ENVIRONMENTAL IMPACTS OF INFRASTRUCTURE WORKS AND ACTIVITIES AND ECOLOGICAL EVALUATION OF THE ALFEIOS RIVER BASIN

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Introduction

The infrastructure works (dams, flood-preventing embankments, gravel pits and lignite mining) have impacts on the hydro-morphological characteristics of the rivers and subsequently to the surface- and groundwater. Such works and activities usually represent factors indicating quality degradation of waters and ecosystems. The hydro-morphological characteristics constitute, among others, important elements for the classification of rivers ecological condition according to the Directive 2000/60/EC.

Purpose

The degradation of the water quality in Europe led the European Parliament to the publication of The Water Framework Directive 2000/60/EC on Water Policy which requires that physical, chemical and biological parameters of inland waters are measured in order to determine whether 'high' or 'good' ecological status has been maintained or achieved. In this context, the present study is an effort not only to estimate the ecological status of the Alfeios River basin, but also to determine actions necessary for its integrated management.

Materials and methods

The present study implements the methods of R.H.S. (River Habitat Survey) and Q.B.R. (Riparian Forest Quality), which are applied in regions where human activities (Floka's dam, power stations, bridges etc) already take place, as well as in regions where the fluvial ecosystem is still maintaining its natural features.

River Habitat Survey (RHS) is a method designed to characterize and assess, in broad terms, the physical structure of freshwater streams and rivers. The field survey element does not require specialist geomorphological or botanical expertise, but recognition of vegetation types and an understanding of basic geomorphological principles and processes are needed. RHS is carried out along a standard 500-m length of river channel. Observations are made at ten equally spaced spot-checks along the channel, whilst information on valley form and land-use in the river corridor provides additional context (RHS manual, 2003).

The QBR index ("qualitat del bosc de ribera" or riparian forest quality) is an easy-to-use field method for assessing the habitat quality of riparian forests. It was designed and developed for use in Mediterranean streams in Spain. The index is based upon four main aspects of the riparian area being studied. Unlike indices currently in use which assess the water quality itself or the habitat directly adjacent to the stream, the QBR index assesses a site's entire floodplain. It generates a score that can then be used to contrast sites, to compare sites to ideal conditions, or to assess the success of restoration project over time. The component factors of QBR are the total vegetation cover, its structure and quality, and the river channel alterations. Calculation of the QBR index in the field is made using a two-sided sheet which is completed by a field surveyor (an 'observer') familiar with the most common tree and shrub species found in the study area. The sum of the individual scores corresponds at one of the five quality classes of the riparian habitat (Munne et al. 2003) which broadly correspond to those suggested in the Water Framework Directive of the European Commission. At each class corresponds a specific color for illustration purposes (Table 1).

Table 1. Quality classes according to the QBR index.

Riparian habitat quality class	Scores	Color
Riparian habitat in natural conditions	≥95	
Some disturbance, good quality	75-90	
Disturbance important, fair quality	55-70	
Strong alteration, poor quality	30-50	
Extreme degradation, bad quality	≤25	

Study area - The Alfeios river basin

The Alfeios River is the greatest in length (112 km) and flow rate (2100×10^6 m^3) river in Peloponnisos and constitutes an important water resource and ecosystem of Western Greece. Alfeios River is also the fifth longest river in Greece among those which have the whole river body in the Greek territory. The river basin covers 3600 km^2 and extends in Western and Central Peloponnisos. In particular it is distributed in the Prefectures of Arkadia (60%), Ilia (30%) and Achaia (10%). Usually it is divided in three sub-basins: the upper one covers an area of 250 km^2, the intermediate is the largest of the three and covers an area of 3048 km^2 and last the third sub-basin is 362 km^2 large. Its main tributaries are the rivers Erymanthos, Lousios and Ladonas (Manariotis and Yannopoulos 2001, 2004).

The geological structure of Alfeios basin is complex. In the mountainous regions, Mesozoic sedimentary rocks of the alpine orogene (limestones, cherts, flysh formations, schists) of the Olonos-Pindos geotectonical zone are prevailing. In the hills, postalpine Tertiary (paleogene and neogene) formations represent shallow marine, lagoonal and fluviatile sedimentary facies. The lower altitudes consist of rocks representing the depositional environments of the Quartenary period (Pleistocene and Holocene), with sedimentary deposits of gravels, sands, silts and clays. (IGME 1980-2003)

In the coastal and lowland areas prevails the Mediterranean climate that becomes more arid and continental towards the inland and the mountainous areas. High precipitation in the central and western Peloponnisos and snow on the mountains ensure the function of a large number of springs in the catchment area thus causing continuous flow even during arid periods.

The catchment area receives an annual average of 1100 mm of rainfall, ranging between 800 mm and 1600 mm in a period of 80-120 days. The annual basin mean air temperature is 19°C, with a range of variation usually less than 16°C (MDDWPR, 1996).

Infrastructure and human activities (tourism, agroindustry and agriculture) in Alfeios River Basin, as well as intense and extended sand and gravel extraction along the main river and its tributaries have severe impacts on the river ecosystems (Table 2).

Results

The initial part of the research deals with the selection of the sampling sites. The RHS methodology requires that every survey stretch is 500 m long. Bank and channel features are recorded at 10 *spot-checks* spaced every 50 m. At each spot-check physical features (e.g. flow type, substrate type), land use and channel vegetation types are recorded (Szoszkiewicz et al., 2006). In the case of Alfeios River it was relatively difficult to locate a high number of spots which allow continuous access to the water and visibility of both banks for 500 m. On the other hand, the QBR methodology doesn't have this kind of requirements, because it is applied on sites at least 100 m apart from each other. Field visits as well as thorough study of the available GIS maps of the entire Alfeios catchment area have led us to select the final sampling sites for this study. Thirteen sampling sites were selected, 9 along the main river, from springs to mouth, and 4 from two main tributaries, where the R.H.S. and Q.B.R. protocols were applied. Data elaboration and evaluation is still in progress.

Table 2. Major activities and events regarding the Alfeios River catchment area.

Year	Major Infrastructure - Human activities
1951	Construction of Ladonas river dam and creation of the artificial lake
1955	Construction of the hydroelectric power plant 8km downstream of the Ladonas river dam.
1965	Construction of bunds on the lower sub-basin of the Alfeios river
1967	Initiation of an intensive gravel extraction from the lower sub-basin of the Alfeios river Draining and extinction of the lakes Mouria and Agoulinista Construction of irrigation channels on the lower sub-basin Construction of the Flokas dam for irrigation purposes Construction of dykes on the middle sub-basin in the area of Ancient Olympia
1971	Operation of two lignite thermoelectric power plants in Megalopolis (2x150 MW)
1975	Operation of a third power plant of 300 MW in Megalopolis
1989	Operation of a forth power plant of 300 MW in Megalopolis
1996	Issue of the decree for the ban of the gravel extraction in the lower sub-basin
2000	Declaration of the entire Alfeios riverbed as an archeologically valued area and ban of any gravel extraction in the municipality of Ancient Olympia
2002	Deviation of the Alfeios river course in Megalopoli for the extraction of lignite

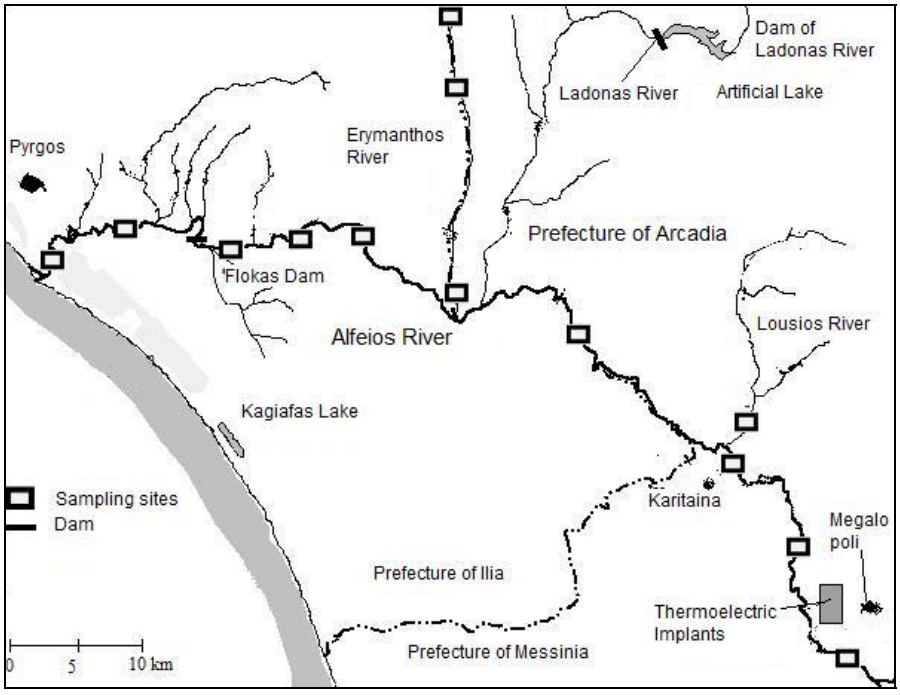

Figure 1. The sampling sites

Partial results of the Q.B.R. protocol are available. After completing the analysis, the sum of the four parts gives the final QBR index. The index varies between 0 and 100. As was expected, the degree of degradation of the fluvial ecosystem is reported on the total score of each sampling site. As reported in Figure 2, the total score tends to be higher in the upper part of the river with the exception of the last sampling site which has the lowest rank because it is situated where the river course was deviated.

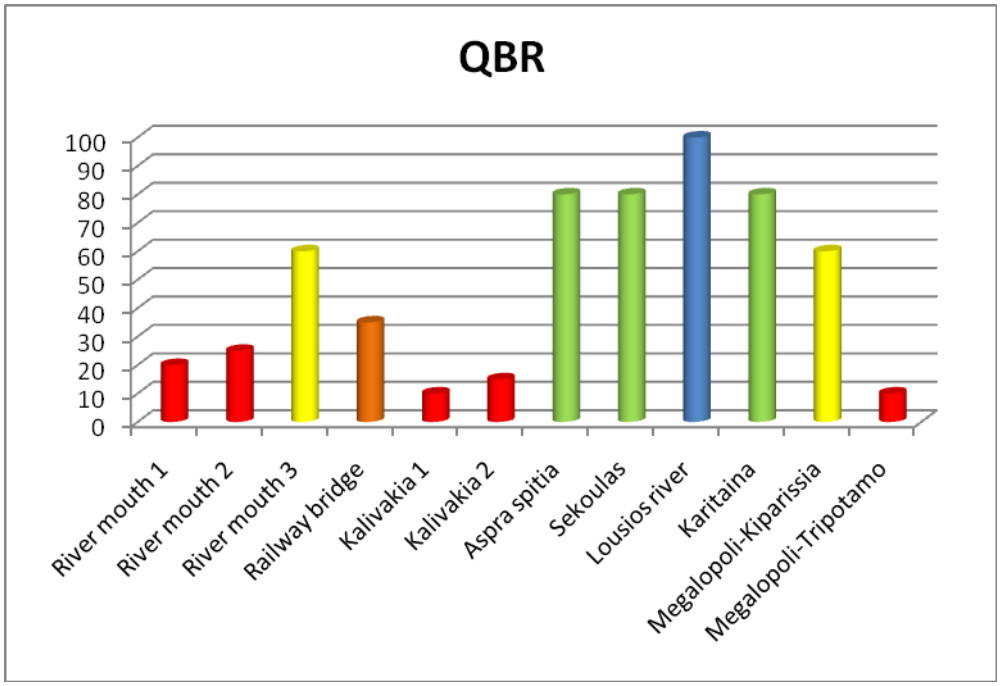

Figure 2. Scores of the sampling sites

According to the preliminary results almost half of the sampling sites belong to the category of the 'extreme degradation' and 'strong alteration' (Figure 3). This outcome was expected in the areas where constructions are present (eg. deviation of the river course, Flokas dam, gravel excavation pits in Kalivakia 1) that affect the fluvial ecosystem. The only site that scored over 95 points is in the Lousios River where the only human activity is rafting. The rest of the areas present a fair or good quality of the riparian zone, which means that it is relatively easier to improve or that their degradation has just started.

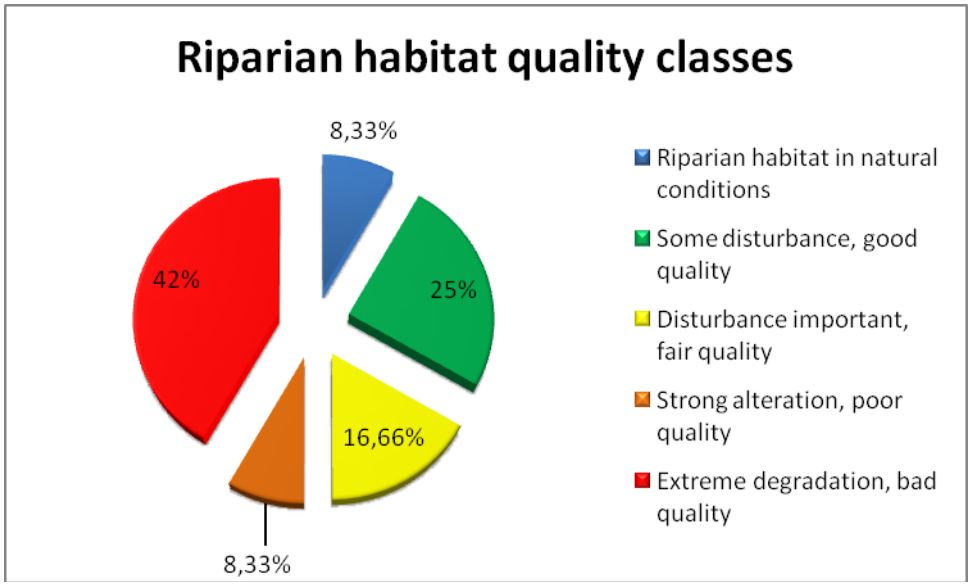

Figure 3. The riparian habitat quality classes in terms of percentages of the sampling sites

The following map (Figure 4) contains the partial results of the QBR index. It is obvious that the lower part of the Alfeios River is by far more endangered compared to the mountainous areas, where the presence of the gorge has a key role in the preservation of the fluvial ecosystem.

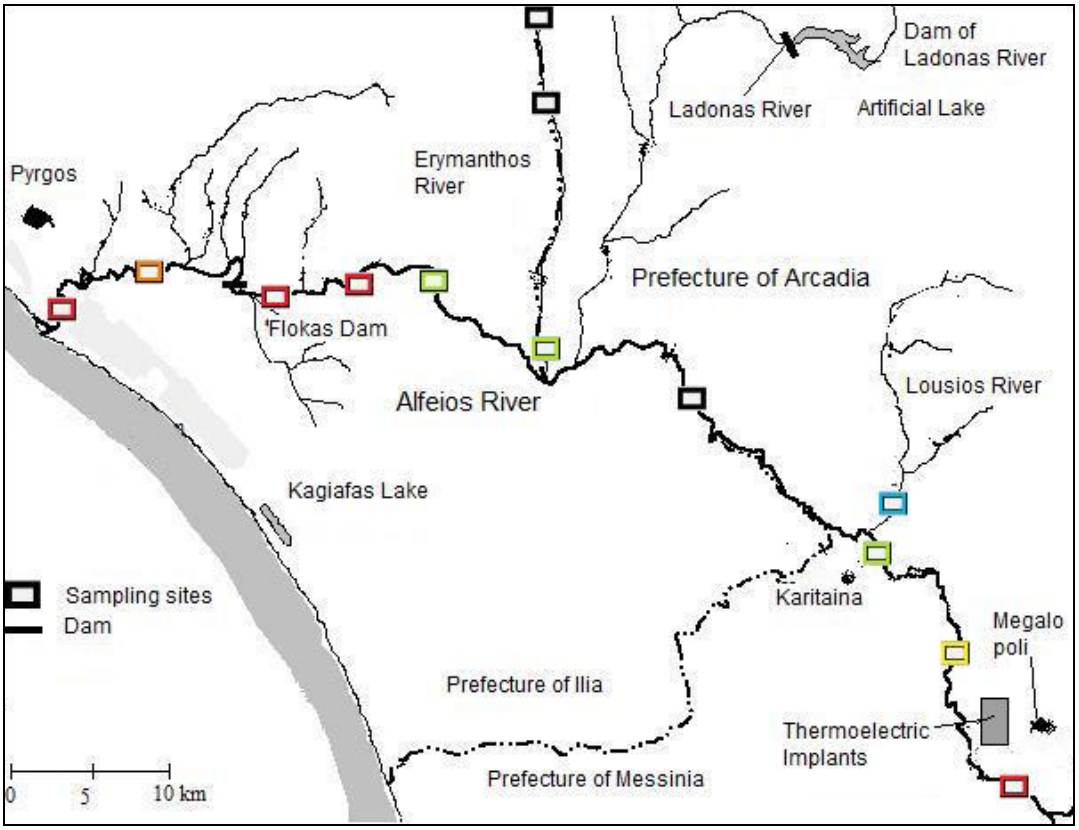

Figure 4. The quality classes of the sampling sites

Although in the Directive riparian habitat is used only for the characterization of 'high status', this system of five distinct classes may be useful for local managers and for restoration targets.

Regarding the RHS index, the elaboration of the data collected has just started. We expect that the geomorphologic evaluation of the sites situated near the dams and the excavation pits will be poor. On the other hand, sites with untouched morphological characteristics of the fluvial ecosystem will be surely encountered. The overall condition of the catchment area will be clearly revealed in the final phase of the elaboration and evaluation process.

Conclusions

Alfeios River constitutes the main water source of western and central Peloponnese supporting the neighboring communities. Although human activities such as settlements, agroindustries, pumping or deviation of water for irrigation, infrastructure works (dams, bridges), gravel extraction, as well as hydroelectric and lignite thermoelectric power plants etc. have been developed along the river and its tributaries for a long time and have led to the degradation of the riparian ecosystems especially in the upper and lower flow sections, some almost unaffected regions do really exist. Therefore, we hope that the ecological evaluation of the Alfeios River will be a useful tool for the sustainable management of the whole catchment area.

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