AN INVESTIGATION OF THE POTENTIAL APPLICATION OF BAUXITE RESIDUE FOR THE IMPROVEMENT OF ENVIRONMENTAL CONDITIONS IN A MARSH ENVIRONMENT

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EXTENDED ABSTRACT

Bauxite residue has a number of applications such as the brick industry, soil remediation etc. In this work a research has been undertaken with aim to examine the possibility in using bauxite residue in the improvement of environmental conditions in a marsh environment. For this work the Ayia, Patras marsh was investigated. Soil sampling has been undertaken from the soil ring round the wetland. The soil samples have been analyzed for basic geochemical characteristics, such as $CaCO_3$ phase, Fe + Mn phase, Al – Si phase. Geochemical maps showing the geographic variabilities of these phases in the soils were drawn. The evaluation of the soil data showed areas with lack of bioavailable Ca and Fe. Basic characteristics of the waters in the wetland, such as pH, temperature, dissolved oxygen, conductivity were determined. Geochemical maps showing the areal variability of these parameters were drawn. The areas with extreme environmental conditions were defined. In addition, correlations among the aquatic and soil qualities in the sub-environment were examined. On the basis of all geochemical data, the environment studied was divided in certain sub-environments.
It is suggested that pot experiments with tree species using soil from the study area and bauxite residue may lead to the development of a method for improving the environmental conditions in similar marsh environments.

Keywords: Application of bauxite residue, marsh environment, remediation

1. INTRODUCTION

In any attempt to apply bauxite residue in the improvement of environmental condition in a marsh environment it is essential to investigate first, the existing environmental conditions in the whole environment.
In addition the physical and chemical characteristics of bauxite residue should be determined. The properties of the Greek bauxite residue have been determined by Pontikis et al (2003). The characterization and applications of bauxite residues from elsewhere have been described by other workers (Prasas and Sharma, 1986; Parekh and Goldberg, 1976; Tauber et al, 1971; Knight et al, 1986).
In the present work the Ayia, Patras marsh is investigated with aim to examine the possibility of using bauxite residue in improving the existing environmental conditions. For this purpose soil samples have been collected and analyzed from the surrounding the wetland area, while water samples from the marsh were also studied. In addition the study included geochemical mapping and the determination of major soil geochemical phases and of the main water parameters.

2. RESULTS AND DISCUSSION

2.1. Soil- Sedimentary System

The wetland is surrounded by a semi-circle soil-sedimentary system. This system, in which the soil is very poor, forms a small mound from which weathering products are transported with rain and wind into the wetland.

Soil samples were collected from this system which have been dried ground and analyzed for major geochemical phases such as: the carbonate phase, Fe-Mn oxides, aluminosilicates.

2.1.1. Carbonates

The carbonate phase (Chester and Hughes, 1967) has a wide range varying between 1% and 31%.

An examination of the geochemical map of carbonates showed that 3 zones can be distinguished. The lowest values of carbonates are found in the southeastern part of the soil system. Carbonates tend to increase from southeast to northwest of the system. At the northwestern part of the zone carbonates decrease again. The highest values of carbonates are found at the southwestern part of the zone.

It is seen that in the soil-sedimentary system there are areas where there is a lack of calcium.

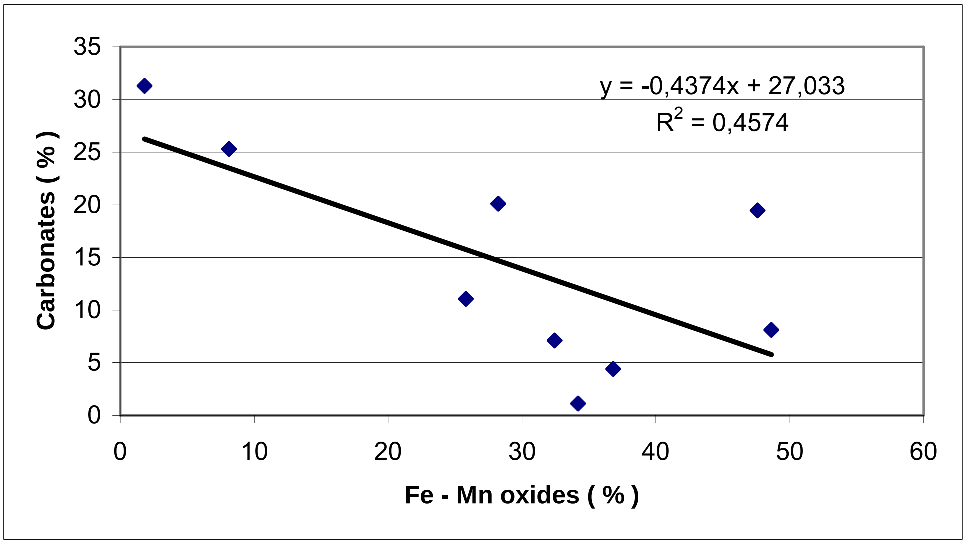

Fig. 1. Relationship between carbonates and iron - manganese oxides

2.1.2. Fe-Mn oxides

The Fe-Mn oxides (Cronan, 1976) in the soil-sedimentary system have a wide range showing extreme values. Their values vary between 18% and 48,6%.

The geochemical map of Fe-Mn oxides shows the following: the highest concentrations of Fe-Mn oxides are found in the eastern part of zone A tending to decrease from southeast to northwest. The lowest values of Fe-Mn oxides are encountered in zone B. Zone C is characterized by elevated values of Fe-Mn oxides. It is concluded that a large part of the study soil-sediment region is characterized by lack of Fe-Mn oxides.

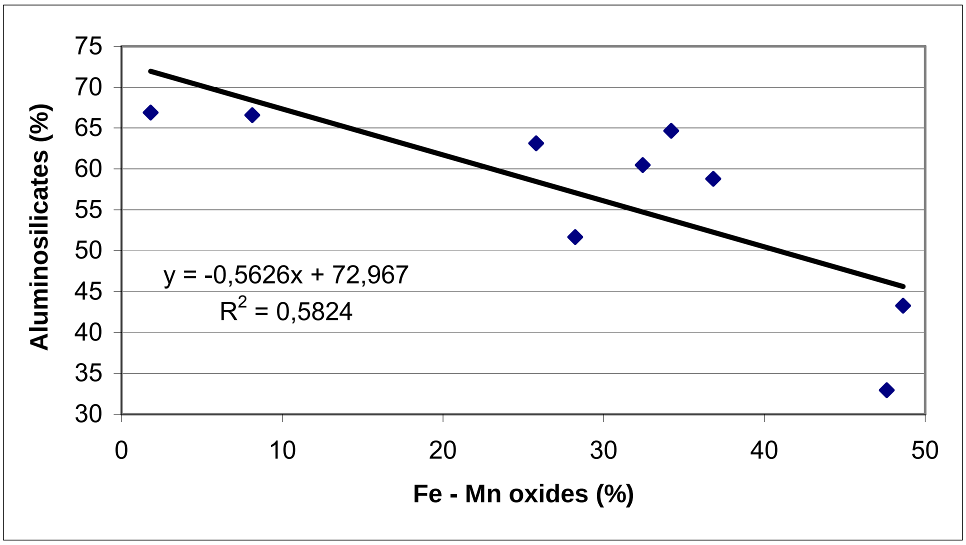

Fig. 2. Relationship between aluminosilicates and iron - manganese oxides

2.1.3. Aluminosilicates

A wide range of values characterizes the aluminosilicates (33%-66,8%). The highest values of aluminosilicates are found in zone B, whereas the lowest values are encountered in zone A. Zone C is characterized by elevated aluminosilicate values. It is noted that in zone A there is a sharp transition from the very low to very high values of aluminosilicates. The levels of carbonates, Fe-Mn oxides and aluminosilicates are shown in Table 1.

Table 1. Concentrations of major geochemical phases in soils

STATION	ALUMINOSILICATES (%)	CARBONATES (%)	Fe-Mn OXI-DES (%)
1	43,28	8,1	48,62
2	63,14	11,06	25,8
3	60,46	7,1	32,44
4	51,66	20,12	28,22
5	66,58	25,3	8,12
7	58,78	4,4	36,82
8	66,88	31,3	1,82
9	32,92	19,48	47,6
10	64,68	1,12	34,2

3. WETLAND

Two subenvironments can be distinguished in the wetland: i) the eastern part which is a narrow elongated piece of wetland and ii) the western and greatest part of wetland which has a rather cyclic form.

In order to investigate the physicochemical conditions existing in the wetland conductivity, pH, temperature and dissolved oxygen measurement were carried out (in spring 2006). The results are shown in Table 2.

Table 2. Levels of major parameters in the wetland

STATION	CONDUCTIVITY (μS/cm)	TEMPERATURE (oC)	pH
1	3720	18,3	7,78
2	761	21,4	7,86
3	1430		7,95
4	751	18,8	7,92
5	820	19,4	7,9
6	806	19	7,9
7	810	19,4	7,92
8	717	17,8	7,72
9	646	18,6	7,27

3.1. Conductivity

Conductivity varies between 646 ms/cm and 3720 ms/cm.
On the basis of the areal variability of conductivity it is seen that the eastern part of zone A is characterized by distinctly high values of conductivity.
However in the same zone very low conductivity values were found. Most area of zone B is characterized by very low values of conductivity.
It is highly probable that the sharp increase of conductivity in zone A of the wetland is due to input of seawater from the nearby coast.

3.2. Temperature

The area of zone A of the wetland with the highest values of conductivity is characterized by the lowest values of temperature.
In addition the temperature increases sharply from east to west in zone A. These variabilities can be justified by sudden input of seawater from the coastline. In zone B temperature decreases from east to west. The low temperatures found in the western part of zone B may result from the input of fresh water into the wetland. The physiography of the wetland justifies this conclusion.

3.3. Dissolved oxygen

Dissolved oxygen varies between 7.4 mg/l and 8.4 mg/l. Its lowest values are found in the eastern part of zone A while its highest values in the western past of zone B. Generally dissolved oxygen decreases in the whole wetland from west to east. It is highly probable that this is controlled by the direction of water flow in the wetland. The area with low oxygen values coincides with an area of stagnant conditions.

3.4. pH

The pH varies between 7.27 and 7.95.
The highest pH values are found in most of zone B. The lowest values are encountered in a small area at the northern part of zone B. Zone A is characterized by elevated values of pH.

4. INTERACTION BETWEEN SOIL-SEDIMENT SYSTEM AND WETLAND

In order to investigate the interaction between the soil-sedimentary and the wetland diagrams were drawn showing the correlation between the parameters measured at the two subenvironments. It has been found that there is a positive correlation between the pH in the wetland and the aluminosilicates of the soil-sediment system. This indicates the influence of the quality of the soil-sediment system on the quality of the wetland. Furthermore pH increases in the wetland with increasing carbonate phases in the soil-sediment system.

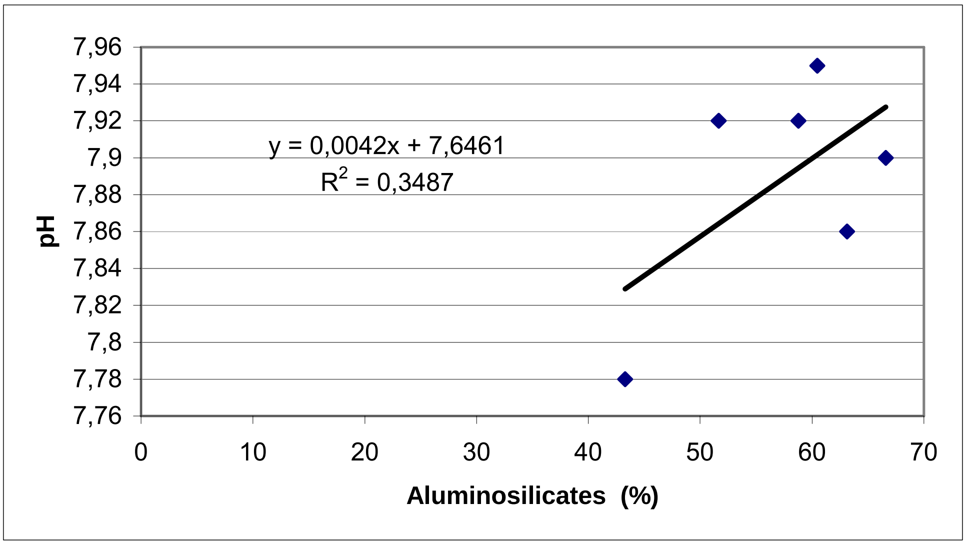

Fig. 3. Relationship between pH and aluminosilicates

An investigation of the morphology and the development in the soil-sediment system showed characteristic underdevelopment and chlorosis of trees such as the eucalyptus species.
The area where this phenomenon is observed coincides with the area where lack of Ca and Fe is observed. The transportation of dry leaves in the wetland causes a serious environmental problem. It is therefore suggested that any action taken towards the improvement of the development of the trees will improve the environmental conditions in the wetland. In order to achieve this it is suggested that experiments can be carried out with the development of species eucalyptus in pots using soil from the study area and bauxite residue from which the trees may uptake Fe and Ca. The results of such experiments may allow the use of bauxite residue in improving the development of eucalyptus and in turn may help in improving the wetland environment.

5. CONCLUSIONS

The results of this study demonstrate that the Ayia, Patras wetland suffers from a number of negative environmental conditions.
The soil-sedimentary system forms a small mound surrounding most of the wetland consisting from soil waste put there recently. No real soil characteristics are observed. In ad-

dition in this system distinct lack of Ca and Fe are located. These coincide with chlorosis phenomenon observed on eucalyptus species and their underdevelopment. Dry leaves of the trees are transported to the wetland, causing major environmental problem. In addition it has been demonstrated that the low quality environment of the soil-sedimentary system influences negatively the wetland environmental conditions. It is suggested that pot experiments with eucalyptus species using soil from the study area and bauxite residue as source of Fe and Ca may lead to the development of a method for the improvement of the environmental conditions in similar marsh environments.

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