

## **A CASE STUDY ON TAHTALI DAM, INVESTIGATING DAM RESERVOIRS WITHIN THE SCOPE OF ENVIRONMENTAL IMPACTS AND THE TURKISH LEGISLATIONS, IN TERMS OF RECREATIONAL USAGE APPROACHES**

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### **Abstract**

The climate change, increasing irrigation and clean sustainable water resources need are today's few most important global environmental problems. Dams are built for centuries to prevent floods, to benefit from hydroelectricity, to obtain drinking and irrigation water and to provide space for recreational activities. Especially from 1950's, as the world population and need for water has increased, the number of dams built was increased greatly. Recently, dams' environmental impacts have been emerged. On one hand, recreational activities and the usage of clean water are affecting the environment and the reservoirs' ecosystem and on the other hand; there is the socio-economic development. By the legislations and the master plans, the problems between these two competing factors can be solved. In this study, dam reservoirs and their environmental impacts have been investigated according to the landscape architectural view then Tahtali Dam has been examined accordingly and recommended recreational activities. For this reason; land uses, before (1995) and after (2005) the filling of the reservoir of Tahtali Dam have been compared from the satellite photographs, air photographs and topographic map then; recommended recreational activities to Tahtali Dam have been examined by comparing with the Turkish legislations. As a result; it has been detected that the outside environmental impacts to Tahtali Dam is greater than the environmental impacts of the dam itself. But still, these two impacts are fastening each other. In addition, it has been seen that the land uses changed and illegal house buildings occur. For this reason, master plan must be prepared for the whole reservoir then, environmental impacts and land uses must be controlled immediately. Additionally, recreational master plans should be prepared for the dams in Turkey and recreational activities should be applied accordingly. As a result of that; as some important sport branches will improve in the country, highly coasted dams will be used to gain income and to protect the reservoirs.

**Keywords:** Dam lakes, dam reservoirs, environmental impacts, Tahtali Dam, master plan, recreational master plan.

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## **1 INTRODUCTION**

Water is an indispensable natural resource for all living beings. Although most of the earth's surface is covered by water, only 3% of this amount is fresh and available. 78% of this 3% amount of fresh and available water exists in the glaciers of northern and southern poles. This situation limits the source of drinking and utility water to the ratio of 22% of the total 3% fresh and available water (Gundogdu&colab., 2007).

Clean and sustainable water resources need is one of the current most important global problems. Depending on the factors, especially as the worldwide monitoring global climate change, increasing irrigation water need and unconsciously used water releasing in to the habitats; the amount of available surface water resources is decreasing and is lacking of quality. With the population of nearly 4 million, the developed industrial infrastructure and the implementations of intensive agricultural productions, İzmir metropolitan province is one of the most water needing places around the Aegean region in Anatolia. Despite that, the annual approximate value of 700 mm of rain is insufficient to fulfill the need of domestic, industrial and agricultural water demands in this region. With nearly equally benefiting from surface and ground water, İzmir province's most important surface water resource is the Tahtali Dam that is on the Tahtali Stream and 40 km. away from the south of the metropolitan (Ileri&colab., 2007).

It is for certain that dams have environmental impacts on the other hand, there are impacts on dams. To control these impacts, master plans for the reservoirs are required. Unfortunately in Turkey, these reservoir master plans are insufficient or not managed accurately. Thus, the level of pollution is increasing on both sides. (Balik, 2009) Under the reservoir master plan, recreational master plans are required to be prepared. Depending on these plans, many recreational activities can be carried out under control. Whether in respect to the protection of the environmental values, or socio-economical development by attracting tourists to the reservoir; abovementioned plans are necessary to be produced and applied efficiently (Balik,

2009). In this study, it is aimed to show the relationships between the land-use changes, the environmental impacts, the legislations, recreational uses, master plans and recreational master plans in the example of Tahtali Dam reservoir.

## 2 MATERIALS AND METHOD

Topographic map (1/100.000), taken photographs (2009), air photographs (1995), Google Earth satellite images (2005) and the previous studies of the study area; Turkish legislations of wetlands and reservoirs and the documents and literature studies on dams and impacts are brought together for this study. At first; the literature, maps, satellite images and photographs of the study area are examined according to the general literature on dams, environment impacts of dams. With the satellite images and the photographs, a land use comparisons' been carried out. Then, according to the Turkish legislations and the data, the suitable recreational activities are recommended and examined. At last, all of the data is gathered and the conclusion's been stated.

### Study Area

Tahtali Dam Lake is located in Menderes ( $38^{\circ} 9'30.86''N$ ,  $27^{\circ} 7'3.07''E$ ), a county of Izmir province ( $38^{\circ}25'7.86''N$ ,  $27^{\circ} 7'43.40''E$ ) which is on the western part of Turkey (Figure 1). Tahtali Dam has been built to meet the increasing need of water of Izmir province sufficiently. The dam reservoir lies between the southeast of Izmir metropolitan ( $38^{\circ}25'7.86''N$ ,  $27^{\circ} 7'43.40''E$ ) and Gumuldur ( $38^{\circ} 4'35.08''N$ ,  $27^{\circ} 1'19.31''E$ ) a town of Menderes county. Including the county in its borders, the reservoir covers 56.000 hectares of area (Yaz, 2000).

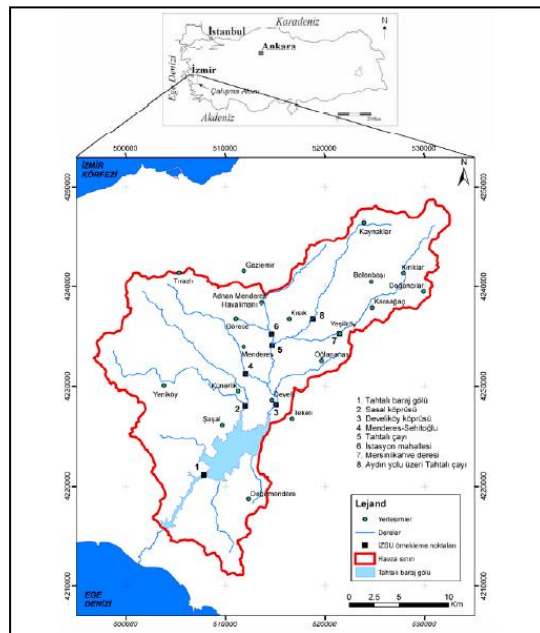


Figure 1: Tahtali Reservoir Area (Baris&colab., 2007).

To prevent the domestic, industrial, agricultural and animal husbandry pollutions; to protect the human health; to maximize the use of drinking water and for sustainability, the government approved the legislations of The Regulation of Reservoir Protection (1992) and The Protection of Water Reservoir Areas Regulation (2002). The protection zones are determined based on these legislations. 0 - 300 m. of distance is the absolute protection zone (1537 ha.). 300 - 1000 m. of distance from the lake is the short range protection zone (2936 ha.) and 1000 – 2000 m. of distance is the medium range protection zone (3500 ha.). Lastly, from 2000 m. of distance to the end of reservoir area is the long range protection zone (43835 ha.) (Balik, 2009).

Flora of the reservoir consists of cultivated plants, sand vegetation, frigana vegetation and maquis vegetation. In some areas, forest pattern that mostly includes red pines (*Pinus brutia*) exists (Erdem&colab., 2002). In the study area, Mediterranean climate is dominant. The climate is characterized by warm to hot, dry summers and mild to cool, wet winters (Erdem&colab., 2002).

### Water Pollution Condition of the Reservoir

According to the literature, as a result of the eutrophication especially in dry seasons, Tahtali Dam Lake is contaminated by the heavy doses of N (Nitrogen) and P (Phosphorus). This process generally occurs as the amount of nitrogen and phosphorus increases continuously, the amount of oxygen decreases. This incident creates an anaerobic environment that is habitat of algae. For this reason, the pollution of Tahtali Dam Lake continuously ruins the quality of the water (Gulbahar&colab., 2005).

The prevalent agricultural activities increase the flow amount of the ground water, many main elements and other heavy metals. At the same time, the fertilizers or other chemicals being used for the agricultural activities ruins the soil's natural ingredient and causes physical, chemical and biological changes. Thus, the acidity or the ion balance values of soil degrades. Additionally, the excessive amount of discharging of the  $\text{NH}_4$  and  $\text{NO}_3$  from the groundwater causes the amount of the chemicals released from underground basin materials by oxidation reaction to reach excessive amounts. As a result of the accumulation of exceeding heaps of nitrogen and phosphorus, the quality of water in the water basin reduces greatly. Besides, the determination of non-point sources of water polluters is a hard and complex problem. The analysis mentioned above is based on the 3 years of research (Gulbahar&colab., 2005).

### Groundwater Pollution Condition of the Reservoir

As a result of the sampling from chosen 35 wells at the medium and long range of the protection zones, it is detected that the groundwater in Tahtali Reservoir has a good quality but affected by the natural and artificial polluters from place to place. Especially, in Cumaovasi and nearby area, agricultural caused nitrate pollution and in Develi and nearby area, the natural arsenic pollution takes attention as point sources of pollution. For the developing reservoir, to protect both the surface water and the groundwater, the legislations should be applied strictly and to protect the sustainability of water resources, maximum efforts should be applied. Lastly, according to the consideration of the interaction between Tahtali Reservoir and the surface water, groundwater quality of the reservoir should be monitored routinely by the government. Thus, the monitoring should be included in the management plan of the reservoir (Ileri&colab., 2007).

### Comparison of Land Uses at Tahtali Reservoir, Before (1995) and After (2005) the Dam Lake

As we compare the land uses at Tahtali Reservoir before (1995) and after (2005) the dam lake is formed, we can see that the settlement areas increased as 26%, industrial areas as 61%, greenhouse areas as 350% (Figure 2; 3). Now, the 35% of the reservoir areas are forest areas, 31% are moor areas and 20% are agricultural areas (both fallow and dry farm lands) (Selcuk&colab., 2008).

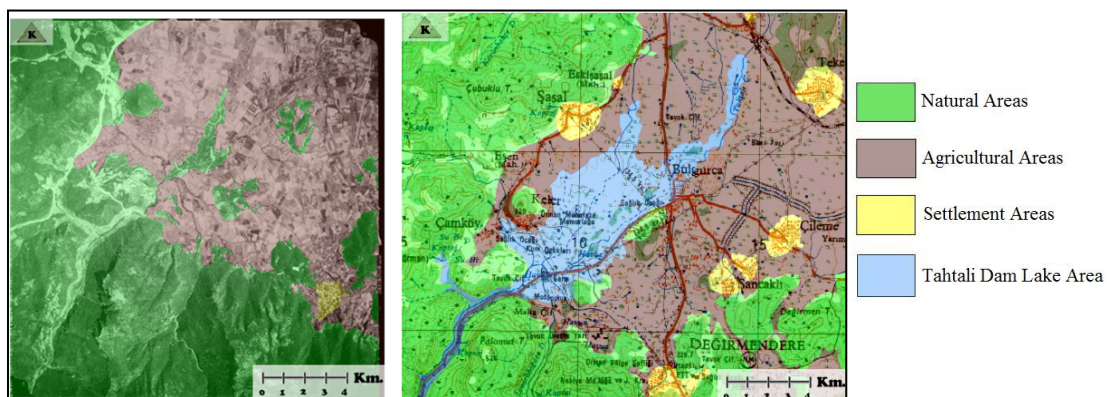


Figure 2: Tahtali Reservoir Area (1995) (Balik, 2009).

Figure 3: Tahtali Reservoir Area (2005) (Balik, 2009).

In 1995, at the absolute, short range and medium range protection zones; the ratio of the natural areas (lands like forests, rangelands and moor areas, except the agricultural areas) to the agricultural areas was 46% to 54%. Because the dam lake water gathered on the agricultural area, this ratio changed as 57% to 42% and 1% of settlement areas are added until 2005) (Figure 4) (Balik, 2009).

In 1995, at the absolute protection zone (Figure 5), 31% of the zone was the natural areas and 69% of the zone was agricultural areas. In 2005 (Figure 6), 42% of the zone is the natural areas, 57% of the zone is the agricultural areas and 0.6% of the area is the settlement areas (Balik, 2009).

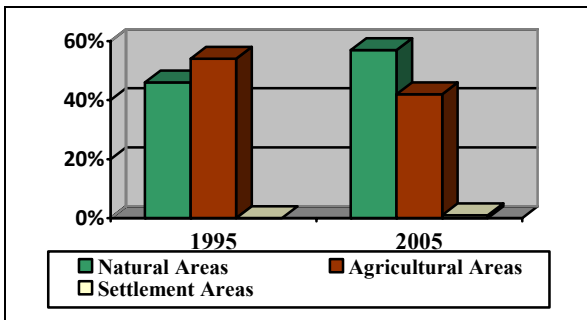


Figure 4: Land uses between the absolute and the medium range protection zones (Balik, 2009).

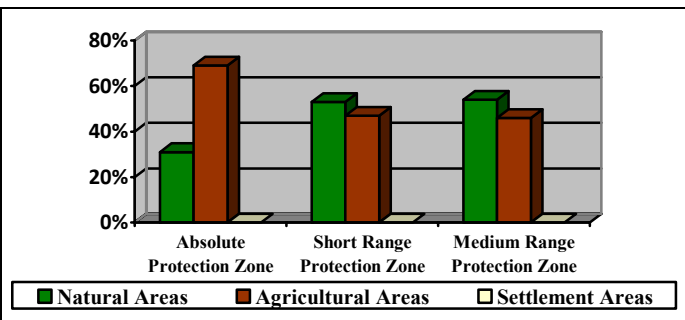


Figure 5: Land use at Tahtali Reservoir Area (1995) (Balik, 2009).

At the short range protection zone in 1995, the natural areas are 53% (Figure 7), agricultural areas are 47% (Figure 8). In 2005, the natural areas cover 60%, agricultural lands cover 38% and settlement areas cover 2% of the zone (Figure 9) (Balik, 2009).

At the medium range protection zone in 1995, the natural areas are 54%, agricultural areas are 46% (Figure 8). In 2005, the natural areas cover 69%, agricultural lands cover 30% and settlement areas cover 1% of the zone (Figure 9) (Balik, 2009).

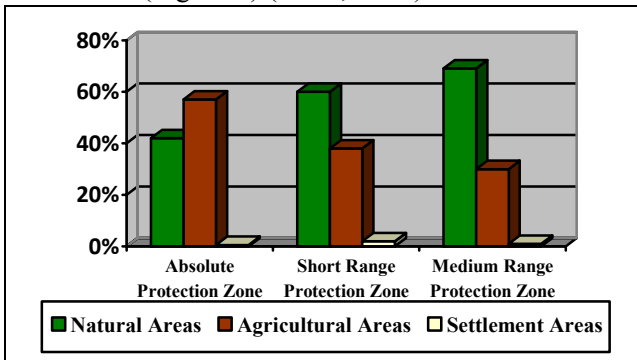


Figure 6: Land use at Tahtali Reservoir Area (1995) (Balik, 2009).

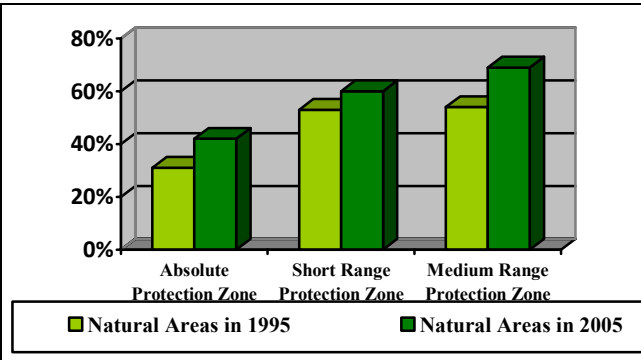


Figure 7: Natural Areas in Tahtali Reservoir (Balik, 2009).

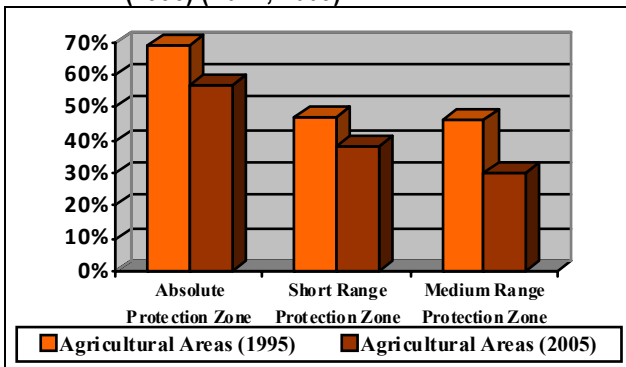


Figure 8: Land use changes of agricultural areas in the zones (1995 and 2005) (Balik, 2009).

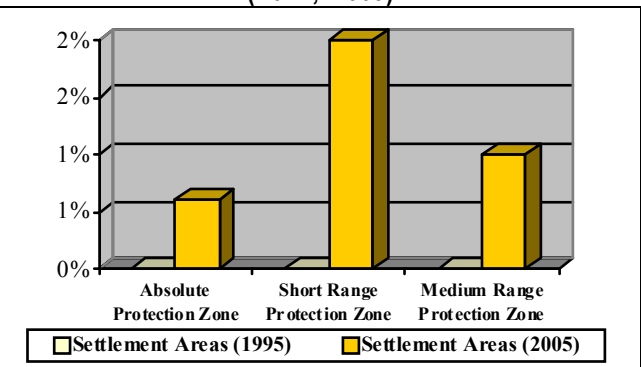


Figure 9: Land use changes of settlement areas in the zones (1995 and 2005) (Balik, 2009)

When we compare the land use changes in the zones between the absolute and medium ranges; after the water gathered as a dam lake, the natural areas' ratio is increased, agricultural areas' ratio is decreased and settlement areas' ratio is increased. After the dam is built, land use strategy and the forestation policy changed and the natural areas increased. Though, the settlement areas couldn't be prevented and so they increased. In the reservoir area, the illegal settlements and the unplanned industrializations couldn't be avoided thus; these areas increase rapidly and become a threat as polluters for the reservoir.

### Recreational Activities Suitable for Tahtali Dam

First of all, it should be stated that in Turkey, there are no recreational master plans for reservoirs. Because the dams' constructions cost high, the money gained from recreational usage lower these costs in a period of time and causes to benefit from the income for the management. The plans must be prepared from high scale to low scale; based on the reservoir master plans, recreational master plans and then recreational

activity plans should be prepared. Recreational potential analysis should be made as the suitable recreational activities should be considered economically and environmentally. An activity may be useful for the economic income but unsuitable for the environmental sustainability or an activity may be unsuitable from the perspective of legislations. Then, this activity should be done by more controlled way or at an outer zone if suitable or should be cancelled (Balik, 2009).

Depending on the Turkish legislations and the natural and cultural characteristics of the reservoir; in the protection zones of Tahtali Dam Reservoir, 7 terrestrial recreational activities are taken as an example of comparison for evaluation. Because Tahtali Dam Lake's water is a drinking water supplier for the area, the activities like fishing, jet-skiing, canoeing and yachting are not suitable to keep the water clean. Thus, the terrestrial recreational activities are suitable for the reservoir. For the suggested activities there's the need for some kind of small structures like toilets, storage rooms or stables. These structures are taken into consideration and are compared with legislations. For example, because the stables are not allowed in the absolute or short range protection zones; horseback riding recreational activity can only take place in the medium or long range protection zones. Below are the suggested recreational activities (Figure 10) (Table 1) (Balik, 2009):



Figure 10: Recreational Activities Suitable for Tahtali Dam with the closest available zones (Balik, 2009).

Table 1: Recreational Activities Suitable for Tahtali Dam with the available zones (Balik, 2009).

Recreational Activity	Pros	Cons	Available Zones
Picnic	Natural characteristics of the reservoir are suitable for picnic. Suitable with many other recreational activities. Accessible for the locals and tourists. High demanded recreational activity. Many locations are available because of the large reservoir area.	Barbeque may be dangerous and it is optional. Pollution control is essential. Dam lake must be protected from the curious visitor thus, the pollution. Ignorant visitors may harm the flora and the fauna. Areas may be overcrowded and uncontrolled. Tables, toilets and fireplaces may be constructed.	Short, Medium and Long Range Protection Zones
Jogging / Trekking	Activity with minimum amount of pollution. Suitable with many other recreational activities. Many locations are available because of the large reservoir area. Accessible for the locals and tourists. Races or tournaments may be organized.	Encountering with hogs or other wild animals. Ignorant visitors may harm the flora and the fauna.	Short, Medium and Long Range Protection Zones
Horseback	Many locations are available because of the large reservoir area. Reservoir area may be a special	Stables and paddock areas should be constructed. Racetracks may be constituted.	Medium and Long Range

	attraction area for tourists.	Educated staff should be working and managing the activity.	Protection Zones
Bicycling / Mountain Biking	Many locations are available because of the large reservoir area. Depending on the condition of the racetrack, bicycle races may be organized.	Storage areas for the bicycles should be constructed. Educated staff should be working and managing the activity.	Medium and Long Range Protection Zones
Archery and alike	Many locations are available because of the large reservoir area. Reservoir area may be a special attraction area for tourists.	Areas may be organized and storage cottages should be built. Educated staff should be working and managing the activity.	Medium and Long Range Protection Zones
Camping	Many locations are available because of the large reservoir area.	Barbeque may be dangerous and it is optional. Pollution control is essential. Dam lake must be protected from the curious visitor thus, the pollution. Ignorant visitors may harm the flora and the fauna. Areas may be overcrowded and uncontrolled.	Long Range Protection Zone
Enduro / Off-Road	Depending on the condition of the racetrack, races may be organized.	Air pollution and noise pollution may occur, and disturb the peace, so this activity must be planned carefully. During the races, area may be overcrowded. Racetrack and other structures are necessary.	Long Range Protection Zone

As we examine the positive and negative sides of the activities, for the recreational activities, it is obvious that the main factors that causes the pollution are; ignorant using, non-planning, mistakes of planning and bad managing.

### 3 CONCLUSIONS

There are 3 main objectives in this research:

- To attract attention on the accurate planning of reservoirs and legislations to manage the balance between the economical and environmental sustainability.
- To emphasize that, based on the hierarchy; master plans, management plans, recreational master plans and recreational activity plans should be prepared and strictly managed urgently in Turkey and other developing countries.
- To support the undeveloped olympic sport branches like duathlon, triathlon or off-road motorsports, these activities should be added to the activity plans of dams (Balik, 2009).

In terms of the environmental impacts; because Tahtali Dam is considered as a new dam (built between 1986 and 1999), the first and the second order impacts are happening but; the third order impacts are in process. Before these impacts; illegal settlements' domestic pollutions, industrial areas' pollutions and agricultural pollutions should be urgently interfered. As the detected pollutions affect the quality of the lake water, in time they also affect the flora and the fauna. When the impacts from the dam and the outer sources join each other, they both trigger each other. Because, the dam's environmental impacts fasten the outer sources' pollution. For example, as the dam lake is formed, it includes stabilized water that's quality is becoming lower. Anaerobic environment occurs, the amount of bacteria increase and thermal pollution happens. When these impacts come together with the pollution of wrong agricultural or industrial practices, the effects fasten themselves. Other than this; in the researches on the water quality of Tahtali Dam, it is said that there is the nitrogen, phosphorus and heavy metal accumulations. These pollutions are originated from wrong agricultural practices. The other trigger reason is by the invading of agricultural areas by the lake water and the occurring anaerobic conditions under the water; the biomass dissolves in the anaerobic lake water by the bacteria. This situation increases the nitrogen and phosphorus accumulation. Thus, for the Tahtali Dam, the outer sources of pollution should be interfered urgently, first by planning then managing

and controlling. Then, the dam's impacts should be managed accordingly. Otherwise, the water quality, fauna, flora and the human life is in danger. Only the steps taken recently for Tahtali Dam are, opening the dam gates and forestation (Balik, 2009). It is wrong to consider that the environmental impacts and pollutions only affect the reservoir area, they ruin the ecosystems in time. Besides; depending on the environmental corruptions, economical products and benefits decrease in a while. For example; decreasing quality and quantity of water, flora and fauna causes, less income from harvests, fish productions, agricultural products, energy and tourism. Besides, there are social effects originating from the land use changes. The agricultural areas that are the sources of income are getting smaller and the illegal settlements are increasing. The managing and inspection processes should include monitoring with geographical information systems (G.I.S.) (Balik, 2009). Many sport branches are not developed in Turkey. It is the result of the sport politics. One of the most important factors that form the fact of sport is the sport places. Turkey is a country with the high ratio of the young population and convenient for many sport branches. For example, for Tahtali Dam reservoir the recreational activities are suggested. It is the sport education and politics that will take attention to the sport places and encourage the young population. As a result, the wrong evaluations lead to frustrations for economical, ecological and social sustainabilities. Therefore, for the application of the right plans and legislations, it is necessary to arouse all civilians and the politicians to think and act accordingly.

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