Sustainable musselculture activity in terms of hydrodynamics. The case study of Chalastra basin (NW Gulf of Thessaloniki)

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Abstract
Based on the framework strategic guidelines for marine aquacultures, the musselculture section has to be operated in Areas of Organized Aquaculture Development (AOAD). Chalastra (NW Thessaloniki's Gulf, Thermaikos) produces the 40% of the national musselculture production using pole and longline systems. Following the legislation, farmers and authorities are in process of reforming the existed units and planning new ones so that the musselculture would remain a sustainable activity in AOAD. The aim of this study is to estimate the appropriate orientation of the mussel units and the lines from which the mussels' socks are hung, in relation to the sea currents' directions for the optimum water circulation in AOAD. The hydrodynamics of Chalastra basin is mainly wind driven and affected both by prevailing northern and southern winds during winter and summer respectively. The mussel units and the socks work as "fence" of the sea currents when the production lines are placed perpendicular to them. Consequently, we propose (a) the division of the studied AOAD in three sub-areas for the pole and long-line units respectively and (b) the placement of the shortest possible length of production lines with orientation parallel to the sea currents.
Keywords: musselcultures, AOAD, sea currents, mussel units' orientation, Thermaikos Gulf

1. Introduction

Mussel culture has been developed in Greece for more than half century with the most important mussel farming areas the NW Gulf of Thessaloniki (Chalastra, Fig. 1a) and NW Thermaikos Gulf. In Chalastra basin a number of longline and pole mussel units are developed at depths > 10 m and < 4-5 m respectively (Fig. 1a and Fig. 1b). Public and private institutional services pursue the foundation and operation of AOAD based on the European and National legislation. As the authorities plan to increase the longline mussel units in the AOAD of Chalastra, the present study investigates the hydrodynamics with basic aim the viability of the mussel cultures, focusing on longline farms (with 11 production lines of 100 m length, 10 m between them, and 0.5 m between mussel socks, Fig. 1c).

2. Material and Methods

Wind and sea currents' conditions were taken into account for the present study. It is well-known that wind constitutes the main factor for the water circulation in the study area while the rivers' influence has been reduced the last decades (ATEITh., 2007) and the tidal effect is of minor importance. The prevailing winds blow from northern directions mainly during the winter and from southern directions during the summer. The NW winds blowing with speeds > 4 Bf generate important sea currents of 5-10 cm/s satisfactory for a sustainable mussel culture activity (Inglis et al., 2000). Concerning the E winds, they are of similar frequency, however weaker and of insignificant influence to the water circulation. So, the prevailing currents' regime results from the dominant NW winds that influence the water circulation in the musselcultures' basin and was studied by numerical models (Fig. 1b) and field works (Konstantinou, 2013; ATEITh, 2007). Recent studies (Savvidis et al., 2015) showed that the majority of the recorded currents in the central area of the basin were 0-5 cm/s for winds ≤4 Bf while the water masses in this area moved towards the production lines at an angle with important percentage of the sea currents moving perpendicular and a small one moving parallel to the lines.

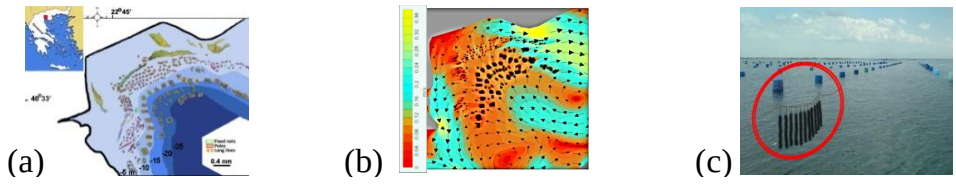

Figure 1. (a) The mussel unit, (b) the water circulation, under NW winds in the study area (Konstantinou et al., 2013) and (c) and a photo of a longline farm with the socks hanging from the product line

The pattern of the water circulation is determined by the prevailing direction of moderate and strong NW winds as mentioned above. Consequently the selection of orientation of mussel production lines should be based on the criterion of unhindered flow ensuring the optimum environmental conditions both for the mussels and the water quality. Flow hindrance is strongly depended on the angle at which the currents approach the production lines as was shown by field data and mathematical models. More specifically, the pattern of water circulation in a mussel farm for currents of 10 cm/s, entering perpendicular to the longlines (ATEITh, 2007, Fig 2, left) shows strong reduction from the center of the unit. On the contrary, flow velocity shows small reduction when the current enters parallel to the longlines (Fig. 2, right). Similar results resulted from modeling studies of Konstantinou (2013).

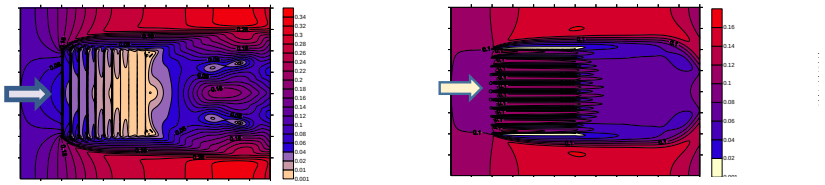

Figure 2. Velocity contours (m/s) in a farm with perpendicular (left) and parallel (right) flow to the production lines

3. Results

The water circulation in the study basin by the prevailing NW winds in combination with the aforementioned analysis for the mussel production lines' orientation, led to the proposal for the division of Chalastra AOAD in three subareas for the longline units and also three for the pole units (Fig 3). The proposed delimitation ensures the minimization of flow hindrance in the aquatic environment of mussel units, offering to mussels better living conditions and water quality.

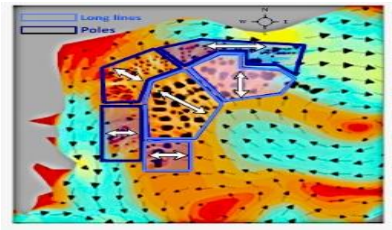

Figure 3. The proposed subareas in Chalastra. The white arrows indicate the orientation of mussel production lines.

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