CLIMATE CHANGE IMPACTS ON CLAM DISTRIBUTION IN VENICE LAGOON: A MODELLING APPROACH.

Michol Ghezzo [1]*, Silvia Silvestri [2], Michele Pellizzato [3] and Georg Umgiesser [1]
[1] National Research Council (CNR) - Institute of Marine Sciences (ISMAR) - michol.ghezzo@ve.ismar.cnr.it
[2] UNEP World Conservation Monitoring Centre
[3] Agri.Te.Co

Abstract

Climate change impacts on growth and settlement of larvae of the clam *Tapes philippinarum* in Venice lagoon have been analyzed using a lagrangian larval growth and settlement model. The model has been coupled to a hydrodynamic-transport model, calibrated by the comparison with experimental data, and run according with different climate changes scenarios on 2030. The two scenarios were: i) increase of temperature, ii) increase of temperature combined with sea level rise. Our results show that an increase in temperature without an increase in sea level displays the worse impacts on the settlement of larval stages in the whole lagoon. Both scenarios implicate a considerable change in settlement distribution in different areas employed in fishing and seed harvesting activities.
Keywords: Fisheries, Global Change, Models, Larvae, Lagoons

Introduction

The Venice lagoon is the biggest lagoon in the Mediterranean Sea, characterised by shallow water areas, complex bathymetries and morphological forms. One of the most profitable activities practised in Venice lagoon is clam fishing. Due to management issues, the activity, initially allowed on the whole basin, is now taking place in limited areas of the lagoon, assigned to fishermen by a local government body through ‘concessions’. While ‘concessions’ are employed for the clam culture, other areas are used as source of seed. The goal of this study was to analyse the dynamics of growth and settlement of Tapes philippinarum clams at the juvenile planktonic and spat stage. The adult organisms may growth in an area far from the area where they have been generated, and this factor becomes important in order to predict the position of the ‘concession’ in the future. In particular, we analysed the dynamics of growth and settlement under two scenarios of climate change trough a lagrangian growth-settlement model coupled with a hydrodynamic-transport model in order to reproduce dispersion, growth and settlement of clam larvae.

Methods

SHYFEM is a hydrodynamic finite element model, which can simulate the circulation and the transport of the water masses and the spatial and temporal evolution of water temperature in the lagoon [1]. The model is able to represent both eulerian and lagrangian transport. This last has been used to calculate the trajectories of lagrangian particles that represent a pool of larval organisms. Each particle is characterised by length, weight, age, settlement state and larvae survival, assumed to be dependent on water temperature. The model has been applied on a bi-dimensional scale on the whole lagoon basin. In order to calibrate each module of the model and to define a reference situation, we have simulated the year 2005 under realistic forcing. Each larva has initial length of 60 micrometers. All particles are transported across the basin and increase their length in function of the local water temperature. When the larvae have a length of about 220 microm they settle on the sediment. When the lagrangian simulation starts the initial particle distribution reflects the distribution of the most productive areas in the lagoon [2]. We assume that a new emission of first stage larval organisms takes place every 90 days in the same initial areas (next generation) and inserts in the lagoon one million of new particles. Two climate change scenarios have been considered according with trends estimated for southern Europe: i) increase of temperature of 0.8°C (T08), ii) increase of temperature and sea level of 0.1 m (L10T08).

Results

The hydrodynamic model has been calibrated with several water level and water temperature measurements. A comparison between experimental data on larval length and weight and simulated data has been carried out in order to verify the functional form employed to simulate the growth and the temperature response from a larval organism.

The comparison between the spatial distribution of the modelled density of settled organisms and the distribution of the most productive areas used to the fishing activity or for the seed harvesting activity indicates that, from a qualitative point of view, the model is able to reproduce the main pattern of distribution. To give a quantitative estimate, three sampling stations have been considered in the inner central part of the lagoon in the year 2005. The comparison between measured and modelled density of individuals per square meter in the areas close to the sampling points indicates that in one case the model can reproduce the order of the measurements, in two cases the model overestimates the data of one order of magnitude. The explanation of this difference is that the quality of sediments has an effect on the settled organisms survival. For this reason we applied 'a posteriori' a corrective factor calculated on the basis of the composition of the sediment in the lagoon. To evaluate the effect of the climate changes on settlement we compared the organisms (particles) successfully settled in the lagoon before the autumnal emission, in the reference simulation and in the scenario simulations. The comparison of the percentage of the successfully settled organisms calculated on the whole lagoon area indicates the T08 scenario as the worst combination, involving a decrease of 1.7% of the successfully settled organisms, whereas in the T08L10 the decrease is only 0.5 %. The number of organisms per square meter that colonises the “concessions” and the seed harvesting areas has been used to evaluate the changes in suitability of each area as consequence of climate changes. Three areas used for the ‘concessions’ are actually the most productive, but they reduce their suitability in both scenarios. At the same time an increase of the number of settled organisms can be found in a qualified area and other areas, not suitable at present. This effect is evident in the T08L10 scenario. With respect to the seed harvesting zone, the most important area shows a decrease of settled organisms in both scenarios in particular in T08.

Conclusions

We developed a tool that is able to reproduce the dynamics of growth, dispersion and settlement of clam in Venice lagoon. The results of our simulation show that climate changes should negatively affect clam settlement in the Venice lagoon, in particular, the actual level of the sea together with an increase in temperature may have the major negative effects. Furthermore, the impact will not be homogeneous across the lagoon. These results suggest that our numerical tool can be successfully employed in support to the decision regards the lagoon and the fishery management.

References

1 - Umgiesser, G., Canu, D., Cucco, A., Solidoro, C., 2004 A finite element model for the Venice Lagoon. Development, set up, calibration and validation. *Jour. Of Mar. Sys., 51*: 123-145

2 - Torricelli P., Boatto V., Franzoi P., Pellizzato M., Silvestri S. 2009 Piano per la gestione delle risorse alieutiche delle lagune della Provincia di Venezia. Provincia di Venezia, Arti Grafiche Zoppelli Dosson di Casier (TV), pp203