ACTION E3

Summary

The development of the Monitoring Program included the monitored parameters, the methodology and frequency of monitoring as well as the sampling points

Physicochemical parameters

The delay on the implementation of Action A4, which included the development of a network of telemetry stations aiming at convenient and valid collection and processing of environmental data concerning the water quality in the area of interest, affected action E3, but i-BEC overcame this problem via the regular sampling of physicochemical parameters. Until telemetry stations were installed and fully operational, at least monthly field surveys were conducted for all the involved parameters. The main physicochemical parameters which are measured are pH, temperature, salinity, specific conductivity, Dissolved Oxygen and turbidity (in situ, field measurements). Furthermore, samples were collected in order to have water analysis at the Laboratory (in vitro measurements). The main parameters which were measured, were nutrients ions (nitrate, phosphate, nitrite, silicate and ammonium ions), heavy metals (cadmium, lead, arsenic, nickel, iron and chromium), pesticides (over 100 pesticides) organic content (TOC) (*Annex 7.1.10 Action E.3, Pictures 1-3)* and biological indicators (chlorophyll a, phytoplankton analysis). Furthermore, microbiological parameters are measured. The main conclusions can be summarized as follow: the environmental situation differs depending on the monitored water bodies, as well as the period of monitoring (winter, spring, summer, autumn). During summer period, the water level decreases, as expected, which leads to an increase of pollutants. On the other hand, during winter period 2014 - 2015, high levels of rainfall were observed and as a result, the whole region of *Epanomi* wetland was covered with water, increasing significantly the volume of water at the *Epanomi lagoons*. This situation led to a reduction of all pollutants concentration. The concentration of pesticides are detected seldom at low levels. The organic content is high, especially at *Epanomi lagoons*. This fact is common in lagoons as well in wetlands, due to the presence of shallow waters. The concentration of pH, conductivity, turbidity and

Dissolved Oxygen are at normal levels. The concentration of nutrients and microbiological parameters are depending severely to the monitoring period and the non-treated effluents that are poured to the monitoring site and area, indicated as point-pollution, whose origin cannot be determined.

The same situation prevails at *Aggelochori* area. During summer period decreases the water level, which leads to an increase of pollutants mainly to the two sampling points in the *Aggelochori lagoons*. The concentration of pH, conductivity, turbidity and Dissolved Oxygen are at normal levels as well the concentration of nutrients and microbiological parameters. Despite the fluctuation in the concentration of nutrients, which are depending severely to the monitoring period and the non-treated effluents that are poured to the monitoring site and area, the most parameters remain to normal levels. The monitoring tasks of sampling and water analysis are done properly at seasonal basis, while the tasks of maintenance and calibration of telemetric stations are done at monthly basis, at least. The system training at the first phase of operation, made possible the calibration of the stations in order to be able, during the operational phase, to distinguish the type of disturbance and the reasons of pollution. From all the results was observed point and uncontrolled waste disposal in unstable timebase and for this reason, the trend to the measured parameters is difficult to be described. The changes of the measured parameters may be due, unless to the non- treated effluents, to the simultaneous implementation of the restoration project. The fact that there is no trend identified, is also confirmed from the telemetry system. The sent data from telemetric monitoring stations were continuous and with no significant change. All the water monitoring procedure as well the results of laboratory measurements are follow the National and EU legislative requirements, such as the Water Framework Directive (e.g. 2000/60/EC).

Due to the short time monitoring period after the completion of restoration works, it is difficult the assessment of the environmental impact and as a result the determination of management decision of the area. It is necessary for the ecosystem to reach in balance so that to launch an objective assessment of results. For this reason, the project should be strengthened by continued monitoring and all the data should be used to support management decisions concerning the protection and rehabilitation of the area.

The increase of human activities in the coastal area of *Epanomi* and *Aggelochori* directly reflected on water quality and indirectly to the conservation of habitats and

species. Most problems arise from cultures, the use of fertilizers, grazing, aquaculture, the salt production activities, professional and recreational fishing, hunting, urban infrastructure, waste report and wastewater, the transport network, the recreational and tourist infrastructure/activities, etc.

The existence of pollutants in the project area comes mainly from the untreated effluents of the surrounding area's seasonal cultures and from the point throwing waste. The main agricultures of the area are: Cotton, wheat, vegetables, grapes and anise. Also the uncontrolled waste dumping in the project area from different human activities, such as hunting or recreational activities, leads to the increase of pollution threat of the area.

To the prevention or alleviation of this pollution threat, the restoration works will contribute, which unfortunately were completed with the integration of the project, so it is difficult to measure for nonce their impact in the area. The InterBalkan Environment Center also supported the project's demonstration activities to decision makers and stakeholders based on hard data. This monitoring program constitutes a demonstrative action, and it is going to act as a tryout for the future establishment of an Observatory (with telemetric and not only measurements) in Thermaikos Gulf, which is a priority target of the Prefectural Authority of Thessaloniki. The provision of the telemetry is essential for the water quality monitoring and the surveillance actions in order to ensure conservations results. The applied technology constitutes an innovative approach of environmental monitoring while for first time in Greece, the telemetry network at the first phase of operation, collects, combines and analyzes background data, creating a level of report regarding the water quality under regular conditions. With spectrophotometer methods of water quality analysis, any deviation from the level of report mentioned is recorded and the incidents of pollution is detected in time giving an alarm signal. During LIFE+ project, in order the monitoring and survey of habitats and species to be more effective, the project team decided that *Epanomi* telemetry station must be reinstalled in a different site where there was a suspicion of pollutants presence.

In general lines all the obtained results will be used by the services of RCM for better monitoring of other areas too and for demonstrative actions of the local population and the productive classes so as to be informed for the impact of their economic activities.

✓ Concerning the telemetric monitoring stations, from the day that they have been installed, hourly measurements are collected from the four telemetric stations. The function of the stations is normal and they are calibrated monthly in order to achieve and collect reliable data. The stations measure physicochemical data (pH, temperature, salinity, specific conductivity, Dissolved Oxygen and turbidity, total dissolved solids, water depth), as well as biological indicators (chlorophyll a) and are fully autonomous. These data are collected in order to detect any environmental changes during the monitoring period and to reveal the true environmental conditions and functions of the monitoring ecosystems. The obtained data reveal the constant, stable, so far, situation, apart from some incidents that took place in the summer period, where the concentrations of dissolved oxygen were reduced. The telemetric monitoring data reveal any instantaneously, permanent or evanescent change that can take place during monitoring period. The classical monitoring programs collect intermittently data, which are snapshots during monitoring period. By the use of telemetric monitoring stations any change that can take place at ecosystems is revealed, as well as the functions of the ecosystems, and the day of sampling can be modified properly. The function of telemetric stations demands at least monthly calibration and maintenance of the stations, for the telemetric unit of the station as well as the electrodes of the probes. Furthermore, due to some random unpredictable events, such as the reduction of water level and that the probes of the stations should be transferred and be repaired at the Laboratory of the i-BEC, with the assistance of the provider company. This caused intervals at the obtained data, but these were necessary actions to ensure the proper function of the stations and the reliability of the obtained data. These incidents are usual when telemetric stations are installed at the sea and at wetlands, due to the presence of many biological organisms.

Monitoring of hydromorphological factors

The main hydromorphological factors related to the development of specific fauna and flora were monitored under the frame of Action E3. In details, exposure to hydrodynamism and substrate structure were estimated. The exposure to water movement influences greatly the composition of the substrate, the structure of benthic communities and the morphology of sessile organisms. In the present study the exposure to water movement was measured in 10 different sites in the sublittoral zone in both sites (5 in Epanomi and 5 in Aggelochori) during the summer of 2013. For

each site the exposure to water movement was estimated by relating the exposure to water movement to the erosion of gypsum blocks placed in the same depth (-5 meters) in the different sites. The erosion value (g h^{-1}) is expressed as the weight loss of the gypsum blocks during a lunar day (24h 45min). The measurements were realized under calm conditions so as to minimize the erosion of the gypsum blocks based on the wave's action. The substrate structure was estimated via granulometry according to the scale of Wentworth. Granulometry did not show the dominance of fine structured sediments, which could lead to anaerobic conditions more easily, in the studied areas.

Monitoring of marine invertebrates

The presence of specific animal species in a marine area can provide important data regarding the status of the environment. In general, animals can be divided into two basic morphological groups based on their ability to move. The first group consists of the sedentary organisms, which live attached to substratum. These organisms (as they are not able to move and thus sustain all abiotic or/and biotic changes) play an important ecological role on the estimation of the environmental stress factors. In this first group, organism such as Porifera, Anthozoa, Bryozoa, Mollusca (Bivalvia), etc., can be found. The second group includes organisms which have the ability to move. These organisms exhibit the advantage to move when there is an important stress factor. The presence of these organisms in a region can provide significant information regarding the water quality. The survey of marine benthos requires the dissociation of hard (rocky) and soft (sandy) substrata. Fauna composition differs between the substrata and this is related to the seasonal cycle of soft substrata due to hydrodynamic forces.

The data collection was performed via the implementation of both destructive (samples' collection) and non-destructive methods (underwater snooping - in situ species determination and photographing of the selected sites). As mentioned, during sampling procedure we distinguish two basic parts: the hard substratum and the soft substratum. Soft substratum is the dominant type of substratum in both sites. Hard substratum is more abundant in Aggelochori than in Epanomi. On hard substratum we identified, among others, Associations of *Cystoseira* genus, which play an important ecological role for the associated fauna. Biodiversity was higher, for both invertebrates and fishes, in Epanomi and particularly at the southern part of the site

(potamos). On soft substrata three Associations of marine phanerogams were identified: Association of *Cymodocea nodosa*, Association of *Cymodocea nodosa* and *Zostera noltii* and Association of *Posidonia oceanica*. *Posidonia oceanica* meadow's density was much higher in Epanomi, which is also reflected to the associated fauna. Monitoring of associated fauna in phanerogam meadows was accomplished in situ with no destructive methods via photography and videos. A Corer and an Ekman sampler were used for sampling on unvegetated soft substrata. Samples collected were preserved and a stereoscope was used for the sorting of the organisms.

The survey on hard substrata was realised by SCUBA diving and megafauna invertebrates that can be identified without the need of stereoscope as well as fish species were recorded in-situ.

According to the experimental protocol, we conducted a preliminary sampling during spring of 2011 and four sampling procedures took place in each site during 2012, 2013, 2014 and 2015. The high frequency of monitoring aimed in the record of as many taxa as possible.

On hard substratum we recorded photophilous biocommunities on the horizontal sides and sciaphilous biocommunities on the vertical sides. Moreover, samples, from sampling areas of 625 cm2 (25 cm x 25 cm) were collected by means of a hammer and chisel. Samples collected were preserved in an appropriate solution for the identification of the species in the laboratory. A stereoscope is used for the sorting of the organisms in the laboratory.

The reflectance of water quality in species biodiversity is the most important aspect of Action E3. Thus, we wanted to use an index in order to estimate the ecological status of the two sites. Taking into consideration the Water Framework Directive and its implementation in the Mediterranean Sea, we used Bentix index (Simboura & Zenetos 2002) in order to monitor the water quality. According to our results of marine fauna, the water quality is better in Epanomi site than in Aggelochori. In addition, no important differentiation concerning composition and structure of benthic fauna was recorded during 2012-2015. At this point we must mention that organisms protected by various legal texts are present in the area (for example *Pinna nobilis*).

Data obtained *in-situ* by non destructive methods are valuable and in addition not time consuming. Thereafter monitoring of the area in the future should be undertaken by underwater video and photography.

Monitoring of marine benthic macroflora

Protection and management of coastal ecosystems presupposes the knowledge of distribution of marine benthic communities, as well as their structure. The base line data are of great importance for the monitoring of benthic populations in time (through the comparison of obtained field and laboratory data). The benthic marine macrophytes and their associations reflect environmental conditions and determine the coastal assemblages. Moreover, they are used as bio-indicators. The benefits resulting from monitoring the composition and structure of marine benthic macrophytic communities are subjective. The data collection was performed via the implementation of both destructive (samples' collection) and non-destructive methods (underwater measurements and identification of species when possible). Monitoring of phytobenthos during the current action included the qualitative and quantitative analysis of macrobenthic associations on hard and soft substratum, in order to estimate the site's ecological status. According to the experimental protocol, we conducted a preliminary sampling during spring of 2011 and four sampling procedures took place in each site at numerous points during 2012, 2013, 2014 and 2015. The high frequency of monitoring aimed in the record of as many taxa as possible.

Samples, from sampling areas of 625 cm^2 (25 cm x 25 cm), were collected by means of a hammer and chisel, regarding the hard substrate. As for the soft substrate the communities' analysis included collection of shoots for identification of the epiphytic macroalgae.

The main aim of Action E3 that differentiated the monitoring of macrophytes under its frame with the monitoring of macroalgae under the Action E2 is the analysis of the obtained data in order to calculate Ecological Status via the Ecological Evaluation Index (Orfanidis *et al.* 2001, 2003, Orfanidis *et al.* 2011). EEI is an index accepted in the EC for the implementation of the Water Framework Directive and in particular for the estimation of a water body's ecological status based on macrophytes, in transitional and coastal waters. For the application of this index, the identified macrophytes are distributed in ecological groups according to their morphology and life strategy. As resulted from Action E3 and in particular from the monitoring of marine macroflora, the water quality is better in Epanomi than in Aggelochori region.