ANCHORS AWEIGH: THE APPLICATION OF CONSEQUENTIAL LCA PERSPECTIVE IN FISHING SYSTEMS

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ABSTRACT

Attributional LCA, which monitors the static state of a specific production system, is increasingly used in fisheries to assess the environmental profile of fleets and seafood supply chains. This approach is not pertinent to assess the effects of (large scale) policies. In contrast, consequential LCA (C-LCA) has been successfully implemented in other sectors to assess the expected changes in environmental impact in a given production system and other (marginal) production systems that may be affected in response to changes in the main system. C-LCA commonly combines LCA with economic models to simulate the interactions occurring between the analyzed systems. However, the use of these models may not be the most appropriate approach to follow for fisheries. Hence, it seems feasible that C-LCA should be combined with stock prediction tools rather than with economic models, to determine how changes in stock sizes and quota restrictions may cause variations in the environmental impact of fishing fleets.

BACKGROUND

Consequential LCA (C-LCA) is usually based on combining LCA with economic modeling to simulate interactions occurring between the analyzed production system, and those that may be affected by its variations. For instance, economic equilibrium models, such as GTAP or partial equilibrium models are used to compute the economic consequences that may occur in the chosen life cycles. Once these are obtained, LCA is used to translate the consequences into environmental impacts. However, using economic tools as drivers of future environmental impact may be the most adequate approach for seafood production systems, since they are natural ecosystems where the main constraint is the availability of the natural resource, especially considering the current overexploitation of most fishing stocks. Therefore, the aim of the study is to provide a theoretical analysis on how to enhance the policy support utility of seafood LCA, by providing a specific framework to calculate the environmental consequences of changes in fishing quotas on an annual basis.

FRAMEWORK

The distortion of ecosystem dynamics in marine environments by anthropogenic activities can be mainly linked to the proliferation of fishing activities worldwide through the centuries. This phenomenon has gradually led to a situation, confirmed by recent FAO reports (FAO, 2012), in which an overwhelming majority of global fisheries are depleted, overexploited or fully exploited. A situation that not only hinders the natural capability of fish stocks to replenish, but also increases the social and economic risks of human communities reliant on this important source of income and nourishment. The need to develop adequate fishing management strategies to guarantee the sustainability of fishing stocks triggered a strong development of stock assessment techniques in an attempt to regulate fish catches through a wide range of actions. In the European Union (EU) these actions have been integrated for the last 40 years in a common strategy, named the Common Fisheries Policy (CFP). The CFP fixes a set of maximum harvest yield thresholds for those fishing species and fisheries where, based on stock assessments, the yields must be controlled to maintain the stock within sustainable practices or where sustainability has yet to be reached.

These thresholds, named total allowable catches (TACs), are a particular type of fishing quota restriction that use stock sustainability and the replenishment capability of the stocks as the main criteria to provide annual scientific predictions of individual fish species. While the annual change in TACs for an individual fishing species in a particular fishery in many cases is relatively limited, there have been cases in which the EU has enforced strong reductions in quota allowance from one year to the next (e.g. Atlantic mackerel in the Southern Stock in 2010) or has closed a fishery due to overfishing–e.g. anchovy in the Southern Stock in the period 2005-2009 (ICES, 2012). Moreover, decennial revisions of the CFP (currently in process in 2013) have delivered substantial changes in the management of fisheries. For instance, the current on-going proposal suggests a gradual ban on discarding, which may imply important changes in fishing practices, ecosystem dynamics in marine environments and in seafood supply chains.

The inclusion of fishery-specific impacts on marine resources in life cycle thinking is a long lasting controversy in the LCA community. In fact, no current assessment method in LCA considers any of the so called *fishery-specific impact categories* within their framework, despite the proliferation of these indicators in recent years (Emanuelsson, 2012; Langlois et al., 2012; Vázquez-Rowe et al., 2012). In this context, the debate between fishery-LCA practitioners has orbited around two main lines: those who defend higher comprehensiveness of LCA as applied to fisheries, in which new impact categories are developed to analyze the life cycle environmental impacts associated with human health (i.e. impacts on ecosystem services), natural resources (i.e. depletion of fish stocks) or ecosystem quality (i.e. biodiversity damage potential) as linked to activities developed in oceans (Langlois et al., 2012); and those who follow the Hospido and Tyedmers (2005) doctrine, seeing LCA as a complementary tool to evaluate environmental impacts beyond the already existing stock assessment methods, as well as other methods to evaluate fishery-specific biological concerns.

Nevertheless, this study does not provide a critical discussion on the advantages and limitations of applying one of the two perspectives, but rather delivers a top-bottom discussion on how these two approaches, when used appropriately, are equally valid to support an expected future development in fisheries-LCA in order to enhance its utility in fisheries management and policy making: the understanding of the environmental impacts linked to fishing systems as a consequence of changes in a particular production system.

METHOD

We propose a consequential method for LCA that considers a two-fold inclusion of stock assessment in life cycle thinking. This methodological improvement is based on a new framework where LCA no longer nourishes from stock assessment data in order to provide additional environmentally relevant information regarding seafood products, but becomes an integrated tool for assessing fisheries beyond the stock abundance of a specific species, creating a so called "two-way catch" perspective in which stock assessment (i.e. overfishing and biomass removal) is included in two different stages of the evaluation process.

On the one hand, scientific predictions on stock abundance, which currently are the scientific basis for the fixation of TACs, would be used in the goal and scope stage of LCA to determine the consequential modeling of the production system. More specifically, stock assessment advices annually delivered by the International Council for the Exploration of the Sea (ICES) would be used as the main source of data to understand the environmental consequences that arise from the loop between stock assessment itself and the final policy-making in the frame of the CFP (the latter eventually creating rebound effects on stock abundance and, therefore, on stock assessment results in the subsequent years). Consequently, it will be of key importance in fisheries C-LCA to monitor the reciprocal feedback between the stock assessment of the fishery, which conditions to a great extent the final TACs, and vice versa, since the final management decisions are going to determine to a great extent (in conjunction with several natural parameters and the extent of illegal fishing) the health of the fishery stocks and their capability to replenish through time. Thereafter, based on the identification of the main consequences (e.g. variable working load; seasonal closure of fisheries; deployment of vessels; reassignment of fishing areas, etc.) derived from the shock exerted to the system due to quota changes, the marginal suppliers for operational inputs would be identified (e.g. changes in energy demand, catch rates for the different species or selectivity in discards) for their inclusion in the consequential Life Cycle Inventory (C-LCI) and subsequent computation in the consequential Life Cycle Impact Assessment (C-LCIA).

On the other hand, as previously described, the inclusion of biotic resource depletion impact categories (or the combination of LCA with stock assessment methods) would be a central part of the methodological innovation in the impact assessment stage, widening the comprehensiveness of the impact categories covered in life cycle thinking. Hence, the proposed methodology would trigger an appealing insight to LCA, by not only providing a detailed analysis on how quotas will affect environmental impacts through consequential modeling, but also by expanding the comprehensiveness of environmental impacts monitored through LCA and potentially delivered for decision making and policy making.

DISCUSSION

C-LCA has shown to have important sources of uncertainty, linked not only to its methodological assumptions (e.g. difficulty to set boundaries; identification of marginal technologies, etc.), but also to the underlying uncertainties of reporting future outputs. Hence, studies usually tackle this limitation by providing a wide range of future scenarios, based on economic, environmental or policy making changes or predictions which are integrated into the expected variation which is the object of the C-LCA (Vázquez-Rowe et al., 2013). Therefore, the different shocks that should be simulated for the selected fisheries should be based on EU new fishing quota recommendations and other derived predictions, in order to understand how these recommendations may affect the environmental profile of fisheries.

Moreover, the predicted shocks that will ultimately determine the environmental consequences may imply important effects on the dietary patterns of European nations, since variations in seafood availability may change the way human populations obtain their protein supply. For instance, a final decision to reduce the TACs of a given species by 25% may entail a considerable shortage of this seafood product for the subsequent year. This issue would most possibly lead to marginal changes in the protein supply. While certain studies have monitored in the past how certain decisions may affect the environmental profile of a specific diet, the use of a consequential perspective in the post-landing stage of seafood supply chains may be calculated based on the predicted changes in seafood supply and on a consumer demand model focused on protein-based products. For instance, the use of basic economic models, such as AIDS (Almost Ideal Demand System) or other comparable models may be interesting perspectives if jointly used with C-LCA.

CONCLUSIONS

The proposed C-LCA method suggests a new framework where LCA no longer nourishes from stock assessment data to provide additional environmentally relevant information for seafood products, but becomes an integrated tool for assessing fisheries beyond the stock abundance of a specific species, creating a so called “two-way catch” perspective in which stock assessment is included in the impact assessment stage through impacts categories or combining LCA with stock assessment methods and the scientific predictions on stock abundance are used to estimate the environmental consequences of different quota restriction scenarios. Hence, it seems feasible that in the case of seafood extracted from natural ecosystems, C-LCA should be combined with stock prediction tools rather than with economic management tools to determine how changes in stock size may cause variations in the environmental impact of seafood.

REFERENCES

Emanuelsson A. (2012). Quantifying overfishing and ecosystem impacts related to seafood products. Life cycle assessment (LCA) and fisheries science to improve the sustainability of seafood. University of Gothemburg.

FAO. (2012). The state of the world fisheries and aquaculture. Food and Agriculture Organization, Rome.

Hospido A, Tyedmers P. (2005). Life cycle environmental impacts of Spanish tuna fisheries. *Fish Res 76, 174-86.*

ICES. (2012). ICES Advice 2012. International Council for the Exploration of the Sea.

Langlois J, Fréon P, Delegenes JP, et al. (2012). A new approach for fisheries impact assessment in LCA. 8th International Conference on LCA in the agri-food sector. St. Malo, October 2012.

Thrane M. (2006). LCA of Danish Fish Products. New methods and insights. *Int J Life Cycle Assess 11, 66- 74.*

Vázquez-Rowe I, Moreira MT, Feijoo G. (2012). Inclusion of discard assessment indicators in fisheries LCA studies. Expanding the use of fishery-specific impact categories. *Int J Life Cycle Assess 17, 535-49.*

Vázquez-Rowe I, Rege S, Marvuglia, et al. (2013). Application of three independent consequential LCA approaches to the agricultural sector in Luxembourg. *Int J Life Cycle Assess, accepted for publication.*