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Environmental Pillars for Sustainable Management System in Ancient Olympia

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Abstract: Sustainability and Environmental friendly management are meanings which were known since the beginning of ages; but were established by the UNEP in 1972 throughout the celebration of the World Environment Day (WED) every year on 5 June; in order to raise global awareness to take positive environmental action to protect nature and the planet Earth. The aim of this paper is to give a chronological series of changes at the unique place of Ancient Olympia, in order to show how nature was before and after the wild fire of Peloponnese at Southern Greece. As foresters and environmentalists we proposed some environmental friendly measures as a systematic treatment of the areas' sustainable management after a wild fire. The post-fire management of Kronius hill and a new plantation based on the existing species with the synergy of natural reforestation gave marvelous solutions after a decade. A series of technical works and protective measures against erosion are suggested in order to achieve the effective development of the area.

Keywords: Environmental Pillars, Sustainable Management, Post-Fire Measurements, Reforestation, Ancient Olympia

1. Introduction

Basic pillar for sustainable development is the protection of nature. The most recent reports of the EU Community Mechanism for Civil Protection point out a large increase in the number, severity and intensity of natural phenomena and man-made disasters resulting in the loss of human lives as properties and having catastrophic consequences on social and economic infrastructure, cultural heritage and on the environment [1]. The potential for severe soil erosion exists after a wildfire because as a fire burns it destroys plant material and the litter layer. Shrubs, forbs, grasses, trees and the litter layer break up the intensity of severe rainstorms. So fire can destroy the soil protection. There are several steps to take to reduce the amount of soil erosion [2].

In Greece during the summer periods' between 2007 – 2009 more than 71 people died and over 200.000ha of forest areas had been burned throughout the wild fire of Peloponnese. At Ancient Olympia (Figure 1) a part of historical forest burned down and due to immense efforts of the firefighters the stadium and the buildings of the museum of Ancient Olympia remained intact.

***Figure 1.** Archeological area of Ancient Olympia.*

Unfortunately the coniferous forest (Pinus halepensis and maki) which was surrounding the archeological area and the Kronious Hill was burned. The reforestation of the burned areas and a protection system against soil erosion are the emergency technical works that must be applied.

2. Erosion Control Techniques After Wildfire

The research on the fate of burnt forest ecosystems includes efforts to understand their post-fire evolution and the factors affecting it, methods for the protection and management of burnt areas aiming at their rehabilitation, the costs involved, and the way in which fire danger changes with time in the regenerating forest [3].

The main step after a wildfire like this at Peloponnese is to bring a team of specialists at forestry, wildlife, ecology, watershed, historic properties, forest engineering's, etc in order to apply effective soil stabilization techniques.

The US Government Technical Team based on BAER teams system proposed the following treatments for Ancient Olympia. A process was implemented for the Kladeos watershed case study and includes two phases. 1st Phase was the emergency stabilization, which involved a) the identification of potential values at risk from the effect of the fire including life, property, roads and cultural resources, b) the identification of how the fire has changed the watershed response based on the map of soil burn severity and specifically address changes to erosion, runoff and slope stability, c) the definition of the emergency of: threat, location, duration and extent, d) the treatment selection based on combinations of land, channel, road, protection and safety with the synergy of stabilizing factors, e) the monitoring within the next years and f) the implementation of recommendations. 2nd Phase was the long term rehabilitation and restoration [4].

The needs for an environmental friendly technique to mitigate the problem generated by soil instability and the incidence of erosion have been provoked the appearance in recent years of two different eco-technological concepts': ground bio-engineering and eco-engineering [5]. Slope stabilization after fire can be achieved by using different types of grass or vegetation and also environmentally friendly simple methods as: seeding, mulching or planting; to the most complex ones that integrate a variety of different engineering techniques using all types of materials (live cribs walls, vegetated gabions, etc) [6].

3. Transition to Restoration

The only safe route forward for restoration and reforestation after a wildfire is to abandon small-scale measurements and go for long term techniques in a timescale of the next decades. In the case study of Ancient Olympia as a forest engineering team we proposed techniques of stabilizing the archeological area by constructing a wall with existing materials of the area (stones, cement, etc) based on the soil stabilization techniques. The purpose of the slope stabilization measurements of Kladeos river which runs through the valley of archeological area is to minimize the sliding and to regenerate the hole area after the fire of 2007 (Fig. 3).

3.1. Eco-engineering Supportive Works

At the ancient walls of Olympia two problematic areas were located which are prone to collapse after some time due to deforestation. Therefore it is essential to give a solution to this problem, without however affecting of the aesthetic of the sanctuary area is needed (Fig. 2). Firstly, the supporting wall at the Sanctuary area has inclined from the vertical alignments and the upper part of it has fallen down. The thrust of the coniferous routes, the country road that passes over the archeological area and the deforestation after the fire made the possibility of the fallen wall more obvious (Fig. 3, 4).

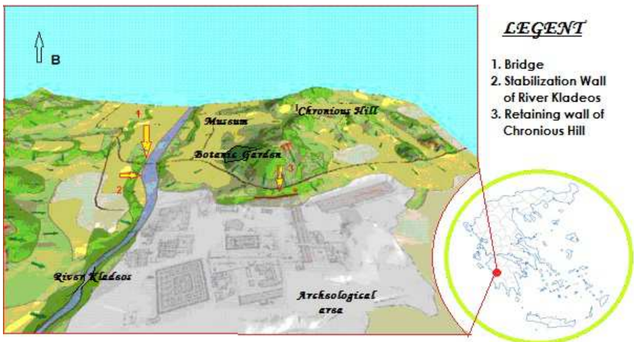

Figure 2. *Environmentally friendly Technical Works in Ancient Olympia after the fire in 2007.*

Figure 3. *Supporting techniques of the existing ancient wall.*

Figure 4. *A anti-aesthetic retaining stabilization system with metallic pillars at the existing part of the ancient wall of Olympia.*

The second measure that has been proposed to be taken was the slope stabilization of Kladeos River. The existing narrow bridge which is narrow and the riot vegetation in the river bed minimize the flow in case of overflow. So the ancient wall near the river bed needs maintenance, stabilization and raise height (Fig. 4, 5).

Figure 5. *The bridge at Kladeos and the vegetation over the ancient wall at the river aside.*

Kraus in 1997 has drawn how the ancient wall it was build in order to give us the opportunity to rebuild it or restore it (Fig. 6).

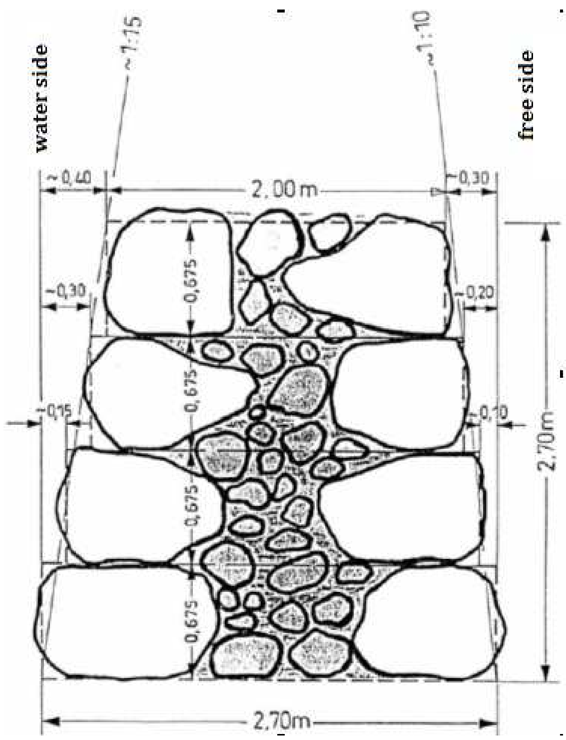

Figure 6. *Technical design of the ancient wall of Olympia at Kladeos riverside.*

The repair solution without affecting the sacred place proposes eco-friendly technical works. In the common areas weight walls and wire containers with suitable anchorage on steep terrain are proposed (Fig. 7, 8, 9, 10).

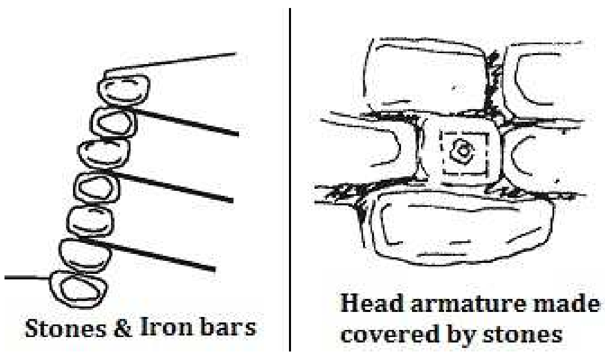

Figure 7. *Stone walls with iron bars and armature made head.*

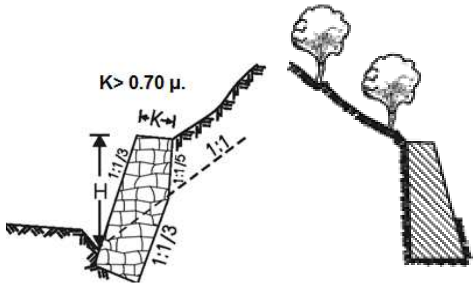

Figure 8. *Weight walls made of stone and concrete.*

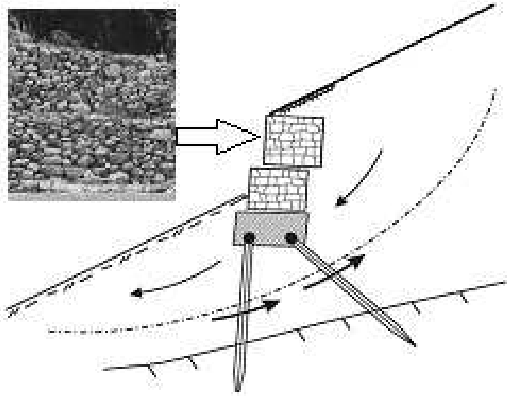

Figure 9. *Wire stonework underground anchorage.*

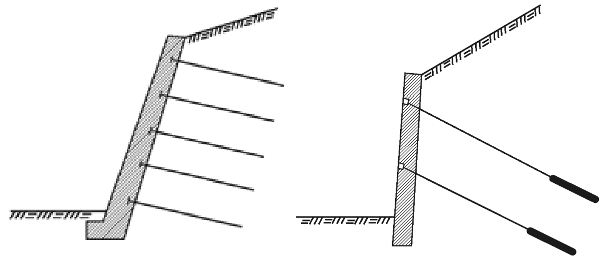

Figure 10. *Anchorage on the downhill.*

3.2. Restoration of Vegetation

As a general principle that nature knows best, restoration must be done with local species. However, since the natural process is slow, we decide with various manipulations to expedite the rhythms in order to have faster recovery.

The impact of fire on semi- mountainous forest species in the area are following:

OAK:

After the fire burned clumps of oaks have the ability of re-vegetation with suckers is a new path. In the case of partial destruction of the oak canvas it can reorganize the movement of juice, a few weeks after the fire. The fires in the oak forests can cause attenuation problems and attacks in neighboring blown clusters. Infestations of insects usually exhibit the greatest intensity in the first year after the fire. Fungi are installed in the first year but the attack culminates from the third year after the fire [7]. No negative effect is observed from the fire to oak atoms which are damaged by fire in an area of less than 20% of the circumference of the shank.

The deep grooves of the lower shell can be protected from heat, while the formation of small square plates on the surface helps to transport fire there. However, the light grey color helps to absorb less heat than a species with darker crust color. The leaves are very favorable for the heat transfer area ratio / volume. The litter carpet in less favorable environments decomposes slowly providing a uniform layer of loose for the transportation of fire.

CHESTNUTS:

According to the records oak such as chestnut trees [8], grow rapidly after fire tillers, without human intervention. Chestnut trees are exposed to the danger of being displaced by better oak species, where chestnut trees and oak coexist. For this reason, reinforced vegetation of chestnut trees is needed. However, where the risk of an entry of fir trees in the ecosystem exist, the fire acts positively, because it reduces the completion between the tree species. The fir ecosystem fire and fir forests, act positively, since it reduces competition.

PINUS HALEPENSIS:

Pinus halepensis fits greatly after fires and easily regenerates after them. The halepensis pine flowering almost every year and cones ripen in the third spring after their fertilization. Maturation cones do not open, but they remain closed for 10 to 15 or more years so they are fertile seeds. Closed cones do not burn nor open during wild fire. However if someone visits a burnt forest of halepensis pine after the first two days (48 hours) of the fire then he will see a rain of seeds that fall to the ground.

These seeds germinate in autumn and after having fallen at least 2 mm of rain, which means that there is enough moisture in soil. The main role in the success of natural regeneration of halepensis pine plays the plant “Cistus incanus or zistrose tree”, which occurs abundantly after fire. The “Cistus incanus”on the one hand protects young seedlings from direct sunlight and secondly, because the fungus that creates mycorrhizae in “Cistus incanus”also creates mycorrhizae in halepensis pine, rising up to 100 times the capacity of water uptake by the roots and therefore the possibility of survival of seedlings.

Since the trees were burned have an age greater than 15 years, the natural regeneration of halepensis pine is guaranteed no replanting is needed. As regards hardwoods, whether these evergreens such as holly, holms oak, etc. or are either deciduous tree such as the poplar, the oaks, etc., are updated very quickly after the fire. In Parnitha already trunk vegetation is giving the first promising message. Early autumn bulbs underground plants as cyclamens’, the yolks, etc have also sprouted [9].

To achieve the vegetation recovery target and the configuration of the landscape, we suggest planting a numerous of trees and shrubs that participated in the composition of the ancient oak forest and from which most were deported or were oppressed by the halepensis pine that will dominate from now on.

After the fire of August 26 of 2007 that destroyed the natural environment, over time around the Archaeological Site and the New Museum was created a botanical garden by the forest service in order to restore the archaeological site and the surrounding wider region to the reconstitution of the Olympic landscape with immediate soil protection measures and restoration of vegetation, based on historical references, in conjunction with the pre-fire conditions and with particular emphasis on maintaining the geomorphology of Kronios hill.

The main plants that can be used for the reforestation of Ancient Olympia are the following:

- Oak (Quercus ithaburensis Decaisne Ssp. Macrolepis (Kotschy) Hedge)
- Fluffy oak (Quercus pubescens Willd.)
- Aria (Quercus ilexL.)
- Quercus (Quercus coccifera L.)
- Pine (Pinus pinea L.)
- White poplar (Populus alba L.)
- Cypress (Cupressus sempervirens L.)
- Apollo Daphne (Laurus nobilis L.)
- Wild olive (Olea europaea L.ssp. Oleaster Negodi)
- Schinos (Pistacia lentiscus L.)
- Ash (Fraxinus ornus L.)
- Oleander (Nerium oleander L.)
- Wicker (Vitex agnus - castus L.)
- Arbut (Arbutus unedo L.)
- Arbut (Arbutus andrachne L.)
- Myrtle (Myrtus communis L.)

In addition to the above plant species and the restoration of specific areas the redbud, the linden, maple and shrubs, the broom, different type of oak and populous can be used. In particular, for the needs of aesthetic improvement and increase of biodiversity of the area among other species (Pomegranate, fig) kinds of aromatic flora such as rosemary, lavender, the wormwood, marjoram, mint, sage and savory can be used.

3.3. Especially for the Kronio Hill of Ancient Olympia

The evolution of Kronios hill is shown in figure 11.

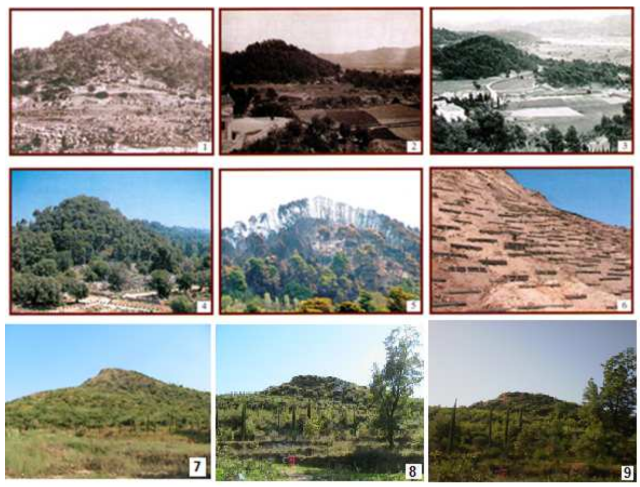

Figure 11. *Evolution of vegetation at Kronios hill (1:1900, 2:1910, 3:1930, 4:2004, 5: 2/9/2007, 6:10/23/2007, 7:07/12/2011, 8:08/11/2012, 9:07.27.2014).*

The result of this work was building a system of specifications based on Mediterranean ecosystem needs. Despite the enduring damage, new shoots and evolution are shown. The ancient forest of Olympia successor is the halepensis pine to evergreen broadleaf subcarriers. The under storey today after the fire was restored, but not the arboreal vegetation except for a few cypresses. We hope to have the second stage of woodland and broadleaf evergreen and Aleppo pine for better protection.

The anticorrosion measures of log bars Kronio hill were almost successful (figure 12b), except for a small area which required an enhanced bracing (figure 12a).

Figure 12. *Unsuccessful, successful (a) and (b) retaining steps.*

4. Results

The restoration of the Archaeological and Greater Landscape of the Ancient Olympia has been declared one of the UNESCO World Heritage Monument, prerequisites research of certain tree species and implementation of technological projects aimed at a reconstitution and protection of the natural environment. The historical background of the operator space in a specific time period has in any case to be taken into account.

The entire project is largely characterized by originality; given the lack of national and international specific actions for Mediterranean forest scientific knowledge ecosystems concerning restoration of the natural environment and archaeological areas after a fire incident for drafting recovery proposal the project is remarkable and unique.

The burnt area, two months after the fire, was immediately filled with herbaceous species of flora and physical referred birth of halepensis pine which gave hope and an encouraging message that Olympia had begun to speed their growth. Also, as expected, the natural regeneration of evergreen - broadleaved species was quite satisfactory. Interventions to protect the soil against erosion and reduce flooding, in conjunction with the installation of vegetation and hydro-seeding, effectively protected all of the burnt area and improved the general aesthetic landscape.

The wire stone armature was an excellent idea for Kronios hill, where was given more attention to aesthetic and manufacture tics. Of course, there were found some localized dispatch success because of exaggeration which was to achieve the best possible result, but also because of the pressure of timetables which brought more pressure on supervisors.

The hydro-seeding was the technique of geo-textile and the application in very steep slopes was crucial. These techniques worked additionally soil for protection, improved considerably rein in semen, the hydraulic properties of the soil and thus the emergence conditions of natural regeneration.

Finally, with respect to the horticultural operations, survival today more than three years after the intervention can be count as a great choice. It was considered quite satisfactory if you think about adversity and problems that were on their irrigation, maintenance and the lack of staff support general. In conclusion, conifers first showed increase compared to broadleaves. Unlike the oaks which showed little growth compared to the other leaved while competition with the reeds is strong.

In order reduce any fu-Lodi risk of fire, which is a natural factor in the Mediterranean environment, planning and the execution of rehabilitation works adapted to local conditions and requirements of the area is taking into account the natural and human environment around the archaeological site.

Further maintenance and general management anticorrosion and horticultural works, as well as the semantic plantings and especially monitoring and impact assessment of projects, were considered necessary actions to be continued for at least four years after the fire, so as to prevent any change in the situation that has been achieved in the archaeological landscape of Olympia.

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