Summary

Human activities determine dramatic changes in natural systems, especially in marine coastal areas of the Mediterranean Sea. This Area suffers the most decreases of Biodiversity by habitat loss and degradation, followed by fishing impacts, pollution, climate change, eutrophication, and the establishment of alien species. To catch up the European commitment of protecting the environment of the Mediterranean Sea by establishing protected areas and enhance the biodiversity, the project *Refugium II* will develop the first multi-purpose artificial reef of Albania, using the one man bunkers of the communist era as reef material. By monitoring end evaluation a year cycle, the development of a test reef will provide evidence, that the biodiversity will increase and symbolize the possibilities of recycling unusable material.

Problem statement

The Mediterranean Sea is one of the most heavily impacted marine areas in the world. Dismissal fishing, ship traffic, and pollution from land are the most cumulative impact of human activity. Climate change increase seawater temperatures, erode the coast, altered the salinity and currents cause serious declines in biodiversity. Eutrophication, impacted by organic pollution through intense land use, degrades the coastal area and his marine habitants. This makes loss of important ecosystems and the aquatic biodiversity, as well as it raises the establishment of alien species that affect the greatest number of taxonomic groups.

The marine ecosystem is heavily endangered and needs to be protected. Since 1991, Albania is member of more than 13 international conventions and agreements dealing with environmental issues. Although, the environmental protection and sustainable use of nature resources is one of the priorities of Albanian government, the management has lacks of the necessary sustainable care. A real protection often takes not place, because the implementation of the existing legislation continues to remain weak and insufficient. On the one side, past communism period Communism period has made people as such and they were not aware of protecting the environment, on the other side the today's system is dictated by the low economic level, unclear land ownership, weak authorities of governmental bodies, low environmental education and the awareness of a healthy environment is slight. During the last twenty years, Albania has been struggling with uncontrolled urbanisation, water pollution, deforestation and illegal/ uncontrolled fishing and hunting. The marine ecosystems were unprotected until 2010, when Albania's first Marine Protected Area (MPA) was established for waters surrounding Sazani Island on the Karaburuni Peninsula. While establishing the first MPA was a milestone for Albanian marine conservation, the extension of protected marine areas and his stabilisation of controlling are still necessary. Compared with his neighbours and the European union, Albania fall behind, regarding the protection of environment and recycling the waste.

One of the most effective tools to increase the biodiversity and protect a costal zone from trawler fishing in the forbidden area is an artificial reef in a endangered zone. For that reason around 300 artificial reefs are deployed in the Mediterranean and the black sea since the second half of the 1900's century, while Albania is still not part of that development. Italy that shares the same Adriatic Sea, developed the first artificial reef in 1970 and more than 70 reefs have so far been constructed, six new sites will be added in the next few years to establish the minimum surface area of 10 km square.

Definition of an artificial reef

Artificial reef is a structure deliberately placed on the seabed to mimic some functions of a natural reef and is to be constructed for several reasons. Regarding environmental issues and protecting nature, first of all it enhance biodiversity and biomass though the additional growth and providing shelter. It restores depleted habitants and provides new substrate for algae and mollusc culture. It is a task of filtering the water body and therefore, it is diminishing the discharge of noxious substance. It prevents the costal erosion and protects sensitive habitants from active trawler fishing activities in the no-take zone. Related to economical matters, an artificial reef elevates the fish stock by protecting juvenile and mature individuals. There is a coupling between the artificial structures and aquaculture IMTA (integrated multi-tropic aquaculture). A new construction creates a touristic attraction and represents a suitable area for diving and sport fishing.

A wide range of natural and man-made materials have been used in artificial reef construction, as for example natural materials like rocks, shells and wood, or man-made structures made of concrete, iron,

steel and plastic, more rarely fibreglass, coal ash by-products, ceramics and ferro-cement. The use of recycled materials is prevalent to reduce the costs. To avoid the dumping of waste at sea strictly regulations are required by national laws and international conventions and protocols. The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (known as the "London Convention"), The 1995 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (known as the "Barcelona Convention"), the United Nations Convention on the Law of the Sea (known as the "UNCLOS"), and the 1995 FAO Code of Conduct for Responsible Fisheries (known as the "Code of Conduct" or "CCRF") give clear legal requirements.

The empiric Investigation on an artificial reef at the Baltic sea (reef NIENHAGEN) during the last 14 years, indicate, that all Materials, will be colonized homogenous in relation to the water depth. In this context, the positioning of the construction in the current and his design of light, what is giving new supply of nutrition and energy plays the greatest role for an optimal colonisation.

Project *Refugium II*

To catch up the Mediterranean engagement of protecting the Mediterranean sea and taking care of a sustainable environment, the project *Refugium II* will develop the first multi-purpose artificial reef of Albania. 20 one-person bunkers, built during the communist era, are to be excavated and sunk as an artificial reef in a suitable place on the nearby coast. What was once supposed to serve the protection of the people could now function as a shelter and breeding ground for maritime wildlife.

The primary objective is:

- To build a test reef to provide evidence, that the structures will have a positive effect on the biodiversity and fish stock in the coastal area.

- The main objective is the monitoring and evaluation of the colonisation of the structures. The priority is given to the ascertainment of the biomass, species range and quantity of the colonization, as well as his biodiversity and abundance.

- Beside the documentation of the hydrological year cycle, a further principal objective is the report of particular incidence in the ecosystem. That evaluates the lateral stability of the elements on the one hand, on the other hand, it develops a better understanding of the ecological effect, in order to give the most appropriate recommendation for an economical and touristic utilisation.

Beside these general goals we will accomplish with a hundred percent guarantee, the project strive further specific objects.

- To use the one man Bunkers illustrate the possibility of recycling waste and raise the awareness in the public community and put pressure on the government's authorities concerning waste management.

- The implementation of the project,will involve the community of the fisherman and further stakeholders, that assumes a educational program, addressing the benefits of the reef. That education and participation will raise the awareness of sustainable environmental use and protecting nature.

- The artificial reef deployment serves human uses, such as scuba diving and recreational fishing. Through the relation of the bunkers with the communism, they have an additional attractiveness for tourist to learn more about the history of Albania though an exciting diving trip.

- Dismantle the legacy of communists paranoia, by bring the landscape back to his natural condition and independent beauty. It is a specific symbol for treating historical errors by turning the waste of the past into a useful refugium for the future.

Site

The pre-assessment that was been undertaken by now, has crystallised an optimal site.

- Regarding logistical issues, Port of Durres is the main harbour of vessel that has the required capacity to carry the bunkers. The city offers a wide spectrum of facilities and accommodation. Also Tirana as the main coordination centre for the implementation and monitoring is reachable in an adequate time.

- The damage by building the artificial reef is little, because there are Areas of the sandy bottom, which doesn't host any poseidonia meadows or other bottom inhabitants with endangered status. Simultaneously natural reefs and poseidonia meadows exist around the area, that will stimulate the colonisation of the artificial substrates.

- The authors of the 'Ecoguide to discover the transitional waters of Albania' published 2013 the latest research of wetland and its costal area. The Information and the possible change of the Area of Durres is updated, that reduce the time and effort for a prevent investigation that requires the implementation of an artificial reef.

- The water offers a solid visibility in every season. That guarantees a accurate monitoring of the reef, before and after the construction.

- North and southwards are equally suffering from climate change, overexploitation of sea and land, degradation of water quality and increase of pollution. The erosion of the coast are best observed by the position of the old military bunkers in Rrushkulli- Hamallaj; They were build 50 to 200m from the waterline and are now within the water, in the second row 20 to 25 m outside of the waterline. On these substrates the nitrogen-loving species like for example the filamentous green algae (Ulva spp.) indicate a heavy load of nutrient from nearby rivers. It is high time to give that area a preserving artificial reef to maintain the highly endangered plant species and fauna and to support the recovering of the water quality.

- The management of waste and protecting nature in Albania is insufficient. The sustainable care and controlling of illegal activities in no-take zones and protected area has a huge lack. As long as there is mismanagement, especially in controlling fisheries, one of the biggest risks for the artificial reef is damaged by illegal activity of dynamite fishing. Durres has one of the most facilitated and managed tourism and promotion of ecotourism and the close harbour has a high level of traffic. This enlivened surrounding brings a higher presence of control and therefore the risk of damage by dynamite fishing is minimized.

- The sector of tourism already flourishes in Durres. This field will welcome a further offer that attracts the visitors. Together with two nearby wrecks, the artificial reef made of one-man-bunkers represent a fascinating offer for a dive trip.

Objects

The project reveals two perspectives of outcomes; On one side, it will improve the current state of maritime coast on the other side we have the recovering of the land by removing the one man bunkers that don't have any further land use anymore.

- Regarding the maritime fauna, based on the results of the artificial reef in Nienhagen (Germany), a rapid increase of fish density and biomass during the first month will happen. We expect a high level of available (and constant) exploitable biomass overall fish assemblage and other species that resident in between the artificial reef structures.

- Considering the maritime flora, we anticipate that it needs a longer period that the suggested 12 month of monitoring for a regulation of a biological ecosystem. But community's of vegetation like plants, algae and mussels will occur and the process we start has a positive impact of a nutrition chain. There will be a colonisation of microorganisms between the growing vegetation which is a higher food supply for the Fauna.

- The one man bunkers give shelter to the small and juvenile fish so that they can grow and migrate to the costal area, that strengthen the local fish population. (Compare to passive protection of maritime fauna like quoting, fishing ban or minimal size requirement, the artificial reef represents an active intervention to increase the fishery value as part of management in the common fishery policy.)

Activities

Implementation

Implementation of Pre-construction phase: By identification of the broader goals, evaluating the ecosystem, analysing the ecosystem and how the environment will be affected by immersion of new substrates, the management plan can be formulate effectively. This pre-clarifications, includes the evaluation of local, social and economical situation and the involvement of potential users as well an analysis of preliminary costs. The artificial reef has to be designed by experts in the field that the physical features of the selected site into account, based on ecological and technical specifications relating to its purposes and setting.
The pre-construction phase includes all undertakings widely from taking decisions for the construct to the submersion of its plan to the component authorities. Some administrational implementation has already been made by previous clarification of the feasibility to build a test reef with the one man bunkers in the Albanian coast. The governmental instances (e.g. Ministry of defence, environment and agriculture) gave their verbal agreement and consent to this pilot project so far and a further cooperation has to ensure. The involvement of regional municipalities and the directory of Fisheries (ministry of environment) and the ministry of internal Affairs is essential for the success of the deployment of the artificial reef.

To ensure the success of the project and reduce the risks that the project brings with, a detailed management plan will be designed. One of the most important factor of the success of the deployment, is the effective cooperation between stakeholders, government authorities, managers, planers, engineers, fishers, divers, the environmental community specialized in questions of waste and recycling, touristic agencies and many more. When the involved parties are implicated into the planning, construction, and use of the artificial reef, these parties are more likely to offer guidance and assistance.

Implementation of Construction phase: Once, the operational long-term management plan has submitted to the competent national and local authorities, all undertakings related to the construction of the artificial reef and its deployment on the sea are developed the construction plan can start. The identification of the deconstruction area of the bunkers, the access to the marine staging and load-in and –out site, as well the storing site (at the port of Durres) has to be granted. The area to place the bunkers in the sea has to be refined by a differential global positioning system and marked with temporary buoys.

Implementation of Post-construction phase: The sustainable management of the artificial reef with exclusion of possible negative impacts on the maritime environment, a monitoring plan has to be designed by experts. His focus defines the success of the artificial reef and will forecast the collection of data, assess the evaluation of the ecosystem and includes the affect to the environment by the immersion of new substrates. Another element of the post-installation management plan is the applied research, that provides also assistance in monitoring and evaluating the efficiency of adopted management measures and identify alternative management options.

Construction

The installation of the artificial reef is the primary objective of this pilot project.

During the operational time offshore, relevant marine authorities will have jurisdictional authority over the reef installation site. The bunkers will be placed with differential global positioning system (DGPS) and marked with temporary buoys while the operation is observe by scuba divers, remote cameras or side scan sonar. The final location of the units will be provided to national and regional hydrographic authorities so they can be included in navigational map updates.

Monitoring/ evaluation

The monitoring and evaluation of the artificial reef includes the two head objective of this project.
Key issue of the post-construction phase is the physical, biological and socio-economic monitoring, as it allows assessing the structural and economical performance of the reef over the time. The monitoring and its evaluation will verify the expected benefits (ecological and environmental) and evaluate the efficiency of the applied control measures.

In this part, the involvement of stakeholders, like professional and recreational fishers and divers is crucial, because they can provide support in reef monitoring, evaluation and maintenance. The participation and arise the awareness of communities is one of the specific goal of this project and will take place as a technical Workshop. (more details at the chapter communication and replication of results)

The evaluation of collected data includes the documentation of the hydrological year cycle and the report of particular incidence in the ecosystem. The evaluation of the lateral stability of the elements and analysis of the biological and economical value after a year of monitoring will achieve a better understanding of the ecological effect. There will occur the evident, that the structures have a positive effect on the biodiversity and fish stock in the costal area. The analysis and evaluation of data is indispensable to give the most appropriate recommendation for an economical and touristic utilisation, as well it is the base for a reef expansion or developing additional reefs in Albania.

See the graphical timeframe attached as an annex.

Plan to ensure community participation

During the implementation of the project, there will be made a stakeholder analysis by direct observation of activities in the area, on-site interviews, mail and phone surveys, to identify the most relevant participators. Possible stakeholder groups are: recreational and professional fishers and divers, resource managers, scientist and environmental communities.

In cooperation with the local governmental authorities and the municipality a workshop and field visit at the location will be done for the fishing community and other stakeholders to imply *Refugium II*. This technical workshop (more details below/ communication) will evince the benefits of a participation of monitoring and sustainable use of the artificial reef. To attract the most variety and quantity of interested party's we consider organizing lectures and advertising the first Workshop through publicity, such as visual media, social media and leaflets.

A seminar at the University of Natural Sciences will inform the students in close collaboration with the university and his experts. Students can participate in finding inventive methods to enrich the monitoring and evaluation process.

Monitoring, Evaluation Plan and Indicators

As indicated earlier, the monitoring and its evaluation it self is one of the main goals of this pilot project. An adequate monitoring program will provide fisheries scientists and managers the information that is required to the test objectively. Essentially, the plan has to ensure that the data is replicable, statistically independent and not compromised by associated legal or financial constraints.

The monitoring management plan will be designed and undertaken by marine sciences experts. This plan will set the first focus on forecast collection of data before and after the reef deployment, both at the reef site and on adjacent natural habitats. The plan will aimed to verify water quality, structural integrity and stability of the structures, absence of increase of contaminants, the occurrence of pests/ invasive species and its planning if they occur and at least the maintain of the navigational safety.

Acoustic mapping verify the stability and hence the efficiency of the artificial reef structures and let understand how the physical conditions of the reef influence the succession of reef communities over time by modifying flow velocity and creating turbulent intensity in sediment accumulation.
Samples will be collected by scuba divers in adequate numbers and time periods, close and in the increasing distance of the reef to asses the radius of influence on the surrounding benthic and soft-benthic epibenthic and algal communities. In situ Observations and photographic techniques taken by divers will

establish lists and area patterns. The participating of fishing gears enable the sampling day and night in each season over the year, and the study of the daily behaviour of species assemblage in the seasonal changes, independent from water transparency.

The combination of various methods makes the describing of the communities associated to the artificial reef possible. The election of techniques will be employed and adjusted according to the morphological and geographical characteristics of the area. Statistical framework will evaluate the monitoring includes before-after control impact, analysis of variance, non-parametric methods and time series analysis.

Also the collection and evaluation of socio-economic data will demonstrate the quantity and quality of usage and public benefits of the artificial reef. Thus will justify the costs of construction and maintenance, provide information for the successful management of the reef regarding to give advice for further projects and investigation related to artificial reefs. A specific plan will conducted by experts in social and economic sciences and includes identification of objects, development of survey instruments and collecting and analysis of data.