Chapter 31
Conclusions and Future Vision on Big Data in Pelagic Fisheries Sustainability

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Abstract The digitalization of the fisheries sector has been limited. However, in this book, the potential for making the sector more competitive and resilient through higher digitalization has been demonstrated using pelagic fisheries as an example. COVID-19 has recently shown the resilience advantages of having a more digitalized industry that makes larger use of big data and artificial intelligence. Moreover, these technologies can help us to mitigate climate change due to lower emissions and to adapt to climate change-induced changes of species distribution. One of the challenges is the accessibilty of enough cost-effective information. This can be achieved if fishing vessels becme also scientific data gathering platforms in a circular data economy. Then the fishing vessels are both users and providers of environmental data.

31.1 Conclusions

The fishery pilots have demonstrated the potential of big data to boost performance in the fishery sector. They have worked in both types of pelagic fisheries: the oceanic tuna fisheries (Spanish) and the small pelagic fisheries (Norwegian). Six separate pilot cases have been defined, addressing key concerns such as the cost of fuel, vessel maintenance, fish finding, fish markets and fish stock management. Therefore, the pilots cover three separate viewpoints: immediate operational choices (i.e. in each vessel during their operations), short-term planning (i.e. fishing vessel trip and fisheries planning) and long-term planning (i.e. fisheries sustainability and value creation).

End users have been actively participating and giving feedback during the whole project period, with participation from the very start in the project's kick-off meeting.

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C. Södergård et al. (eds.), *Big Data in Bioeconomy*,
https://doi.org/10.1007/978-3-030-71069-9_31

Six fishing companies have been involved in the project to test the framework and give feedback to ensure the most useful implementation. The fault detection and energy efficiency tasks have been developed for on-board and shore applications with fishing company machinery surveyors. End users from the fishing industry have advised researchers about which data integration and visualization are most useful for operations planning. Several fishing vessel owners have provided feedback about the project objectives and how they can benefit them. Other end users are national and international organizations interested in fisheries sustainability. There have been several opportunities to show the project progress and receive feedback from these organizations, which include regional fisheries associations, International Council for the Exploration of the Sea (ICES) fisheries experts, Food and Agriculture Organization of the United Nations (FAO) stakeholder meetings and the European Fisheries and Aquaculture Research Organizations (EFARO).

Tuna oceanic pilots have achieved the installation of vessel fuel consumption monitoring systems collaboratively with end users and the big data cluster for data storage, integration, processing and visualization in AZTI facilities.

Oceanic tuna fisheries immediate operational choices have data monitoring in place in all vessels, with periodical uploads of data to servers for shore analysis. Data analytics have produced fuel consumption equations and propulsion engine fault prediction models. The fault prediction models provide helpful advice for maintenance operation planning and for preventing unexpected engine malfunctions, thus increasing safety.

Oceanic tuna fisheries planning has all the components deployed and partly operational with data feeding the system in terms of environmental data, vessel data and fish catch data. Data integration is in progress using PostgreSQL database and R scripts. Data analytics have been performed using a machine learning pipeline and forecasting maps contrasted with historical data (for statistical validation) and experts' judgement.

Small pelagic pilots have established services and pipelines to facilitate the pilots' objectives, as well as developed demonstration versions of the associated end user tools. The implementations are running partly on-board fishing vessels, partly on the SINTEF Marine Data Centre infrastructure.

Small pelagic fisheries operational choices have instrumentation on-board four pilot vessels. This instrumentation collects data from a range of sensors and systems. The collected data are aggregated on-board each vessel, where it forms the basis for the decision support system. All vessel instrumentation is also connected to the SINTEF Marine Data Centre and data are collected automatically from the vessels when they are in range of shore-based cellular data networks. This enables updating and correcting the on-board database in case of failures, or if in retrospect one is able to apply corrections to individual sensor signals.

Small pelagic fisheries planning have operationalized the SINMOD in-house ocean model system that simulates physical and biological processes. It now provides daily forecasts of the physical and biological parameters important for the distribution and availability of small pelagic fish species. This information is made available through an online service, available for the shipowners participating in the project.

Small pelagic fish stock assessments has improved on board vessels data acquisition for hydroacoustics. SINMOD has been extended with fish population simulations. Models for automatic classification of acoustic signals have been developed with an accuracy over 90% to differentiate fish aggregations from other acoustic signals.

Small pelagic market predictions and traceability has developed components performing data scraping and caching in local databases. This is operational for download and data collation for Sildes and the Norwegian Fisheries Directorate. A web service has been developed, which allows the users to search, filter and analyse historical catch and market data. This enables shipowners to better perform long-term planning, such as deciding how to split the year's fishing between different fish species.

31.2 Future Vision

The fisheries pilots have shown the great potential benefits for the fishing industry from big data and its associated methods and tools. At the same time, it seems evident that even though we piloted with some of the most modern and technologically advanced fleets in the world (Spain and Norway), they are in many respects quite immature in terms of digitalization. To achieve many of the possible benefits, several developments must first take place. One of the main hurdles to overcome is posed by the lack of standardization of data exchange, in particular for on-board fishing vessels. This implies that for each vessel, specific tailoring is required to interface vessel sensors, which is costly for large scale data collection in large fleets with many vessels. Another issue recently identified is the closed nature of many of the sensors and devices on-board. This complicates data capture and storage. Also, future work should focus on forecasting biomass by species, instead of aggregated predictions, including non-targeted species estimates to avoid incidental fishing. This would help with quota management and compliance of target and bycatch species. Integration with commercial systems can help develop multi-vessel approaches and incorporation of biomass estimates from echosounder buoys. Furthermore, fuel consumption models should be incorporated into a decision support system to forecast potential benefits and costs of alternative fishing routes. Moreover, with enough digitalization, this system could coordinate multiple vessels from a variety of gears in different fisheries. This further digitalization could also make fishing vessels become oceanographic data capturing platforms that improve the capacity to observe the marine ecosystems. This added capacity could be used to improve biomass distribution forecasting in a kind of circular data economy, where the users of processed data are also providers of raw data.

Acknowledgements The developments in DataBio have formed the base for several ongoing projects, such as SusTunTech (Horizon 2020 grant agreement No. 869353), SMARTFISH H2020 (Horizon 2020 grant agreement No. 773521) and FishGuider (Norwegian Grant agreement No.

296321). In return, these projects have helped in the framing and publishing of the future vision in this chapter.