regulations are not always well-designed or innovative [1]. Although the rule of law ensures a good level of preservation of several threatened species in Asia, more juridical innovation is needed to enhance its regulatory effectiveness in specific cases. Such cases are represented by bottom-trawling and mangrove depletion, which cause threats to food security since species that might be consumed locally are, instead, massively exported or depleted. A very common issue in the regulatory domain is the distortion of costs that oil subsidies and taxes on equipment by the government causes, inducing a lack of internalization of societal costs. Above all, oil subsidies continue to encourage unsustainable forms of fishing (such as the trawling of depleted species), even where métiers are profitable.

6. Comparing the Métier Profiles of West Africa and Southeast Asian Estuary Eco-Regions

The fisheries sector in West Africa plays an important part in the national economies of the three coastal states involved in this study, Senegal (SE), Guinea (GN), and Guinea Bissau (GB), through the promotion of exports, the creation of jobs, and the satisfaction of food needs in the rural and urban populations. The fisheries sector is made up of small ships (canoes and salans) and light gear, such as different types of gillnets or hand lines (GB2, GB4, and GB5, GN1 to GN4, SE1 to SE3), and an industrial export-oriented sector equipped with trawlers (SE4, GN5 and GN6, GB1 and GB3). The screenshot below shows the deliberation matrix for West Africa. The profile line indicates the codes of all 15 métiers identified in the three countries (Table 6).

Regarding the métier and the country, a set of various indicators are mobilized for the evaluation of the societal cost of métiers by country experts, meaning that the societal cost of each métier depends on the context in which it takes place. Each indicator is used with a different value (characterized by colors).

The evaluation exercise shows that métiers in the eco-region can be roughly grouped into a domestic small-scale sector, with small ships (canoes and salans) and light gear, such as the different types of gill nets or hand lines (GB2, GB4, and GB5, GN1 to GN4, SE1 to SE3), and an industrial export-oriented sector equipped with trawlers (SE4, GN5 and GN6, GB1 and GB3). Globally, the performance of small-scale métiers was evaluated as more positive, regarding a variety of issues from social justice to livelihoods, through providing income and revenues, including income for women (in processing), and providing food security to local populations (Figure 4).

Table 6. Métiers in the West Africa eco-region.

Code	Vessel	Gears	Target Species
SE1	Pair of canoes	Purse seine	Sardinella, bonga, horse mackerel and chub mackerel
SE2	Canoe	Surrounding gill net	Sardinella and bonga
SE3	Canoe	Hand-line bottom ice-box canoe	Pandora, chub mackerel, catfish, seabream, biglip grount, snapper
SE4	Trawler	Coastal fish trawling	Crevalle jack, threadfish, large-head hairtail, shrimps, squid
GB1	Demersal fishery	Trawl	Demersal fish
GB2	Pirogue	Gill net	Demersal fish
GB3	Shrimp fishery	Trawl	Shrimps
GB4	Pirogue	Gill net	Shrimps
GB5	Simple monoxyle pirogue	Gill net	Ethmalose
GN1	Salan (artisanal)	Gill nets	Croacker
GN2	Salan (artisanal)	Gill nets	Bobo croacker
GN3	Salan boat	Drifting gill nets	80% Ethmalosa
GN4	Salan (artisanal)	Handline and set longline with or without icebox	Snapper, emperor
GN5	Trawler	Fish trawling	Catfish, Bobo croaker, croaker
GN6	Trawler	Shrimp trawling	Shrimp

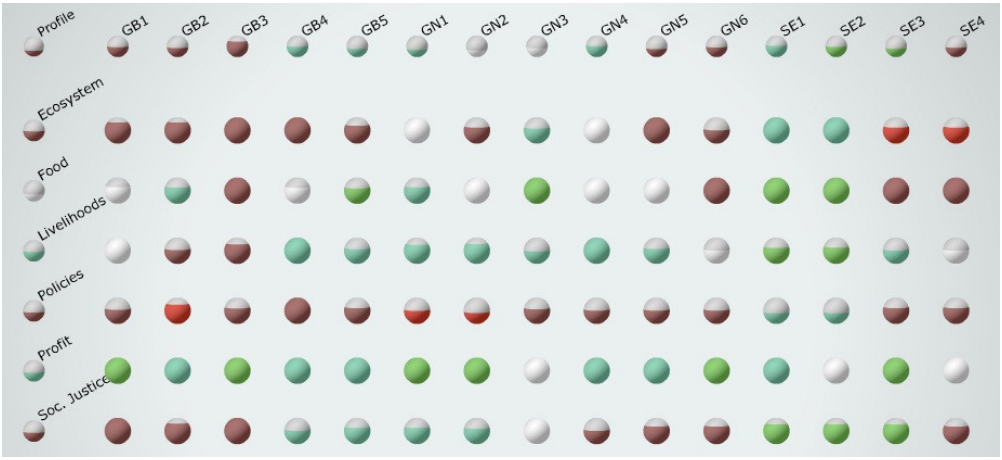

Figure 4. The profile of métiers in West Africa. [red = very bad]; [dark red = bad]; [white = medium]; [green = good]; [dark green = very good].

Although more profitable, métiers related to trawling provide less local revenue and food security. They also have an almost systematic negative impact on ecosystems, both on fish stocks and on the benthos. This low evaluation of the performance of trawlers in terms of the ecosystem does not mean that other métiers all have higher evaluations.

The low evaluation of performance issues of some artisanal métiers is related to inadequate conservation techniques by the local population (smoking fish with wood from the mangrove, as in GB2 and GB4) or fishing highly valued species for export (e.g., croakers, emperors, and snappers in Guinea—GN4). Policies in the eco-region do not receive a good evaluation and should, thus, be adjusted according to the situation.

As shown in Appendix B, some indicators are mobilized systematically according to each eco-region. In "Ecosystem issues", indicators that are systematically used are the conservation of the ecosystem and the conservation of species. In "Food issues", the

indicators are food security and safety, and food sovereignty. In "Livelihoods issues", the indicators are employment provided by the fishing chain, and income provided by the fishing chain. In "Policies issues", the indicators are the legal and institutional activities with regard to the fishery sector, and the enforcement of law and regulations with regard to effective inspection and surveillance. In "Profit issues", the indicator is the economic profitability of fishing. In "Social justice issues", the indicators are the distribution of income within the fishery sector, and the distribution of income along the chain. Other indicators are used specifically by eco-region or by métier: for example, for the "Ecosystem" issue and for some métiers that are only found in the Africa eco-region, the indicator "Length–frequency analysis of catches" is used; and the "Impact on ecosystem services" indicator is only used in the Asia eco-region.

The diversity of the selected indicators resulting from expertise, stakeholder dialog, and the deliberation processes gave rise to a "patchwork" vision of societal cost. This "patchwork" character is both a representation of the diversity of the effect of fisheries and a common basis for the better management of aquatic resources affecting sustainable development in coastal zones.

7. Discussion of the Indicators Used to Model Societal Cost in Sustainability Assessment: Toward a Monetarization of the Societal Cost

In developing this SA approach, the evaluation process could provide a basis to determine what might seem to be a good, legitimate, and socially acceptable decision or policy, through structured argument and practical judgment, for the better management of marine resources. The question highlighted in this article is asking who decides on the categories of information and criteria to meet the need for better-informed decision-making and social engagement in science policy–social interfaces. Deliberation helps in involving the actors in the processes of discovery and awareness of the effects of fisheries, in the dialog around knowledge (whether scientific or not) and uncertainty, and in making sure actors contribute, each in their own way, to the construction of capacities and the improvement of the knowledge base in the decision-making process.

The monetization approach that we have proposed, by means of a single-criterion measurement, makes explicit the process of establishing the criteria and indicators of monetary assessment. Deliberation takes place, firstly, on the construction of a monetary assessment of the effects of fishing. Then, the interpretation of the monetary measures can be carried out regarding the diversity of meanings of the effects of fishing, expressed within the multi-criteria and multi-actor analysis. Finally, the deliberation could concern an assessment of the quality of the monetary approach.

The quality of the monetary approach would concern both the substantive dimension (quality and transparency in the choice of criteria and indicators, and in the choice of appropriate tools for the monetary measurement of indicators), the procedural dimension (in particular, through the choice of the interface, so that the actors can access and contribute to the representation of the effects of the different fishing professions in the different eco-regions and the expression of the social significance of these effects), and the contextual dimension (appropriation of the results by actors at the local, institutional, and regional levels).

Determining performance issues from a deliberative perspective helped to define the key concerns expressed socially. However, only some of these performance issues make sense in terms of monetization: ecosystem health, sustainable livelihoods, and profitability. The other issues (social justice, food (security, safety, and sovereignty), and regulations and policies) are not subject to monetarization.

The societal cost, from a deliberative perspective, is conceptually different and is conventionally measured with a different metric (qualitative, monetary indicators). Table 7 relates the process of selecting a set of indicators, which is the basis of a monetary evaluation of the societal cost of métiers in terms of the selected issues. For example, for the "sustainable livelihoods issue", a set of indicators was mobilized during the deliberation

process: employment provided by the fishing chain, income provided by the fishing chain, gender balance and equity in terms of opportunities for women, basic material needs and health, freedom (in terms of place and control indicators), self-actualization, and extra income from tourism. The monetization process involves selecting indicators that can be expressed in monetary terms. Monetization can be achieved in different ways:

- The indicator already has a value in monetary terms.
- There is a monetization agreement for the indicator.
- It is necessary to look for proxy indicators that will allow the indicator to be expressed in monetary terms.
- It is necessary to produce the information in monetary terms; or
- The indicator has no monetary expression.

In complementarity, a first attempt to construct the societal cost of métiers in monetary terms was developed by Wang et al. [11]. The ECOST model adopts the approach of measuring the societal costs and benefits of fishing activity in terms of value, which involves the measurement or conversion of social and ecological costs and benefits into monetary terms [10]. The societal cost was defined as the sum of the social, economic, and ecological costs. In Table 6, only part of the indicators identified in the deliberative process found a correspondence with the indicators in monetary terms developed by Wang et al. [11]. It is necessary to identify other sources to continue the process of economic valuation and to clarify those indicators that cannot be monetized.

The construction of societal cost in a deliberative perspective is based on the mobilization of a diversity of sources of measurement in monetary terms. Aggregation is not the goal of the process. Rather, it is a composite monetary valuation to make explicit the diversity of costs and benefits. This also makes it possible to understand which actors selected these indicators and what judgments were made (expressed through the color and the subjective weight selection in the deliberation matrix). The objective of such an assessment process is to establish a dialog around an interpretation of the evaluation of costs and benefits from the perspective of sustainable development.

As outlined by Frame and O'Connor [27], from a starting point in or, at least, familiar from, economic analysis, the requirements for a dialog model of knowledge as an underpinning of SA are characterized by conditions of complexity. This means that the SA performance issues and the individual indicators that have been suggested through the discursive process are of varying scope regarding data availability and the possibility of governance. The two approaches, multi-stakeholder deliberation on the one hand and monetary quantification, on the other hand, are often set in opposition; yet, once the intrinsic limits of each approach are appreciated, it is obvious that neither the one nor the other alone can provide a guarantee of a successful and pertinent SA outcome. A social choice decision about profitability, sustainable livelihoods, social justice, food security, regulations and policies, and ecosystem health is a matter of responsibility and justice [5,38] that must be arbitrated through political processes.

Table 7. Selection of indicators for a monetary assessment of the societal cost of métiers in China (M1).

Issue	Pertinence of the Issue for Monetizing	Indicators Chosen in a Deliberative Approach	Total Used (X Time)	Indicators for the Economic Valuation	Source	Economic Valuation of Costs (a + b)	Economic Valuation of Benefits (a + b)
Livelihoods	*Pertinent for monetization*	Employment provided by fishing chain	25×				
		Income provided by fishing chain	24×				
		Gender balance and equity—opportunities for women	14×				
		Basic material needs and health	7×	Basic material consumption (residents in the PRD)	(Wang et al., 2015)	67,256	
				Basic material consumption (fisherman in the PRD)		39,229	
				Health care (residents in the PRD)		7049	
				Health care (fisherman in the PRD)		6795	
		Freedom (place and control indicators)	7×	Freedom and choice	(Wang et al., 2015)	9132	
		Self-actualization	3×				
		Extra income from tourism	2×				

8. Conclusions

From a decision-making and policy assessment point of view, there are both advantages and disadvantages to choosing monetary and deliberative evaluation procedures. The choice of using monetary valuation methods arises directly in the context of an attempt to transpose traditional economic valuation methodology into an arena for which it was not originally devised, and where it may not be able to be applied in a meaningful way. Deliberative evaluation processes are intended to exploit the knowledge and deliberative capacities of interested members of a society in distinctive ways, which is compatible with the democratic principles of debate and public accountability [39]. Using monetary or multicriteria analysis highlights a problem of arbitration over ends and purposes from a sustainability perspective, which is, in this sense, a social choice problem. in this way, the evaluation of the societal cost of métiers, within deliberative and monetary approaches, contributes to resolving, from a social perspective, the question posed earlier: "Sustainability of what, why, and for whom?"

Author Contributions: Methodology, P.F. and G.F.; Writing—Original draft, J.-M.D. All authors have read and agreed to the published version of the manuscript.

Funding: The study has been conducted under the project "Ecosystems, Societies, Consilience, Precautionary Principle: Development of an assessment method of the societal costs for best fishing practices and efficient public policies", which is funded by the EU Sixth Framework Program (Contract No. 003711).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors would like to thank Aurélie Chamaret and Pierre W. Johnson for their contribution to this work. They also thank reviewers for their comments.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Mobilization of indicators for métier evaluation in the Southeast Asia eco-region. [red = very bad]; [dark red = bad]; [white = medium]; [green = good]; [dark green = very good].

Issue	Indicator Title	Used X Time	CH1	CH2	CH3	CH4	CH5	TH1	TH2	VN1	VN2	VN3
Ecosystem	Conservation of species	9×										
	Conservation of ecosystem	9×										
	Trophic level of catch	5×										
	Impact on ecosystem services	3×										
	Existence of juveniles in sufficient proportion	1×										
	The species is in a position to reproduce itself	1×										
Food	Food security and safety	10×										
	Food sovereignty	4×										
	Fair use of natural resources	1×										
Livelihoods	Income provided by fishing chain	10×										
	Employment provided by fishing chain	10×										
	Gender balance and equity—opportunities for women	7×										
	Basic material needs and health	6×										
	Freedom (place and control indicators)	6×										
	Self-actualization	3×										
	Extra income from tourism	2×										
Policies	Efficiency of existing regulations	9×										
	Existence of illegal fishing activities	9×										
	Enforcement of law and regulations—effective inspection and surveillance, etc.	9×										
	Legal and institutional activities with regard to the fishery sector (sufficient or not)	4×										
	Subsidies to the fishery sector	3×										
Profit	Economical profitability of fishing	5×										
	Total net income minus total net costs	5×										
	Revenue for this metier	5×										
	Total costs for métier	5×										
	Other occupation takes time and brings additional revenue	1×										

Table A1. *Cont.*

Issue	Indicator Title	Used X Time	CH1	CH2	CH3	CH4	CH5	TH1	TH2	VN1	VN2	VN3
Social Justice	There could be a salary or income link to catches	4×										
	Distribution of income	4×										
	Distribution of income along the chain	4×										
	Comparison of fishery income/other economic sectors	3×										
	Gender balance and equity—opportunities for women	1×										
	Extra income from tourism	1×										

Appendix B

Table A2. Mobilization of indicators for métier evaluation in Africa and Southeast Asia eco-regions. [red = very bad]; [dark red = bad]; [white = medium]; [green = good]; [dark green = very good].

Issue	Indicator Title	Asian Countries (Used X Time)	African Countries (Used X Time)	GB1	GB2	GB3	GB4	GB5	GN1	GN2	GN3	GN4	GN5	GN6	SE1	SE2	SE3	SE4
Ecosystem	Conservation of ecosystem	9×	15×															
	Conservation of species	9×	15×															
	Trophic level of catch	5×	3×															
	Existence of juveniles in sufficient proportion	1×	2×															
	Length–Frequency analysis of catches	-	2×															
	Impact on ecosystem services	3×	-															
	The species is in a position to reproduce itself	1×	-															
Food	Food security and safety	10×	15×															
	Food sovereignty	4×	15×															
	Fair use of natural resources	1×	-															
Livelihoods	Employment provided by fishing chain	10×	15×															
	Income provided by fishing chain	10×	14×															
	Gender balance and equity—opportunities for women	7×	7×															
	Freedom (place and control indicators)	6×	1×															
	Basic material needs and health	6×	1×															
	Self-actualization	3×	-															
	Extra income from tourism	2×	-															
Policies	Legal and institutional activities with regard to the fishery sector (sufficient or not).	4×	14×															
	Enforcement of law and regulations—effective inspection and surveillance, etc.	9×	14×															
	Existence of illegal fishing activities	9×	9×															
	Efficiency of existing regulations	9×	7×															
	Subsidies to the fishery sector	3×	6×															
	Existence of conflicts between different métiers	-	4×															

Table A2. *Cont.*

Issue	Indicator Title	Asian Countries (Used X Time)	African Countries (Used X Time)	GB1	GB2	GB3	GB4	GB5	GN1	GN2	GN3	GN4	GN5	GN6	SE1	SE2	SE3	SE4
Profit	Economical profitability of fishing	5×	15×															
	Total net income minus the total net cost	5×	-															
	Revenue for this métier	5×	-															
	Total costs for metier	5×	-															
	Other occupation takes time and bring additional revenue	1×	-															
Social Justice	Distribution of income within the fishery sector	4×	15×															
	Distribution of income along the chain	4×	14×															
	Gender balance and equity—opportunities for women	1×	8×															
	Organization of production, processing and distribution	-	3×															
	Comparison of fishery incomes/other economic sectors	3×	3×															
	Fair use of natural resources	-	2×															
	There could be a salary or income link to catches	4×	-															

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