# Summer School on Education for Sustainable Development in Protected Areas and Biosphere reserves

Water management in the area of Phocis prefecture and Parnassos National Park

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# 1. Introduction

Water is more than just a liquid. Water is life.
The succeeding essay was written during the Summer School on Education for Sustainable Development in Protected Areas and Biosphere reserves in Amfissa, Phocis prefecture, Greece, from 6th to 19th of July 2014. In this essay a short study of water management in the area was undertaken by 5 colleagues from different backgrounds and countries. The scope of the essay is to shortly summarize water management of the Phocis prefecture and Parnassos national park with regard to water supply, irrigation, urban uses, the waste water issue, sewage treatment plants, etc., in the present and past with special regards to educational programs and awareness campaigns in place. Additional educational activities and programs will be proposed to enlighten the need of education for water preservation and management as part of education for sustainable development.

## 1.1. The background of authors – everybody

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Savvas Vasileiadis is a guide in Management Body of Olympus National park from 2009.

## 1.2. Water and water management

Water is essential to sustain and promote life. As a resource it has been considered invaluable for humans, settlements, economical activities and agriculture throughout history and demand for water has been increasing with growth of population and all other human activities. Today it is still the most important factor of prosperity. For a large part of the human population it is heavily acquirable and scarce resource even with the enormous leap in technological advance of securing drinkable and usable water in the past century. Growing pressure on water resources – from population and economic growth, climate change, pollution, and other challenges – has major impacts on our social, economic, and environmental well-being. Many of our most important aquifers are being over-pumped, causing widespread declines in groundwater levels. Half of the world's wetlands have been lost to development. The world's water is increasingly becoming degraded in quality, threatening the health of people and ecosystems and increasing the cost of treatment. Some 780 million people around the globe still lack access to clean water and thousands perish daily for lack of it.
Water management is an interdisciplinary field concerned with the management of water resources. People in this field are concerned with ensuring that a supply of clean, potable water will be available to people who need it, while balancing the needs of industry and the environment. A number of different topics fall under the umbrella of this field, from sewage treatment to wetlands restoration. Many national governments have departments that are in charge of water resources, and regional governments often have smaller offices of their own to focus on this issue. One area of water management involves handling the water in the natural environment. This includes monitoring the amount of water in the environment, seasonal and annual changes in water levels and other characteristics, and keeping an eye on the cleanliness of water supplies. It can also include things like keeping waterways fully navigable, eradicating invasive species from protected environmental areas, and flood control measures which can range from building levies to expanding wetlands to create a trap for floodwaters.

### 1.3. Phocis prefecture and Parnassos national park

Modern Phocis has an area of 2120 km² (819 mi²), of which 560 km² (216 mi²) are forested, 36 km² (14 mi²) are plains, and the remainder is mountainous. The massive ridge of Parnassus (2,459 m/8,068 ft), which traverses the heart of the country, divides it into two distinct portions. The neighboring prefectures are Aetolia-Acarnania to the west, Phthiotis to the north and Boeotia to the east. Much of the south and east are deforested and rocky and mountainous while the valley runs from Itea up to Amfissa. Forests and green spaces are to the west, the central part and the north. Its reservoir is the Mornos Dam on the Mornos river. It covers nearly 1 km to 3 km². It was completed in the 1960s, and GR-48 was extended to pass through the dam. With a population of 40,343 (2001), it is one of Greece's least populous regional units, and has a population density of 19 persons per km² (49/mi²). In the summer months, the population nearly doubles due to the influx of tourists. Most of the villages are in the south, the southeast and the east, especially in the areas between Amfissa and Itea. The north and the west are the least populated.

Parnassos Mt. consists of spectacular cliffs and rocky areas. Its geology is mostly hard limestone (76.6%). Limestone forms particularly impressive karst on Parnassus; some formations are nationally known, such as the Sinkhole of Lilaia and the Corycian Cave. The climate is humid, with an average annual precipitation of 1468,2 mm at an altitude of 1300 meters. Winters are particularly harsh and long lasting, while summers are cool. Despite rainfall's intensity, surface runoff is low, due to the prevalence of permeable limestone, which justifies the large number of springs. Parnassos is a complex ecosystem, with a wide variety of landscapes and habitats, resulting to a rich and rare biodiversity. The protected area is characterized by a large number of special scientific importance and significance plant taxa. There have been reported 854 taxa, 6 of which (*Centaurea musarum, Hieracium gaudryi, Eryssimum parnassi, Euphorbia orphanidis, Bupleurum capillare, Campanula ripicula*) are endemic, while, a large number are stenoendemic (endemic to Central Greece, Greece etc). Several species in the area are assigned to different risk categories according to WCMC, P.D.67/1981 , UNEP, RDB and the Berne Convention. *Quercus coccifera*, *Quercus ilex* and *Pistaccia lentiscus* are characteristic species of this zone. Regarding the fauna of Parnassos, there are 5 species of mammals, 2 amphibians, 2 reptiles and 2 invertebrate species recorded and listed (Directive 92/43, Annex II) 38 species of birds (Directive 79/409, Annex I) and 68 additional bird species protected by international treaties. In addition, at least seven species of mammals are protected by Greek law, and several vertebrate species included in the Red Data Book of Threatened Vertebrates of Greece. Other protected areas established within the responsibility area of Parnassos NPMB are the Aesthetic Forest "Dasos Tithoreas" (PD Gov. 125/D/1979), the Wildlife Refuge " Asprochoma - Fine - Prontoli – Arachova" (Gov. 1043/V/1976), the breeding ground for prey "Amfikleia" (GG 406/V/76). Regardless its natural - ecological value, Parnassos is a place of enormous cultural - historical heritage, i.e. the Sanctuary of Apollo and the Oracle of Delphi. In addition, the great cultural - historical value of the area is enhanced by the ancient and modern monuments, as well as the rich history of the region.

## 2. Methodology

In this chapter we are going to present all the methodology that we have used in order to achieve our aims. Brainstorming is a group or individual creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members, for this reason we have done some meeting among the members of our group and put down our ideas about how to develop the report, what to take in consideration and the division of labour. After we have done this we started to search for information, in order to do this we used different type of techniques and tools. Internet research is the practice of using Internet information, especially free information on the World Wide Web. The tool of Google „google scholar" is very useful when you are searching for scientific articles. We used also another, more traditional, source of information that is a simple library research, especially, in this case, we were able to find some hydrological maps of the region. To integrate this type of approach we have tried also to keep in contact with local people aware and able to give information about our topic. So we

interwieved one of the organizer and head of the centre. We can define an interview as a conversation between two or more people where questions are asked by the interviewer to elicit facts or statements from the interview. Interviews are a standard part of journalism and media reporting, but are also employed in many other situations, including qualitative research, that's why we like to support this kind of approaches.

## 3. Results

### 2.2. Past and present water management and geography, geology, hydrogeology and climate

During the past times water management in the area of Phocis was of the utmost importance and today there are multiple examples of different approaches to ensure an abundance of quality water for people, industry and agriculture. Through observation and information gathering we could find multiple examples of very complex, and thoughtfully planned management schemes of water management. One of the perfect examples of critical water management in the past can be found in Amfissa in the Harmina quarter. In that area there are several springs of water that were used for the processes of leather production. Leather production in the area brought the city high income. After production, water was diverted in different parts of the city and used by the general public. This is an example of water management that we see today as well. After the introduction of more chemically dependant production techniques, leather production was mostly abandoned to preserve the water management system still used at that time by the general public, as well as because of the decrease of profit from the production. Water at the coastal part and the city of Kira as well as most other places in the vicinity were using water tanks in the ground to preserve raining water for later use. The same principle of water management for households can be seen all around the Mediterranean. The most important example of critical and innovative water management is the irrigation of olive oil trees in Amfissa. The plain between Amfissa and Kira is under the influence of sea water because of a low geographical profile. Sea can easily penetrate into the underground water and increase levels of ions in the ground. To prevent such practice, people would use an irrigation method of completely flooding the area, and in fact push the salty seawater away from the olive oil trees. Such practice led to formation of new subspecies in Amfissa and use and export of olives used mainly for human consumption and not production of olive oil.

### 3.1 Geography, Geology, Hydrogeology And Climate

Greece is the most earthquake-prone country in Europe, as it located at the convergence of the Eurasian plate over the African one, as well as the western termination of the North Anatolian Fault Zone. The active stress field in Greece is complex, as it generally switches from extension to compression from east to west, with its main axis also showing a variety of directions. The interaction of these various factors through time caused an intense fragmentation of both the mainland and the islands. In terms of seismic hazard assessment, it is of imperative importance to define the active or capable faults and assess their earthquake potential.
There are however several constraining factors:
1. Segmentation of faults; although fault zones seem segmented at the surface, they still may produce large earthquakes by been activated along their entire length.
2. Lack of outcrops; the largest part of Greece is covered by sea, so most of the active faults are offshore ones, not allowing for direct observations. Although they usually are of small risk to large cities, they can affect islands, as they've done numerous times in the past.
3. Mechanical interaction; it is not uncommon that the rupture starts in one fault and then continues to another, seemingly unfavourably oriented in respect to the local active stress field.

The Itea - Amfissa valley divides the Mount Giona. to the west from the Mount Parnassos to the east. This NNW-SSE oriented geomorphological depression is the result of an extensional detachment observed along the eastern slopes of Mt. Giona. This tectonic structure extends from

the coastal area of Galaxidi at the northern margin of the Corinth basin to Prosilio village towards the north-Northwest at a distance of 25-30 km. The fault plane of the low angle normal faults observed along the detachment, dip 25-40o to the east - northeast. At several segments of the detachment the fault surface is marked in the landscape by a geometrical morphotectonic plane dipping to the same direction and with the same dip as the fault, observed from altitudes of 1200 - 1400 m to 600 - 1000 m. Sequences of breccias - conglomerates that are several hundred meters thick, are deposited along the slopes of Mt. Giona on top of the hanging-wall of the detachment. The breccias dominate along the western outcrops of the sediments near the fault whereas the conglomerates prevail in the eastern outcrops. The top of the sediments forms a planation surface that is well developed in the Aghia Efthymia village. The altitude of the planation surface is increased in elevation towards the north. In particular, the planation surface lies at 0 - 100m at Galaxidi, 400 - 600m at Aghia Efthymia and 1100 -1200m at Prosilio. The footwall rocks are part of the Upper Triassic - Jurassic carbonates of the Parnassos - Giona tectonic unit whereas the hanging-wall rocks belong to Upper Miocene - lower Pliocene brecciasconglomerates which are overlying the Cretaceous limestones and the Tertiary flysch. The bottom of the present-day valley where alluvial sedimentation occurs, is located several hundred meters below the neogene breccias-conglomerates, implying an important uplift during late Pliocene - Quaternary. The overall structure is deformed by E-W active normal faults bordering the northern margin of the Corinth rift structure. The southern prolongation of this detachment may be traced in the Peloponnese, south of the Corinth rift and in particular in the Feneos - Stymphalia, Merkouri and Eastern Parnon detachments. The change from N-S to E-W extensional structures has occurred within Pliocene. Delphi-Arahova-Amfissa Fault System consists of a series of W-E, WNW-ESE and NW-SE normal oblique fault segments, concluding to strike-slip motion in the western end of the zone D.A.A.F.S. is a recent (Middle/Late Pleistocene – Holocene) tectonic structure responsible for the creation of Amfissa/Itea basins and the spectacular Delphi-Arahova valley.

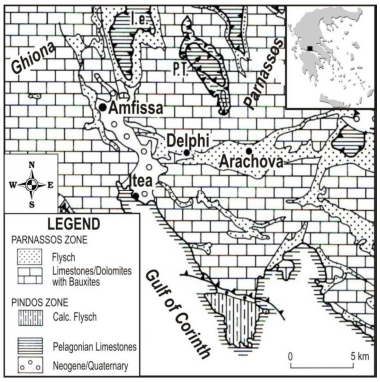



Figure 1. Simplified geological and tectonic map of the Parnassus–Ghiona zone (modified after Dercourt et al. 1980 [1]).

### 3.2.1 Hydrogeology

Groundwater and the fractured carbonate rocks through which it moves constitute a dynamic system in which both the fluid and the container are actively reacting and changing in time and space. Differential enlargement of fissures by solution will drain off groundwater concentration increases dissolution rates and further enlarges the incipient swallow-holes, ceves and caverns. But mineral precipitation and sedimentation can also deduce the size and even block such openings, and then the ciroulating groundwater must find, and by using enlarge, new paths as it moves vertically or sub-horizontally down to the sea. Past emergence may have left traces of paleokarsts; changing land forms have produced changes in surface and groundwater, as well as the tilting and faulting of the post-alpine orogeny, have produced and

later deformed zones of intense karstification, many of them now droqmed by the rising sea.

### 3.2.2 Karst Hydrogeology at Amfissa and Around

Karst is a type of landscape, and also an aquifer type. Karst areas consist of solid but chemically soluble rock such as limestone (most important) and dolomite, but also gypsum, anhydrite and several other soluble rocks. Karst landscapes show characteristic landforms caused by chemical dissolution, such as karren (crevices and channels, tens of cm wide), dolines and sinkholes (closed depressions, tens of m in diameter) and poljes (large depressions with flat floor, several km 2 or more). Streams and rivers sinking underground via swallow holes are also frequent.
Karst aquifers are characterised by a network of conduits and caves formed by chemical dissolution, allowing for rapid and often turbulent water flow. A karst aquifer may be present even when there are no discernible karst landforms at the land surface, and even when there are no known and accessible caves. Hundreds of millions of people worldwide live in karst areas and are supplied by drinking water from karst aquifers. These aquifers include valuable freshwater resources, but are sometimes difficult to exploit and are almost always vulnerable to contamination, due to their specific hydrogeologic properties. Therefore, karst aquifers require increased protection and application of specific hydrogeologic methods for their investigation. Other problems frequently encountered in karst areas include: soil erosion and rock desertification, leakages of channels and reservoirs, collapse of underground cavities and formation of sinkholes, and flooding. Resolution of these problems requires involvement of karst hydrogeology experts.

### 3.2.3 Hydrogeologic characteristics of karst aquifers

Karst aquifers form by flowing water containing carbon dioxide (CO 2) which dissolves carbonate rocks. Therefore, there is a close relation between aquifer evolution, the formation of caves (speleogenesis) and groundwater flow. Although there are many similarities among different karst systems, every karst system is also a special case and generalisation is difficult. The properties of karst aquifers greatly vary in space. There may be large quantities of water in a cave, but a borehole a few metres away may be completely dry. The aquifer hydraulic properties depend on the orientation of geologic fabric elements; for example, the hydraulic conductivity is typically high in the direction of large fractures and conduits, but may be low in other directions. Recharge water may originate from the karst area itself (autogenic recharge) or from adjacent non-karstic areas (allogenic recharge). Infiltration occurs through the soil and unsaturated zone (diffuse infiltration), and may also be concentrated via swallow holes/sinks (point infiltration). There are two or even three types of porosity in karst aquifers: intergranular pores in the rock matrix, common rock discontinuities such as fractures (fissures) and bedding planes, and solutionally-enlarged voids such as channels and conduits developed from the initial discontinuities. Whereas groundwater flow in the matrix and small fissures is typically slow and laminar, flow in karst conduits (caves) is often fast and turbulent. The water table in karst aquifers can sometimes fluctuate 10s or even 100s of metres in short periods of time, and karst springs typically show rapid variations of discharge and water quality.

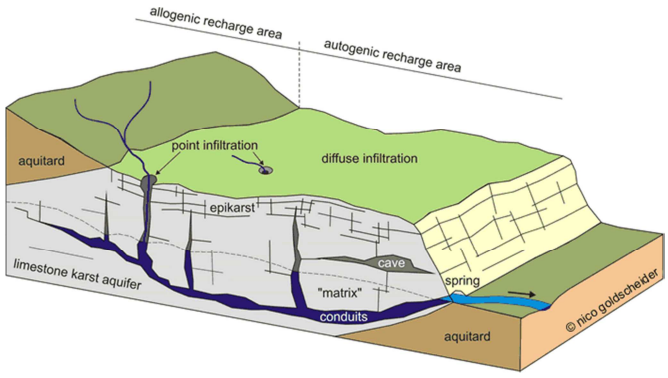



Figure 2. block diagram: Block diagram of a heterogeneous karst aquifer illustrating the duality of recharge (allogenic vs. autogenic), infiltration (point vs. diffuse) and porosity/flow (conduits vs. matrix) (Goldscheider

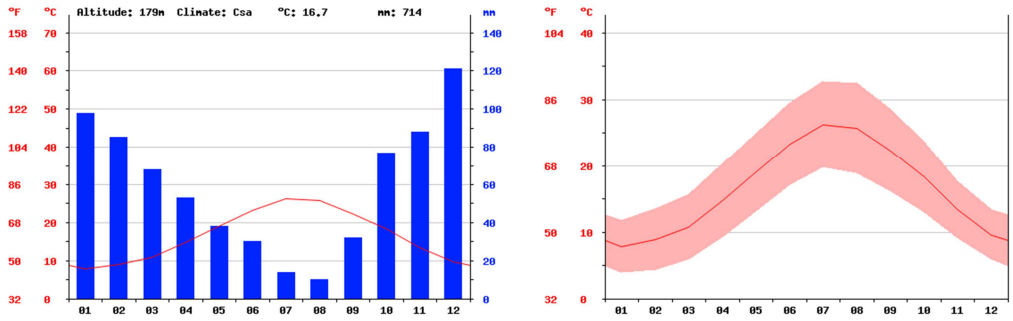
& Drew 2007).

Contaminants can easily enter karst aquifers through thin soils or via swallow holes (sinks). Inside the aquifer, contaminants can quickly spread over large distances, due to rapid and turbulent flow in the conduit network. Natural attenuation processes, such as filtration and retardation, are often less effective than in other aquifers. Due to the high degree of heterogeneity, it is difficult to drill a successful water supply well into a karst aquifer. In mountainous karst regions, the water table is often very deep below land surface, sometimes 100s of metres. Karst springs are typically very large, but also quite rare. Even in humid regions, there are often large areas without any accessible water because surface water runoff and rainfall quickly infiltrate into the karst aquifer and flow to distant springs. Water suppliers prefer water sources with stable discharge and water quality, but karst springs often show high variations of both. Periods of excellent water quality may be interrupted by short contamination events.

### 3.2.4 Climate

In Amfissa, the climate is warm and temperate. In winter there is much more rainfall in Amfissa than in summer. According to Köppen and Geiger climate is classified as Csa. The average annual temperature in Amfissa is 16.7 °C. The average annual rainfall is 714 mm.

### 3.2.5 Climate graph and table




The driest month is August with 10 mm. Most precipitation falls in December, with an average of 121 mm. The warmest month of the year is July with an average temperature of 26.2 °C. In January, the average temperature is 7.8 °C. It is the lowest average temperature of the whole year.

| month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 98 | 85 | 68 | 53 | 38 | 30 | 14 | 10 | 32 | 77 | 88 | 121 |
| °C | 7.8 | 8.9 | 10.8 | 14.8 | 19 | 23.3 | 26.2 | 25.7 | 22.4 | 18.3 | 13.4 | 9.6 |
| °C (min) | 3.9 | 4.3 | 6 | 9.3 | 13.2 | 17.2 | 19.8 | 18.9 | 16.2 | 13 | 9.2 | 5.9 |
| °C (max) | 11.8 | 13.6 | 15.7 | 20.4 | 24.9 | 29.5 | 32.7 | 32.5 | 28.6 | 23.7 | 17.7 | 13.4 |
| °F | 46 | 48 | 51.4 | 58.6 | 66.2 | 73.9 | 79.2 | 78.3 | 72.3 | 64.9 | 56.1 | 49.3 |
| °F (min) | 39 | 39.7 | 42.8 | 48.7 | 55.8 | 63 | 67.6 | 66 | 61.2 | 55.4 | 48.6 | 42.6 |
| °F (max) | 53.2 | 56.5 | 60.3 | 68.7 | 76.8 | 85.1 | 90.9 | 90.5 | 83.5 | 74.7 | 63.9 | 56.1 |

The difference in precipitation between the driest month and the wettest month is 111 mm. The average temperatures vary during the year by 18.4 °C.

### 3.3 Present water management

Within the Greek government the Ministry of Environment is in charge of water resources management and the Ministry of Interior is in charge of supervising municipalities which are responsible for providing water and sanitation services. The Ministry of Finance plays an important role in providing subsidies for investment. Water management in Phocis is left to the local government of the municipality. The local water

basin of Mondrose river is mainly used by EYDAP, a governmental company and production facility of fresh water for Athens. Mondrose dam collects high quality water from the region and it is then transported to Athens via a canal. The canal is 200 km long and parts of it are open which leads to high losses of water due to evaporation and theft from local people who use it for irrigation of their fields and olives. Because of high availability of water, such threats are not well managed.

Amfissas water supply is also dependent on the canal as part of the water from Mondrose dam is converted to a local water treatment facility. The facility is not operated in a sustainable way and due to old age of the facility (it was built 30 years ago and not well managed in the meantime) only method of water treatment is addition of chlorine based not on analysis of incoming water but the “feeling” of the operator. Analysis of water quality is undertaken in Athens based on samples taken from the facility. The results are not widely circulated and remain, in a great extent, hidden to the general public. Such an approach to low information sharing lead to an insecurity of people in using the potable water from the system and a high number of population uses bottled water. Problems also arise from asbestos water pipes. They cause cancer and people are not willing to risk their health, also due to an abundance of bottled water of a relatively low cost.

High percent of the population in the coastal settlements have private wells and water cisterns, although such water usage is found scarcely. Private wells are also used in the mountain areas and to provide water for olive trees irrigation in Amfissas plain as well as in the mountains. Pumping water from wells is contributing to salting the fertile land in Amfissas plain due to rise of underground waters and introduction of water from sea to the underground water aquifers.

Sewage treatment plant exist in the area but not much information is available on its work and quality of the treated water. It was constructed some 20 years ago and the education of the people working in the plant is not adequate for today's level of complexity of water treatment. Primary and secondary treatment of sewage is undertaken. There is no analysis on discharge of water from the treatment plant into the sea. Sewage is not collected from the whole area and a large number of people in the region use septic tanks as a mean to collect sewage waters. Problems arise when they are constructed in areas that easily leak sewage into underground waters. Such practice can cause polluting of wells with pollutants from sewage waters in the area. Sewage water problems exist all over the region since no significant network of sewage pipes exist in the mountain area of Parnassos that is attractive for its winter sport resorts. Tourism in other parts of the region is not well developed and it could be a significant factor of sustainable development if it would be developed in a sustainable way. Unfortunately, we did not find a strategy of sustainable development of tourism in the area.

Other significant problem in the Parnassos national park and especially in the water reservoir of the Manrose dam is the ban on intensive farming and agriculture. Agricultural activities are a source of high pollution, but if best available technologies are used, no such problems arise. However, the national government imposed laws and regulations on the local people disabling their income structure and made the area not desirable to live in. Mountain areas are of low interest for investments in the beginning because of less connections to other transportation means rather than roads. Mining industry is one of the feeding forces of the region and this is the second bauxite site for excavation in the world. Bauxite is mined in the region and transported to other regions by ships to be processed. Problem with the mines is in destruction of landscape, runoff waters carrying heavy metals and no restoration of landscapes at abandoned sites. Open mines are used because of bauxite deposits near the surface of soil and the following low cost of such excavations. Mining operations are also in place for reaching deep deposits of bauxite. Open mines are a heavy impact on the landscape and their mitigation last for hundreds of years. There are possibilities of planting new soil and trees in those mine and such technologies were used in the past but did not yield good results because of low knowledge on the subject. Runoff waters from both open and underground mines are full of heavy metals polluting soil in the nearby area and making it unusable.

Phocis prefecture lies on the sea side and has access to sea which gives the local people a great opportunity in using a valuable resource for cultivating maritime cultures, fishing, transport, tourism, etc. Most of these opportunities are realized to a great extent. Fishing is a traditional activity and shipbuilding in the area was a huge industry in the past times although today it mostly ceased in the area. Fishing is encountering today a problem of depleting the natural habitats of local species and as a result lower income. Similar problems occur on a global scale. Maritime production of certain species is also present and will probably represent

the main way of fishing in the future. To control the quality of water there are 168 biological stations in the Corinthian Gulf. Again the same problem of lack of information on the quality of water is observed and not much is known on the subject. Tourist activities on the coast are scarce, as was mentioned earlier. The ESD centre in Amphissas is a regional centre and performs daily and multi-day student educational programs. The programs of ESD centre Amphissas are related to issues and knowledge of management of natural and anthropogenic local and wider environment and linked to national and global environmental problems. It is oriented towards the formulation and attempt to tackle environmental problems existent. Interdisciplinary approach is used and follows the new school curriculum (DEPS) and is adapted to the cognitive level of students (elementary - middle school - high school). There is some involvement of the school community and the local community. The mountains of Parnassos and Giona, the Corinthian Gulf, the grove of Amfissas, the river channel Mornou, the surrounding area of the city of Amfissas, the archaeological site of Delphi, the maritime city of Galaxidiou and Road Safety Park Municipality of Amfissas are areas of action programs of ESD Amfissas. The management of biodiversity (flora, ecosystems and landscapes), water, soil, energy and waste, climate change, the cultivation of olives, the basic principles for a sustainable built environment, geological changes in space and time, protection and enhancement of cultural heritage, creating conscious society in road safety education are the subject of the work of environmental groups in Amfissas.

### 3.3.1 Problems with farming in water basin area

During the interview we focalized our discussion also on the problem of the area of Parnassos about the water harvesting, in order to give water to the city of Athens. The problem is not related to the water quantity but to the agricultural management of that specific area. In fact, what we know is that there are big limitation about the possibility to have any activities that can modify the actual water composition, such as the increase of nitrogen content in the soil that is strongly related to any intensive agricultural activities. In other world the local people haven't benefits from a resource that is them territory, instead they have got limitations.
I'm going to report a similar situation happened in French that can give some suggestions. The Vittel company (now owned by Nestle) produces water bottle (Vittel mineral water originates in the town of Vittel, at the foot of the Vosges Mountains, France North-East), but at the begging of the 80', due to the increase of nitrogen due to the local agricultural techniques, there was the risk to lose the brand (according to the French laws). So what they did is to start a research to find the problem, then in 1989 they started to have negotiation with the local people proposing to stop the their actual activities and reduce the emissions of nitrogen, this negotiation last for ten years with the help of an intermediate and they give us benefits and incentives to the farmers:

1) long-term security through 18-30 years contracts
2) subsidy of 200 €/ha/year
3) up to 150,000 € per farm to cover costs of new equipment and buildings modernisation
4) Agricultural workers paid by Vittel to apply compost in farmers' fields (to ensure optimal applications)
5) Extension services paid by Vittel (including annual individual farm plans and introduction to new social and professional networks)

At the end this kind of approach was successful and now days all farmers have subscribed this type of contract. That's what is called payment for environmental service (PES) that can generate a great source of income in every part of the world where there is a social, environmental and economic impact due to a use of a natural resource.
Referring to the case of the Greek area there is also the problem that the national laws are now forbidding the agricultural practices. But, as the Vettel case study demonstrate, is possible to achieve a solution just starting to have negotiation and we thing that this type of situation as to be taken in consideration when we speak about ESD.

## 4. Conclusion

Four main problems were recognised during this research: lack of information on water management in the area, small revenues paid by companies for local resource use, overuse of water for agriculture and poor infrastructure.
Lack of information on water quality available for public is the biggest problem that was found during the research. Common view by the public is that potable water is not good for drinking because of various reasons from infrastructural problems to lack of information and commodity of bottled water. Use of rich regional resources does not provide enough revenue to the general public leading to a shortage of money for investments in local infrastructure. Examples are bauxite mining and supplying the capital with water. Both resources, water and bauxite is thus exploited by companies that do not return much of the profits into the local area of exploitation. Furthermore, local people are taught and told to be grateful to the companies for providing jobs from mining and for bringing water to the public via the canal. Third problem of overpumping of ground water leads to salt water appearing near surface and pollution by sodium, chlorine and potassium which makes soil not viable for agricultural use. Poor infrastructure related to water management (water and wastewater treatment plants, pipes, etc.), waste disposal and quality control leads to poor sustainability of the local community.
Some of the problems mentioned before could be tackled by increasing local participation and awareness of possibilities of the region for sustainable development. Dissemination of information on water quality and ways to resolve problems that are recognized by the general public should probably be the first step. Implementation of ESD programs for the local community as well as children is another possibility. Programs in place at the local ESD centre should be opened to the local public and adjusted to their needs. These programs could address problems as well as solutions and recommendations on an individual and municipal level. Informed locals could in future manage their problems by themselves, if possible, and impact authorities to develop and implement policies and strategies along with action plans to solve local problems.

## 5. Literature


- http://pacinst.org/issues/sustainable-water-management-local-to-global/
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