REEF formers

Because we care about what's below the surface

Vertical Mussel Reef Farming:
Exploring climate change solutions with economic, social, and ecologic significance

ABSTRACT

Essentially, this project applies our technology for vertical mussel farming, with the aim to evaluate the extent of its bio-effectivity at different locations within the Black Sea basin. According to their specifics our vertical mussel reefs, when applied at large scale, are able to recover marine biocenoses damaged by eutrophication. Following are some of the long-terms goals we expect the vertical mussel reefs to help tackle: the sustainable and natural recovery of eutrophied marine ecosystems and habitats, reducing deforestation consequential to the growing food necessity, may protect the coastline, combat climate change.
Here are some of the effects we have observed that are directly linked and consequential of the installation of our vertical mussel reefs:

- The damaged bottom communities gain access to the more favorable above-bottom layers of the sea.
- The marine food chain is restored at its key link – the mussels, which assimilate the primary phytoplankton production, and intensify its relationship with the organisms higher in the food chain.

From our point of view, the solutions to large scale problems we are and will be facing should be designed with consideration of both environmental and socio-economic consequences. We are interested in solutions that can on the one hand boost economic growth and on the other – to restore the ecological balance and biodiversity in eutrophic marine regions. The key to answering this question is in restoring one of the most widely spread natural bio-filtrates of the marine ecosystems in the moderate latitudes – the mytillus species.

INTRODUCTION

We are currently involved with an EU-funded project for Research and Restoration of the Essential Filters of the Sea (REEFS). It is a pilot project focused on the scientific research of environmental impact of the artificial reefs in the Black sea countries. REEFS is a joint cross-border initiative of five partners from – Bulgaria, Ukraine, Romania, Georgia and Turkey. In times of Blue-Green Solutions/Technologies and Green Finance there is a need for integrated, systemic solutions which bridge sectors and scales and help to identify solutions which are beneficial to many aspects can be easily scaled and applied as well for neighboring requirements like sweet water or other climatic zones or industrial cultures.

The proposed vertical marine farming can be seen as a mirrored solution or equivalent to recently widely discussed urban farming and has far reaching implication for sectors like food-production, sea-water purification, education, work, industrial development, settlement structures and sewer systems, as well as agricultural production and soil amelioration.
The approach is based on what is called nowadays smart (geo-)engineering, and reaches far into the field of architecture and design (social and cultural systems design).

PURPOSE AND CONTEXT

Sustainability is a vital necessity for all species, but it could be achieved only after we have recovered seabed biocenoses damaged by eutrophication. The first case study of our project is the Black Sea, it is an inner marine basin, connected to the world ocean through the straits of Bosphorus and Dardanelles. As in the case of most coastal zones located at such vicinity to intensive industrial, agricultural and civil activities the Black Sea suffers eutrophication. As a consequence the phytoplankton biomass increases uncontrollably, leading to hypoxia or anoxia (forming a gradient increasing towards the bottom of the water column), and followed by the formation of large dead zones. This process has reached colossal proportions in the Black Sea and other similar basins (North, Baltic and Adriatic Seas) and threatens not only the flora and fauna of sea, but those of the land as well as human health and safety. At the scale at which industrial agriculture functions, we already observe lasting consequences, but the problem of the eutrophication is a matter of disruption in the marine food chain.

GEO-ENGINEERING THROUGH HABITAT REMEDY

As an inhabitant of all the temperate zones of the world ocean, the species blue mussel has an important role in marine food chains that makes it potentially a strategic ally in the effort to remedy damaged ecosystems. It is an important filter feeder that consumes nutrients and micro-algae from the water – 1 m^2 of adult mussels in the case of the Black Sea filtrate at a rate of 160 000 l/m^2 per day. Vertical substrates provide mussel larvae with good access to food, O2, and safety from benthic predators.

Their shells additionally expand the reef's surface for a multitude of epizoic creatures. Their larva phase has an important zoo-planktonic role, as it feeds the young of many species. Thus, their presence may lead to an overall ecosystem boost.
In geo-engineering man and nature should work in symbiosis, expressed in synergetic economic, social, geo-political, food and feed, climatic and multiple ecological benefits. At the core of our project is rethinking the challenges of eutrophication as a valuable resource and an opportunity for elegant solutions and an abundant and sustainable future. Eutrophication is essentially a disruption in the food chain in the face of consumers of phytoplankton, so by building habitat for the blue mussel in the form of artificial vertical reefs, we may achieve eco-systemic balance and habitat improvement for the many other species.

ECOLOGICAL IMPACT

- recover bottom communities - gives them access to more favorable upper layers.
- restoring marine food chain, the mussels consume phytoplankton, and intensify its relationship with organisms higher in the food chain.
- provide habitats and breeding sites diverse in temperature, salinity, pressure and luminosity.
- filter a wider range of water layers unlike most existing artificial reefs and mussel farms.
- it covers a minimal area of seabed and does not deviate the demersal currents.
- restore light transmission of the aquatic environment, thus restoring macro-algae and their communities.
- provide shelter from creeping predators (i.e. snails as Rapana venosa, m. Stars, etc.) to numerous benthic and pelagic species.
- enrich the zooplankton with larvae - a million times more than the number of adult reef inhabitants.

MUSSEL FARMING

Vertical Mussel Reefs is an innovative aquaculture technology, which expands the aquatory suitable for farming as it can be applied at open sea up to a depth of 100m. The reef structure is essentially a welded polymer grid forming concentric cylinders.
The latest design covers 4 m^2 of seabed and has an equivalent surface of about 300 m^2. The entire structure is submerged and anchored to the bottom, so its top is located at least 4-5m below the surface. Essentially, the reef is a rigid floating underwater structure, which allows for stable and even attachment of molluscs it is under attack of strong currents and waves. The folded framework increases the effectiveness of the structure as a reef. Another crucial characteristic of the design is that it is establish covers in multiple layers of the water column.

The structures are designed as a substrate for the blue mussel; however their design can accommodate equally well algaeculture or for other marine creature. We expect that the positive effect of a reef-like habitat will be independent of the farming population of the structure. We expect that each specific zone in the ocean with appropriate depths (10 - 100 m) will be suitable for a specific configuration of the vertical reef structures, and may need to be combined with benthic reef structures.

ECONOMIC IMPACT

- new opportunities for aquaculture development in close and open sea areas, boosting directly and indirectly blue growth in farming, processing and technical equipment sectors.
- recovery of fisheries and employment - forms natural zones for restoration of fish populations: by counteracting over-fishing, bottom trawling and other unsustainable fishing methods and by providing niches and security for breeding, growth and feeding suitable for young and adult fish.
- increased food security - with extensive protein production in the marine environment, which is less dependent on atmospheric factors.
- counteracts climate change by mineralizing CO2 in the carbonate shells
- reduces acidification of marine water, which protects other carbonate shell species, more sensitive to acidification - i.e.
- corals, crabs, micro-plankton, etc.
- costal protection by decreasing of energy of big waves and continuously mineral material supply of beaches with shells
- positive effect on coastal and marine tourism by improving coastal water clarity and sea-life.

SUMMING-UP AND OUTLOOK

Vertical approaches are en vogue as the depth is indeed a new frontier as beside high-rise buildings deep-reaching structure allow smart architectural designs which can create a habitat or polis for living structures across scales. In time of the negotiations of Global Goals and Objectives (Millennium- now Sustainable Development Goals (MDG-SDGs)), solution to address leverage points and deep drivers are beneficial for improving/solving also other problem areas and provide room for socio-cultural and aesthetic approaches for environmental, glocal „Problematiques“, real Win-Win solutions in view of the side-effects and broader general aims of society and the environment.

For more check the reefformers.com website.

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