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Research Article

MANAGEMENT AND SOIL REMEDIATION AS PART OF ENVIRONMENTAL CAREERS - THE CASE OF ARGENTINA

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ABSTRACT
In recent years there has been a steady growth in production of goods and services as well as an increase in population and life quality. The generation of environmental liabilities as a result of production techniques, threatens the preservation of essential resources for sustaining life on Earth. Environmental education as a pedagogical activity is fairly recent, and it represents an interesting challenge. Through this work the attention was focused on soil remediation, for which the degrees of importance that this topic has in education in Argentina and in a European country were evaluated. It was concluded that this topic is not widely regarded nationally in Argentina as few professional university courses include subjects related to pollution and soil remediation in their curricula, unlike the situation in Spain. The academic subject "Management and Soil Remediation" was also discussed. This subject aims at providing students with the basic guidelines to characterize and diagnose degraded and/or contaminated sites, offering tools to understand the behavior of pollutants, as well as the criteria for selecting remediation techniques depending on the type of contamination. From the perspective of environmental liabilities and the maintenance of ecosystem services provided by soil, it is important to offer training on land management as part of the curricula, in order to facilitate decision-making processes leading to proper action.

Key Words: Environmental Education, Ecosystem Services, Sustainability

INTRODUCTION

Throughout history, education has been the most powerful instrument to achieve social ascent. Therefore, critical and reflective quality education is required, thus overcoming the dichotomy between science that produces and school which passively reproduces (Burbano, 2009).
Environmental education and the use of creativity in this area are essential and strategic to solve problems that new generations will face and also as means for achieving collective awareness of the need to conserve natural resources (Sanchez and Gomez, 2009). According to UNESCO (1987), changes in environmental education have specific objectives: i) to promote awareness of the interdependence between economic, social, political and ecological elements to stimulate committed attitudes; ii) to provide each person with opportunities to acquire the knowledge, values, attitudes, responsibility and tools to protect and improve the environment; and iii) to create new patterns of behaviors towards the environment among individuals, groups and society as a whole.
In this regard, soil preservation, as well as air and water, are essential to sustain life on Earth (Hurni, 1996; Catizzone, 1998), with a key role in the provision of goods and services. Population growth and rising quality of life result in increasing pressures on soil resources, and warn us about the need to pay special attention to environmental risk weighting. As a result, the uncertainty about limits in the ability of ecosystems to absorb changes and provide necessary ecological services without becoming impaired has become greater (Solbrig, 2000). Soil degradation processes are significant and deserve special attention in order to evaluate physical and economic losses (Zink, 2005). In fact, the decrease in soil functionality has an effect on the overall environment (Brissio, 2007), so providing for its protection is mandatory.
Our investigation focused in evaluating the evolution and importance that soil science has in education programs of environmental university careers.

STUDY DESIGN

Soil productivity and soil conservation education is an inescapable relationship captured in different paradigms and, consequently, research reports based on diverse settings (Morras, 1997; Catizzone, 1998; Yakovleva, 2005; Branzini and Zubillaga, 2012). The literature offers substantial contributions in the area of soil production and soil degradation in relation to its function in the ecosystems. In fact, the term soil quality is one of the most important concepts to relate these concepts. Soil quality is related to the concept of soil capability, which is as old as human civilization itself (Carter et al., 2004).
In this study, a review of universities websites was conducted in order to obtain the data. Universities of two countries of different continent but with the same language (Argentina and Spain) were selected. It was considered

that these countries have different viewpoints and environmental situations; however there is the possibility to improve the exchange of students and researches. At each university, programs and disciplines that included subjects related to soil and environment, were surveyed.

To evaluate the inclusion of environmental university degree courses in Argentina more than 100 universities, both public and private, were surveyed. Different environmental courses were identified, such as, i) degree in environmental or related sciences (L), ii) environmental engineering (EN), iii) degree in environmental management (D), iv) technical degree in environmental management and auditing or environmental planning (T).

RESULTS AND DISCUSSION

The role in degree education

Environmental issues have been strongly installed in academic circles, in which there is a vast offer of university degree courses related to this topic. Unlike other disciplines, professional and academic study plans related to the environment contribute to the survival of humanity and prevent deterioration of resources, and that is precisely where their importance lies. Argentina is currently ranked as one of the countries offering better environmental education.

Of all universities relieved, 25% of them offer environmental courses within their academic degrees. In the different university careers identified differential approaches were observed regarding both the environmental components and their modes of interpretation (Table 1).

Table 1: Universities in Argentina which offer environmental careers.

University Name	Degree
1. University of Buenos Aires (UBA)	L
2. Technological National University (UTN)	L
3. University of CAECE	L
4. University of Salvador (USAL)	L
5. University of Flores (UFLO)	EN
6. Argentinean Catholic University (UCA)	EN
7. National University of San Martín (UNSAM)	EN
8. National University of Avellaneda (UNDAV)	L
9. National University of Tres de Febrero (UNTREF)	EN
10. University FASTA (UFASTA)	EN
11. Provincial University of Sudoeste (UPSO)	D
12. National University of Río Negro (UNRN)	L
13. National University of Comahue (UNCOMA)	T
14. National University of Córdoba (UNCOR)	EN
15. National University of La Punta (ULP)	T
16. National University of Litoral (UNL)	EN
17. National University of Formosa (UNF)	L
18. National University of Catamarca (UNCA)	L
19. University Juan Agustín Maza (UMAZA)	L
20. National University of Patagonia “San Juan Bosco”	T
21. University of Marina Mercante (UDEMM)	L
22. University of Congreso (UCONGRESO)	L
23. Autonomy University of Entre Ríos	L
24. University Blas Pascal	L
25. National University of Arturo Jauretche	L

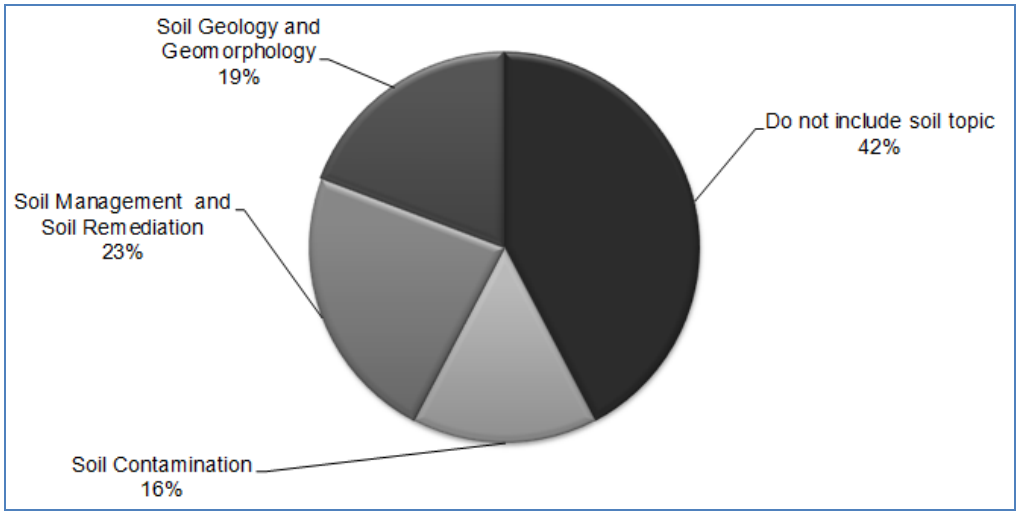

Figure 1 : Percentange disricution of enviormental careers of Argentina that include or not topics related to the soil resoureces

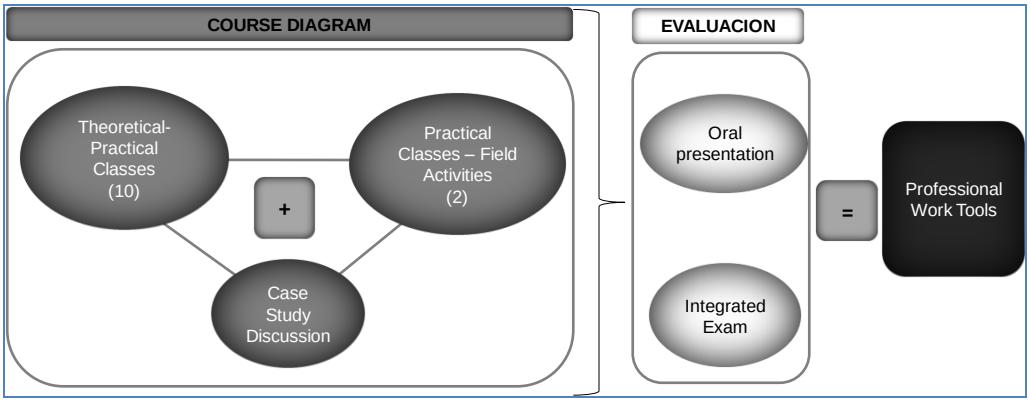

Figure 2: Structural scheme of the management and soil remediation subject of the LiCiA FAUBA

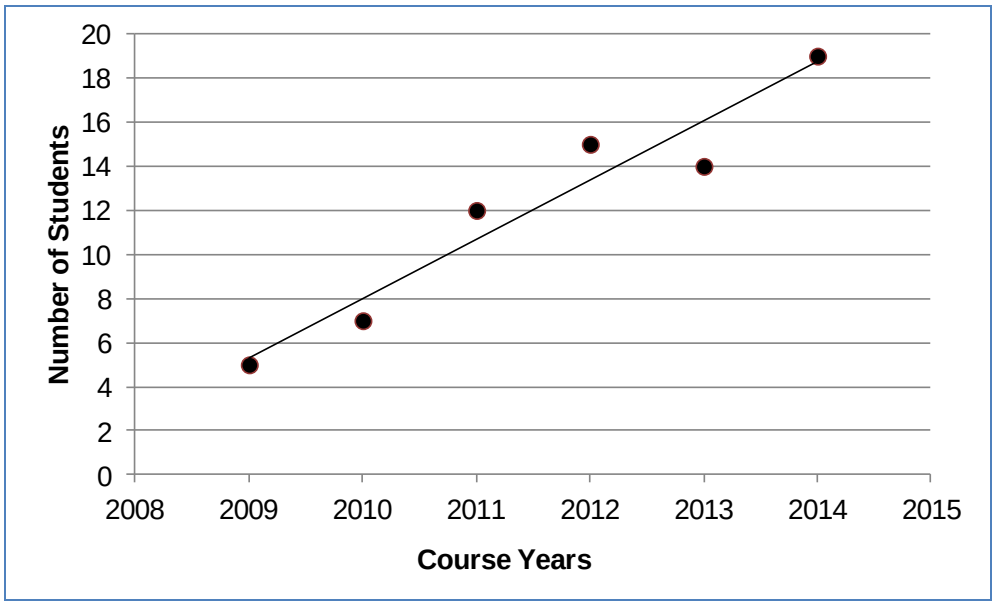

Figure 3: Number of student's management and soil remediation course

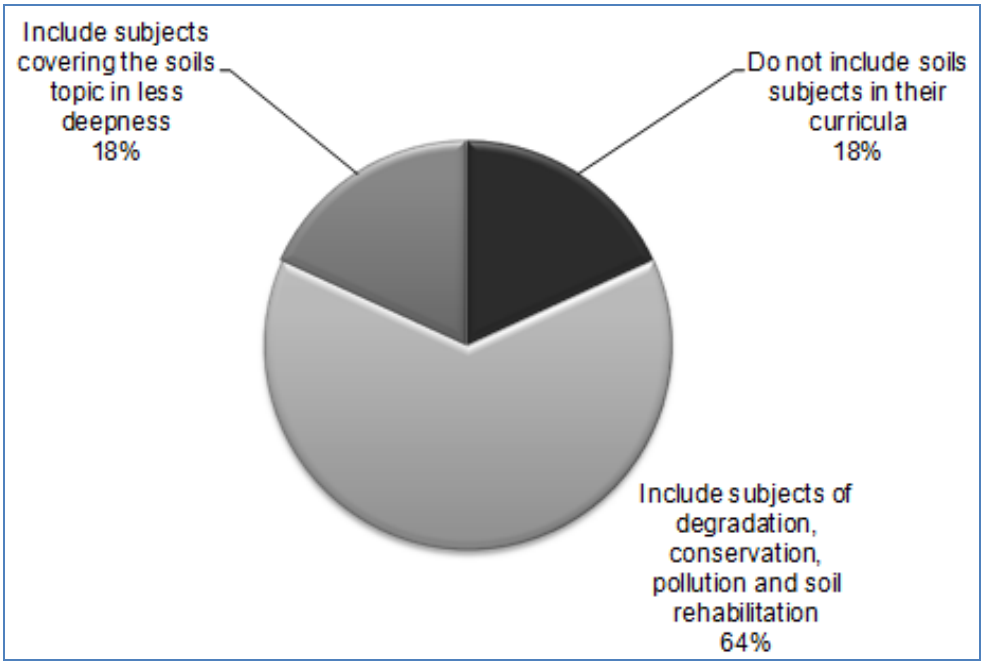

Figure 4: Percentage distribution of topics addressed in the education study plan of environmental careers in eleven universities in Spain

Table 2: Universities in Spain that offer environmental careers.

University	Degree
1. University of Salamanca	L
2. University of Almeria	L
3. University of Granada	L
4. University of Malaga	L
5. University Pablo Olavide Sevilla	L
6. University of Córdoba – Andalucía	L
7. University of Jaén	L
8. University of Huelva (UHU)	L
9. Autonomy University of Barcelona	L
10. University of Alcalá de Henares (UAH)	L
11. Autonomy University of Madrid	L

According to the collected data, 42% of careers in Argentinean universities don't include courses associated to soil topics in their curricula. However, not all universities with soil courses include management and remediation of soil resource (Figure 1).

Figure 1 show that in Argentina there are different careers with subjects related to soil contamination. Also, other careers address issues related to soils geology and geomorphology; and in only six of them, there are subjects related to management or soil remediation can be found. One of those is offered in the Degree in Environmental Sciences from the University of Buenos Aires (UBA) at the Agronomy College. The subject "Management and Soil Remediation", offered by this institution, is part of the curriculum in the last years of the degree course as an optional module. In this course of the Degree of Environmental Science (LiCiA), students are provided with theoretical and practical tools to approach different situations that impact soil resource. The full course comprises 32 hours, and includes six units that cover the following topics: i) Soil management; ii) Deterioration processes ; iii)

Physical degradation and changes in quality; iv) Toxicity as a process of deterioration; v) Diagnostic methodologies for degraded soils; vi) Remediation techniques and vii) Transformation of contaminants. During classes active participation of students is encouraged after reading scientific articles, in order to study different cases as examples of the various issues addressed in this field. Through various activities, the best remediation techniques relevant to different situations are discussed and the appropriate parameters to detect the symptoms of resource degradation are determined. Additionally, a field exercise is performed in which students participate in the sampling of degraded soil to verify and carry out conventional soil sampling strategies, putting into practice the knowledge provided on the course (Figure 2).

The course has been taught for 6 consecutive years. The number of students has increased significantly from the first to the latest year of course (Figure 3). However, given the fact that the career has a short history, it is necessary to continue this analysis in the following years and also assess how many of the students who are enabled to take the subject (i.e. those who have approved the correlative subjects), choose this course.

Given the particular situation of Argentina, it is interesting to observe what happens in other countries. In order to compare the curricula of Argentina with other country, Spain was selected. Moreover, the Table 2 illustrates the Spanish universities offering degrees in environmental careers Universities.

Our findings show that in most of the education study plans offered by Spain, the issue of soil remediation in particular, has large importance, since several degree careers include at least three subjects centered on this topic in their curricula. Only two of the eleven careers evaluated exclude subjects on soil and related topics. As shown in Figure 4, the majority of universities analyzed include issues related to remediation, conservation, pollution and/or degradation, while the remaining subjects discuss those topics but with less depth ("Pollution heavy metals" and "Soil Science").

In this European country the soil environmental topics is addressed with higher intensity than in Argentina, and graduates have, in most cases, more tools to understand the complexity of soil resources and remediation guidelines, which can feasibly be applied in other cases of environmental degradation. This approach implemented in Spanish universities may be due to various causes, which will be the objective of subsequent research studies.

These results suggest that in Spain, soil quality is more considered as the capacity of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Larson and Pierce 1994). Consequently, it is a holistic concept recognizing soil as part of a dynamic and diverse production system with biological, chemical, and physical attributes (Sanchez et al., 2003).

According to the results of this study, it is important to note that the inclusion of soil and environment subjects in the curriculum, impacts on professional activities (Kimaryo, 2011). In fact, the problems arising from the exploitation of the soil, such as the production derived from agriculture, livestock, mining, oil and gas, among others, simultaneously produces environmental problem that degrade the resource over time. Soil is a valuable provider of ecosystem services, so it is essential to have a comprehensive understanding of the ecosystems functioning, coupled with good management and good practices, in order to avoid soil degradation and loss of quality and productive capacity. However, reality frequently shows that production is not implemented in sustainable ways, which makes it necessary to have the appropriate tools and knowledge to restore degraded soils and remediate them physically, chemically and biologically once the environmental liability has occurred.

Taking account some history, the soil science data as an independent science is recent. The independence from the parental science occurs through a conceptual clarification of the study object and also through the generation of specific terminology that allows professionals to manage and transmit these concepts (Morrás, 1997).

During the early twentieth century, Argentina was considered "the breadbasket of the world", following a production model oriented to internal development and integration into the international market, based on the productive capacity of its soils, mainly in the Pampas region core. Today, paradoxically, a century later, Argentina remains dependent on its soil since its primary economy is becoming more dependent on exports of grains and by-products, especially soybean flour and oil. Moving from a historical production of 30 million tons to the current 100 million tons has implied an enormous challenge from the point of view of resource sustainability. This is even more so when, joining the Agri-Food and Agribusiness projections of the Participatory and Federal Strategic Plan 2010-2020 (PEA, 2010), the objective is to reach a yield of 150 million grain tons in less than 20 years. The challenge is how these goals can be achieved while preserving soil's ability for future generations. Based on growing knowledge, technological innovation processes in agriculture have acquired greater speed and dynamics, placing a strong demand on the education system. This consists of a systemic and interdisciplinary approach to all aspects related to preservation of soil health, anticipating potential negative impacts and/or remedying or mitigating them when these could not be avoided. Therefore, educating and raising awareness is the premise.

The importance of land degradation and soil contamination in Argentina is that when agriculture is expanded and intensified, environmental problems are generated. These problems can be the alteration of: i) biogeochemical cycles; ii) land use; iii) global biodiversity at all levels; iv) biota dispersion beyond natural boundaries, through the action of man, among others (Chapin et al., 2000). According to the National Action Program to Combat Desertification (PAN), 1999, 60 million hectares out of the 276 million that make up the national continental territory, are affected by different processes and levels of desertification and land degradation along a process with an evolution estimated at 650,000 hectares per year. Therefore, researchers have a fundamental role in the generation of new tools that replicate the processes occurring in nature, and promote nutrient recycling, biodiversity and natural regulation mechanisms. Farmers also influence the conservation of the ecosystem properties and functions, facing the challenge of planning a diverse and complex agricultural system which stays productive as well (De la Fuente et al., 2008).

In Argentina, in addition to agriculture, there are other productive activities that generate disturbances in the environment. Among them, the magnitude of the problem caused by the mining activity is worth mentioning. Mining companies cause the most significant and irreversible damage to the environment, compared to other industrial sectors (Kapelus, 2002; Yakovleva, 2005). Their negative social and environmental impacts are extremely evident, including industrial accidents, environmental degradation, health and safety issues and violation of human rights. Some of the main problems associated with mining are environmental liabilities that have caused severe damage to the environment and people`s health. Identifying these environmental liabilities and the obligation to repair areas or contaminated sites with risk for the population should be legislated in order to mitigate the negative impacts on the environment. Such is the case of Act 14,343 issued by the Province of Buenos Aires Legislature, which states that all affected environment, which constitutes a contaminated site, must be recomposed in order to achieve minimum environmental conditions and public health. In this piece of legislation, remediation is considered as a task or set of tasks to be developed in a contaminated site, intended to reduce pollutant concentrations obtaining acceptable levels of risk for the protection of human health and the ecosystem integrity. In this way, functionality could be recovered (Morales Lamberti, 2008).

Among all applied sciences, Soil Science is one of the most modern, as it started to develop in the early twentieth century. Soil studies in Argentina had an increasing growth along the last century, following the development of agricultural and livestock activities, throughout the country, with their particularities and heterogeneity from the point of view of agro-ecological conditions. The first studies were based on knowledge about the quality of soils, with an emphasis on recognition and mapping of semi-detailed scale. They were carried out in the '60s, mainly by the National Institute of Agropecuary Technology (INTA), followed by studies on desertification (Panigatti, 2010). Biases in soil studies are reflected in the work of successive Congresses of the Argentinean Association of Soil Science (AACS). According to Morrás (2003), initially, many scientific papers that could be defined as "pure mapping", were presented in the Congresses of the AACS, followed by cartographic papers with genetic content and finally multidisciplinary cartographic papers. Then, disciplines such as management and soil fertility, studies of microbiology and biochemistry, followed by soil physics have presented significant progress. In accordance with Pedro (1986) Soil Science is defined as "a pure science, which rests on the basic sciences and itself has a number of applications in domains as diverse as agronomy, environment, metallogeny, civil engineering, (...)", thus, turning it imperative to advance in the studies of soil beyond its role in the agricultural target. Aspects such as its role in ecological sustainability or the provision of ecosystem services have been the result of other soil studies, including, among others, quality, pollution, remediation and Technosols. Thus, Soil Science advances into a new era that could be defined as the "management of soils in ecosystems" (Jamagne et al., 1998).

As a result of the information above, the creation of the commission of Soil Pollution in AACS, is a significant step to raise awareness that soil resource is a system liable to be degraded. Considering that some commissions were originated in the '60s, it was only in 1998 that this branch was incorporated to the organization of the association. This commission has been given several different names, some of which were: Pollution, Soil and Environmental Quality, Land and Environmental Media, and the latest proposal, Land and Environment. In spite of all these name changes over time, all names have considered soil as a living system that interacts with other systems and whose degradation might affect the ecosystem services it provides.

CONCLUSION

As final considerations, the importance that knowledge of remediation patterns and soil management have in the training of environmental professionals should be highlighted, particularly considering that the world depends on food production to feed a population of more than seven billion people. The expanding demand for food from a growing population represents a challenge for soils, because the ability to meet this demand depends on them to a large extent. Associated with production, as mentioned above, environmental responsibilities appear. Appropriate

practices to remedy degraded soils will define their aptitude to get back into production, or simply allow them to continue providing various ecosystem services that the resource naturally provides. It is necessary to employ some examples such as Spanish universities, which includes the soil and its management in a profound focus and attention.

Consistent with the present work, the inclusion of soil science and environmental subjects in Degree in Environmental Sciences in Argentina is imperative in order to apply these concepts in professional activities related to sustainable exploitation of soil. This will emphasize the need for training for action.

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