

SELECTION OF SUITABLE COASTAL AQUACULTURE SITES USING HYDRODYNAMIC MODEL AND MULTI-CRITERIA DECISION ANALYSIS IN MENAI STRAIT, UK

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ABSTRACT

As a consequence of declined stocks of the main economic fishery species, the coastal aquaculture has flourished (FAO, 2014) and brought new challenges for sustainable coastal management. The expanding demand of aquaculture products drives the aquaculture industry to explore more cultivation areas. However, the coastal areas are of diverse interests and crowded with various users. As a consequence, conflicts between coexisting users have been intensified. The aquaculture suitable site selection approach is capable of mitigating the conflicts as well as identifying the location with optimum environmental conditions at the designing stage, and it consequently contributes to the sustainable aquaculture development. In Menai Strait, the blue mussel (*Mytilus edulis*) is one of the main culture species of local coastal farming. The tidal flats in this strait offer relatively suitable farming sites for shellfish cultivation, enabling its high production that accounts for 60-75% of the total UK production of farmed mussels (FSC, 2010). Moreover, the local aquaculture industry suffers from expanding demands, which is a common issue in the coastal farming.

The aims of this study are demonstrate a new method for selecting suitable mussel farm locations and to suggest alternative expanding locations for local shellfish cultivation in Menai Strait by conducting Multi-Criteria Decision Analysis taking the environmental, social-economic and conservation factors into account.

In the suitable site selection process, diverse criteria consisting of 3 pillars (environmental, economic-social, and conservation pillars) were used for enabling effective mussel production and mitigating the conflicts between coexisting users. The results of hydrodynamic simulation by Delft3D-FLOW and weightings of criteria obtained from the questionnaire survey were incorporated in the Multi-Criteria Decision Analysis (MCDA). GIS boundary data of statutory mussel water body and Special Area of Conservation (SAC) were collected from the website of Nature England and were converted into evaluation values for MCDA.

The main results of present study were as follows

- (1) The different performances of suitability in the environmentally suitable map and social-economically suitable map suggest that not only environmental factors but also social-economical factors influence the locations of suitable cultivation sites. The shipping zone was suitable for mussel cultivation in terms of environmental conditions, however, it yielded very low suitability in social-economically suitable map. The areas in the west of Port Penrhyn did not yield significantly high suitability in the environmental suitability map in contrast to the social suitability map. For achieving the sustainable aquaculture development, it was considered significant important to combine the environmental and social aspects.
- (2) The final outputs of this site-selection study indicate that a total area of 17.57 km² in Menai Strait yields more than 0.75 in the suitability score, and these areas occupy 40.54% of the whole region. Comparing with the areas of current farming sites, which are approximately 10 km² in total, the area of suitable sites is larger than the current farming

area. Therefore, the total area of suitable locations was considered to be sufficient for alternative farming sites from the quantity point of view.

- (3) There were two main sites qualified as potential alternative mussel cultivation sites in both north and south of the tidal channel. Some natural mussels were found in the northern alternative site, indicating that larval supply that would result in high efficiency in mussel cultivation. The southern alternative site was on the west of current farming sites are close to the current farming sites, and the location may be convenient for fisherman to expand or relocate their farming sites.

This study demonstrated a local-oriented approach to select suitable mussel cultivation locations in Menai Strait, UK. The application of hydrodynamic simulation reduced the dependency on historical and observed records, and it provided some data sets that were not available through traditional observation methods. The weighting of each criterion provided a way to consider the different importance among criteria, and it took diverse stakeholders into account. The utilization of Geographical Information System (GIS) may enhance the applicability of the method developed in the present study.

Key words: Aquaculture; Site selection; Blue mussel (*Mytilus edulis*); Hydrodynamic simulation; Multi-Criteria Decision Analysis;