

TOXIC POLLUTION AND ENVIRONMENTAL REHABILITATION IN A VALUABLE MEDITERRANEAN COASTAL LANDSCAPE

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ABSTRACT

The coastal site of Schinias in the Marathon plain, 45 km N-E of Athens is a land area of 9 km² with a variety of natural habitats: freshwater spring, coastal wetland, coastal sand dunes covered by a pine forest and a rocky peninsula covered by Mediterranean maquis; an important diversity of flora and fauna species, including threatened resident and migrating birds, freshwater fish, amphibians and reptiles, live in the terrestrial and the marine biotope. This peri-urban ecosystem is valuable for environmental education and recreation; however multiple anthropogenic pressures have been exerted for decades. In 1923, the wetland was partially drained. The largest part of the area remained a semi-dried marsh in which military bases, a small power plant and a small civil airport were established. Environmental pressures such as a decrease of surface water and brackishness of underground water, toxic pollution by substances that were leaking into the water etc. have resulted in habitat degradation. A significant part of the wetland's soil was polluted by PCBs. Protecting and upgrading this area under serious pressures seemed to be a very difficult enterprise fifteen years ago. The major event of the Olympic Games 2004 was used as an environmental tool. A Rowing Centre was constructed by the appropriate technical works, which also upgraded the natural ecosystem. Sampling and chemical analyses of polluted soil were conducted; the complete dismantling of the old military base, the industrial infrastructure and the airport as well as pollution abatement and ground rehabilitation were costly projects that restored the wetland. The area where the military installations had been established was covered by natural soil; natural Mediterranean and aquatic vegetation has regenerated. Eight years after the Games, a significant improvement of the natural landscape has been achieved. On the other hand, social responses towards environmental conservation measures have been partially adverse, especially those from the local community and some ecological organizations. The remediation of the military installation did not gain a real approval of the local society, although it did not generate negative reactions. Potential risks from the toxic materials did not constitute a high priority for the officials and the whole idea was anyway met with indifference by the majority of the inhabitants.

Keywords: Schinias wetland, military bases, toxic pollution, PCBs, polluted soil, ground rehabilitation, environmental remediation, social responses.

1. Introduction

The coastal site of Schinias in the Marathon plain, 45 km N-E of Athens, is of a particular interest as a natural landscape of ecological value and outstanding scenery (Hadjibiros 2005, www.itia.ntua.gr/filotis). It is a land area of 9 km² with a variety of natural habitats: freshwater spring, coastal wetland, coastal sand dunes covered by a *Pinus pinea* and *Pinus halepensis* forest and a rocky peninsula covered by Mediterranean maquis; the forest covers an area of about 1.20 km² on a sandy strip about 400 m wide. The wetland covers an area of about 7 km²; very few coastal wetlands are still extant in the coastlines of south-eastern Greece and the Aegean islands that are generally dry and covered by Mediterranean maquis and phrygana. More than 320 species of flora and a significant diversity of fauna species, including threatened resident and migrating birds, freshwater fish, amphibians and reptiles, live in the land biotope.

Inflow of freshwater from Makaria spring (500-1700 m³/hour) and stagnation of fresh and brackish water in the wetland during many months of the year are essential factors for ecological habitat formation and function, for coastal forest persistence and regeneration and for land and aquatic wildlife diversity (ENVECO 1997). The cultural landscape is also interesting; in the wider area, there are important archeological sites while it maintains characteristics of the classic Attica coastal landscape.

The area of Schinias is valuable for nature conservation education and outdoor recreation for more than four million people living in the Attica region. Nature lovers would find there a tasteful and functional space for mild activities such as hiking, cycling, swimming, bird watching. Schinias is very attractive for families with small children as well as for disabled people because the mild inclines of the ground facilitate movement on foot, on a cycle or a wheel chair. Effective conservation of this site should be a high priority on the basis of its important natural and cultural landscape values. On the other hand, some responses towards ecological conservation have been adverse up to now, especially those from the local community.

Multiple and persistent anthropogenic pressures have been exerted on the wider area for decades. Scattered second-home developments on the adjacent hills, road-network expansion and agricultural land changes have a negative impact on the everyday landscape. The wetland of Schinias has been degraded since the 1920s, when the water of the spring was diverted to the sea; only about 10% of water inflow remained available for the wetland, therefore the dynamic balance between surface and underground salt, brackish and fresh water has been modified and the wetland has been partially drained. Environmental pressures such as a decrease of surface water and brackishness of underground water, noise and toxic pollution, urban solid waste disposal as well as uncontrolled hunting, fishing, grazing, motocross, car parking, camping and housing have acted for decades, resulting in considerable natural landscape degradation: habitat fragmentation, decrease of nesting, wintering or resident bird populations, extinction risk for endemic and rare species, limited regeneration of *Pinus pinea* (ENVECO 1997).

However, the drainage project has never been completed; only a part of the wetland has been cultivated, while the rest has remained a semi-dried marsh; in 1953, four years after the Greek Civil War, an American Navy communications base and a small civil airport were established on the wetland. The location of this coastal wetland, close to the centre of the Aegean Sea, was of a high strategic value; the Cold War had just begun and the optimization of military communications was important for the security of the American fleet in the Mediterranean Sea. The base was operative until 1990; it occupied an area of 32000 m² with a small power plant, warehouses, fuel containers and auxiliary buildings. A network of numerous antennas made of American sequoia timber extended all over the wetland serving military communications operations. The electrical power plant with 4 large diesel machines, 6 large transformers, electrical tables and large fuel store containers constituted the industrial installations.

In 1990 the installations became property of the Greek Navy and they remained unprotected without any use for several years. On March 23, 2001, some parts of the 6 transformers were stolen, probably for the exploitation of the copper contained in them; to reduce the weight, the perpetrators emptied the toxic liquid that served as insulator on the ground; about 450 m² of the wetland's soil were heavily polluted by PCBs. Initially, the authorities were not willing to support any integrated approach of the problem; they simply decided to remove 141 tons of the polluted soil and send for incineration as toxic waste in a specialized facility. Later, during 2002 and 2003, they decided to remove additional soil quantities of about 300 tons. The appropriate complete dismantling of the old industrial infrastructure and the military facilities as well as a proper pollution abatement and environmental remediation (Roitman 1997, USEPA 1997, Bieber 1998, Ministère de l' Aménagement du Territoire et de l' Environnement 2000, Toshisuke *et al* 2003) of the natural ground they occupied was a difficult and costly project.

An advanced environmental rehabilitation of this degraded Mediterranean coastal landscape would not be feasible without a powerful political boost. A major event like the Olympic Games and the related technical works were used as a tool to achieve environmental goals; the

construction of an Olympic Rowing Centre had been planned in the wetland. However, the question whether a complex technical work could be beneficial to a valuable landscape received firm negative answers by many Greek or international NGOs; they were strongly opposed to what they considered as an artificial construction in a protected site. They refused to consider possible positive outcomes resulting from an environmentally friendly technical project. The subject was a dominant one in the Greek mass media for a long period and took on significant international proportions. Finally, decision makers considered that the fears about a degradation of the natural landscape or its archaeological value were exaggerated or unfounded and the initial plan was applied as it was (Hadjibiros 2010).

The author of this paper has followed all these procedures, through his involvement in the design and implementation of technical works in Schinias for five years (1997-2002) and his presidency of Schinias Marathon National Park Management Board for six years (2003-2009).

2. Methodology and actions undertaken

Protecting and upgrading this peri-urban environment under serious pressures seemed almost impossible in the middle of the 1990s. In spite of its ecological value, establishing and operating an environmental conservation area in Schinias could not easily overcome the obstacles related to various adverse local interests; actions like restoring the flow of abundant and clean water to the wetland or securing the necessary financial support for dismantling the disturbing and polluting infrastructures would be minimally probable (Hadjibiros 2010).

Nevertheless, in the context of the country's preparation for the Olympic Games 2004, socioeconomic conditions became favorable for ambitious environmental design. The creation of a unique ecological, cultural and athletic centre in Schinias seemed like a fascinating idea. The construction of the Olympic Rowing Centre was planned to upgrade environmental conditions in the wetland. The founding of Schinias Marathon National Park was decided, aiming at the control and reduction of illegal and environmentally harmful activities (grazing, hunting, motocross, camping, debris disposal etc.) that constituted a long-lived status quo.

Careful environmental impact assessment (ENVECO 1997, Romas *et al* 2005) showed that it was possible for the Rowing Centre project not to destroy but, on the contrary, to upgrade ecological functions. The small airport was removed. The Rowing Centre was constructed under strict environmental terms. The location and design principles adopted for this facility, which comprises two interconnected semi-natural lakes, aimed at restoring ecosystem quality. Water diverted from Makaria spring to the sea has now been conducted to the new lakes; their overflow has been driven, through spillways, to the wetland. The restoration of the water's natural flow caused essentially a lifting of the drainage that had begun in 1923; the creation of the new lakes increased the available freshwater water quantity and quality (by regulating its salinity). A fire suppression system feeding with water from the new lakes has been constructed; this should contribute to the protection of the coastal forest against fire. Nevertheless, rehabilitation of the ecosystem would be dubious without upgrading surface and ground water quality by limiting potential toxicity (Di Marco and Buckett 1993) at negligible levels.

2.1. Rehabilitation of the area formerly occupied by the military industrial installations

Sampling and chemical analyses of polluted soil were conducted in 2002. Pollution by PCBs was found to reach 1500 mg/kg in the soil of the locations from where the transformers had been removed; in some other places of the industrial area it reached 95-450 mg/kg. The decision to rehabilitate the site was made later and the works did not start before the end of June 2004, one month before the official opening of the Olympic Games. The potentially dangerous materials were removed from the buildings in 10 days; all the constructions and facilities -with the exception of the underground ones- were demolished during the next 20 days. The works stopped for the Games, they restarted in September 2004 and were completed in the following months. A program of borehole drillings (54 boreholes, max depth 5m), for samplings (2 per borehole) and for chemical analyses was carried out in the wetland for several months. PCBs concentrations were found to reach 58 mg/kg in a small number of samples; significant

concentrations of other toxic substances, e.g. As, Ba, Cr, Pb and petroleum residuals were also detected. In a few samples taken from greater depths, the results indicated some chronic PCBs pollution, probably related to the normal industrial operations. Following the results of these analyses, a considerable volume of polluted soil, concrete and asphalt (in which PCBs concentrations exceeded 10mg/kg) was removed, treated as toxic material and sent to incineration facilities (Liakopoulos 2003, Zafiris and Papargyropoulos 2003, PRISMA DOMI 2004, GEOPRAXIS 2005). The whole area where the military installations had been established was covered by natural soil; natural regeneration of Mediterranean and aquatic vegetation has appeared since January 2005. The whole remediation operation reached a cost of about 1.4 million Euros.

Chemical analysis of soil and water samples did not indicate any significant toxic pollution in the following years. The concentrations of PCBs were below 10mg/kg in the soil. However, experts could not guarantee that PCBs concentrations in the soil would be under 10mg/kg in the whole area of the former industrial site; therefore, it should remain permanently enclosed by the old military fence for precautionary reasons.

3. Results

A few years after the Olympic Games, significant improvement of the natural landscape had been achieved. In fact, the technical aspects of the project have proved to be reliable and, consequently, the environmental outcomes in Schinias are very positive (Panagiotidis and Zogaris 2009). The channeling of water from Makaria spring increases the available quantity of freshwater in the wetland and provides better hydrological conditions of groundwater; an improvement of the forest's natural regeneration is expected. The natural annual fluctuation of the water's presence in the wetland constitutes an essential restoration of ecosystem function and increases the attractiveness of the area for the birds. The decrease of disturbing activities strengthens the naturalness of the existing ecosystems. The abolition of the airfield, the removal of the industrial infrastructure and the environmental remediation have restored the naturalness of the wetland and limited the concentration of toxic pollutants and the risk of biomagnified toxicity to acceptable levels. As a matter of fact, the environmental situation is the best one in the last 80 years and the conservation prospects are positive for the future (Hadjibiros 2010). The freshwater fish fauna has increased. At least five species have been observed; among them, the endemic *Pelastgus marathonicus* whose presence in the water of the Rowing Centre has been ascertained. Bird diversity goes up spectacularly: 117 species were recorded in Schinias before 1997; 236 species have recently been recorded. This number includes at least 52 species that reproduce regularly in the area. The number of aquatic birds that winter there is now greater than any other count before 2004 (Panagiotidis and Zogaris 2009, Hadjibiros and Sifakaki 2009).

4. Discussion

The technical intervention was successful for the upgrading of the natural landscape in Schinias, although many ecological NGOs were opposed; however, the local community is not ready to assimilate restrictions and management rules and it seems to need much time to adapt to them (Hadjibiros 2010). The National Park has been created but overcoming negative local reactions has not been possible yet. Many inhabitants protest because they disagree with the management rules, e.g. the control of cars movement in the Park, the limitation of building, the restoration of the marsh etc. Public hearings, local educational initiatives etc. have not led to significant results. Moreover, up to now, there has not been any significant support by the users, who could potentially reach hundreds of thousands and could put a well organized Park to good use. Some local public authorities expressed reservations for the environmental management, possibly because they indirectly served dubious interests of local businesses or land owners who were restricted by the operation of the National Park. Some local officials expressed unfounded wishes about an exploitation of the area based on a luxurious tourism development after 2004; the Rowing Centre should turn into a marina for tourist boats and the wetland into a golf course! Social support to the initial plan of ecological management was too weak to deal with protests for restrictions on cars movement and wetland flooding or with expectations to

build in the wetland area. Even the socially attractive perspective of a Park with special possibilities for disabled persons did not produce any significant positive reaction from the local people. In this context, the indifference of the inhabitants about the environmental rehabilitation was indicative; the restoration of the natural landscape was not a real priority for them and the remediation of the military installation did not gain an approval of the local society, although it did not generate negative reactions; nevertheless, some local officials claimed the old military facilities intending to repair and assign them to the municipality. Potential risks from the toxic materials did not constitute a priority concern for the officials and the whole idea was anyway met with indifference by the majority of the inhabitants.

On the other hand, the environmental fate of this small Mediterranean coastal wetland has been determined by its military value for many decades; because of this, the wetland has not been completely drained and polluting military activities have been established. Even today, local activities are prohibited in a part of the wetland, because a small base of the Greek Navy is still operating in a fenced section of the Schinias area; this authoritative exercise of power is accepted by the local community without objection. The presence of this base is negative for the natural landscape but access restriction contributes to an increased protection of local biodiversity. In fact, this fenced tract is the only part of the National Park that is fully protected from people's daily activities that can impact on nature. Of course, it may create other potential environmental risks, e.g. toxic substances, which may be used for military activities, could be leaking into the surface and ground water.

In fact, the main factors that undermine the ecological conservation effort have been the neutral apathy of the larger part of society along with the actions of certain local interests. The old belief that wetlands should be drained, together with the modern pressure to coastal land use change that prevailed since the 1980s have contributed to the development of the dominant local mentality. Paradoxically, the environmental movements and the local community have converged in an unfavorable attitude towards this integrated environmental project; the former because of their intransigent ecological positions, the latter because of its ecological ignorance and expected short term economic benefits. Finally, the actual environmental situation has been determined mainly by the Olympic Games. Due to this major event, proper works have been able to upgrade the landscape in Schinias; however, the Olympic Games will not come back soon and the long-term preservation of ecological values strongly depends on uncertain socioeconomic and political conditions (Hadjibiros 2010). In fact, the rapid economic growth of Greece during the last decades has left a significant deficit of environmental awareness, especially among the populations outside the big urban centers. Greek economy of year 2007 was in the 22nd place globally in relation to per capita GDP, but the environmental concern has remained quite low; for the time being it does not verify the rise that could be expected according to the Environmental Kuznets Curve (Inglehart 1997, Diekmann and Franzen 1999, Xepapadeas 2003). Indisputably, the serious economic degradation and the decrease of GDP of the last years did not contribute to any increase of environmental concern.

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