

Human Resources in Environmental Engineering. Actuality, Needs and Perspectives in Mexico

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SUMMARY

In this work, the main environmental problems of Mexico and the present availability of human resources are analyzed to establish the needs for education and training. In addition a detailed inventory on human resources, professionals and institutions related with Environmental Engineering, as well as an evaluation of the present state of research and technology development in the field are explained. Finally, a proposition is made to articulate, in coordination with the Mexican Government, the human resources formation, the research activities, the technology development and the professional associations with the environmental problems, in order to achieve an efficient and rapid solution to these.

INTRODUCTION

The definition of Environmental Engineering in Mexico has evolved in accordance with social, economical and technological advances around the world and within the country. However, in most academic curricula there is still a lack of recognition that in Mexico there are environmental problems typically corresponding to the so called first world (the presence of very agresive toxics as a product of a highly developed industry for example) as well as problems related to underdeveloped countries (such as lack of basic sanitation and the irrational use of natural resources). It is easy to think that the solution lies in the proper modifications of academic programs, so that graduate students automatically are prepared to confront with the environmental reality that sorrounds them. But this is an incomplete approach, because solutions require not only the implementation of formal academic programs, but also a real link among three activities: research, technological development and training and qualification of human resources at various levels and types of programs. As obvious as it may seem, in Mexico, the relationship of this particular triad and of it with the mexican social, economical and political reality is absent, although it is of paramount importance to achieve the proper solutions to our environmental problems, and also to establish a more preventive approach in the future.

MAIN POLLUTION PROBLEMS IN THE COUNTRY

The process of industrialization in Mexico has been very quick in some areas but without an environmentally proper infrastructure. The industrial activities are unevenly distributed along the country, thus provoquing a great development in defined areas, which in turns concentrates pollution problems in those areas, specially urban. On the other hand, there is a strong tendency of growth by the most contaminant sectors of the industrial field, as well as other so called subsectors such as agriculture and municipal development. Table 1 shows the environmental areas that have a need of specialized personnel accordingly to the type of economical activities, which of course are distributed all along our country. Figure



1 shows the pollution problems in Mexico as well as their location in the country.

RESEARCH

Environmental engineering research activities in Mexico have been developed in a rather disorganized manner, in which each group defines its priorities and research lines, without taking into account duplicity or possible interactions. Multidisciplinary research has not been used, except in environmental impact studies, but these are made more with a bureaucratic than a technical approach, and often times do not really serve as a basis for applying corrective measures. In some cases private enterprises do contribute, although in a limited way, as sponsors or promoters for research, but the majority of them tend to ask advice out of the country or import foreign technology. In total, there are 35 research groups in the country, most of them recently formed (< 10 years), 43% located in Mexico City, 11% in the center part, 9% at the northeast and 11% at the southern part of the country. It is important to say that very few of them undertake all fields related to environmental engineering, so 74 work in the water field, 26 are dedicated to air problems and 31 are working with solid residues. Based on our main problems, the fields on environmental engineering that should be taken into account for research projects are: a) Solid wastes, of which the most important aspects are municipal and hazardous wastes; b) Air, field on which the main research work is related to the development of pollution control devices and none on mathematical modeling; c) Water, line of research most studied but on which there still are many pollution problems to be solved as proven by recent studies⁽¹⁾, according to which, the main research needs are low cost waste water treatment systems for liquid industrial wastes, industrial sludges treatment and disposal systems, water reuse and some others; d) Specific items such as thermal pollution, noise and soil erosion.

TECHNOLOGICAL DEVELOPMENT

Although this is a paramount problem in environmental engineering in Mexico, its achievements are very scarce, due to a lack of systematic work and very few groups dedicated to the matter. There are some Mexican patents (around ten) but they lack promoting and commercializing programs like in other countries, where the governments themselves promote the use of national technologies.

EDUCATION OF HUMAN RESOURCES

The first postgraduate program in the country was established in 1951 at the National University of Mexico (UNAM), corresponding to the first Latinamerican postgraduate educational program to obtain masters and doctors degrees in Sanitary Engineering⁽²⁾. At present the name is master and doctor in Environmental Engineering. The main objective of this postgraduate program is to conform a group of engineers in order to select, design and implement viable solutions to the specific pollution problems of the country, by the development of certain activities such as: technology development and adaptation, research, management and operation of pollution control systems, design and planning, administration and legislation, and education.

Based in institutional data, it was established⁽³⁾ the need for 3,500 environmental specialists, of which 1,500 should have a masters degree and 250 doctors, covering all the fields in Environmental Engineering, plus and additional 5% each year, which is a more precise estimation than that of the World Health Organization (that is 3,240, or one Environmental Engineer for every 25,000 inhabitants), but the specific requirements of the country are not homogeneous, and depend on the geographical density, industrial activity or regional characteristics. To cover these special needs of education, there are a number of institutions and programs along the country, as can be seen in Tables 2 (for Bachelor's level) and 3 (for postgraduate level)



in addition to informal education where we have more than 60 programs.

Table 1. Economical activities and their impact on environmental degradation

Activity	Type of pollution and impact				
	Air	Water	Noise	Soil	
				Solid wastes	Erosion
Agriculture	0	3	0	2	3
Urban development	3	3	3	3	3
Livestock	0	2	0	3	0
Food	1	3	0	2	0
Sugar	0	3	0	3	3
Cement	3	3	1	3	0
Pharmaceutical	3	3	0	3	0
Fertilizers	3	2	0	2	0
Synthetic fibers	3	3	0	3	0
Galvanoplasty	3	3	1	3	0
Hydroelectrical	0	2*	0	0	0
Minery, metallurgy, iron and steel	3	3	2	3	0
Nucleoelectrical	1	3	3	3	0
Pulp and paper	3	3	2	2	2
Petrochemical	3	3	2	3	2
Basic inorganic chemical	3	3	1	3	1
Thermoelectrical	2	3	3	0	0

0 = no impact; 1 = minimum, 2 = medium, 3 = maximum

* The change from current to static generates ecological problems and induces eutrofication

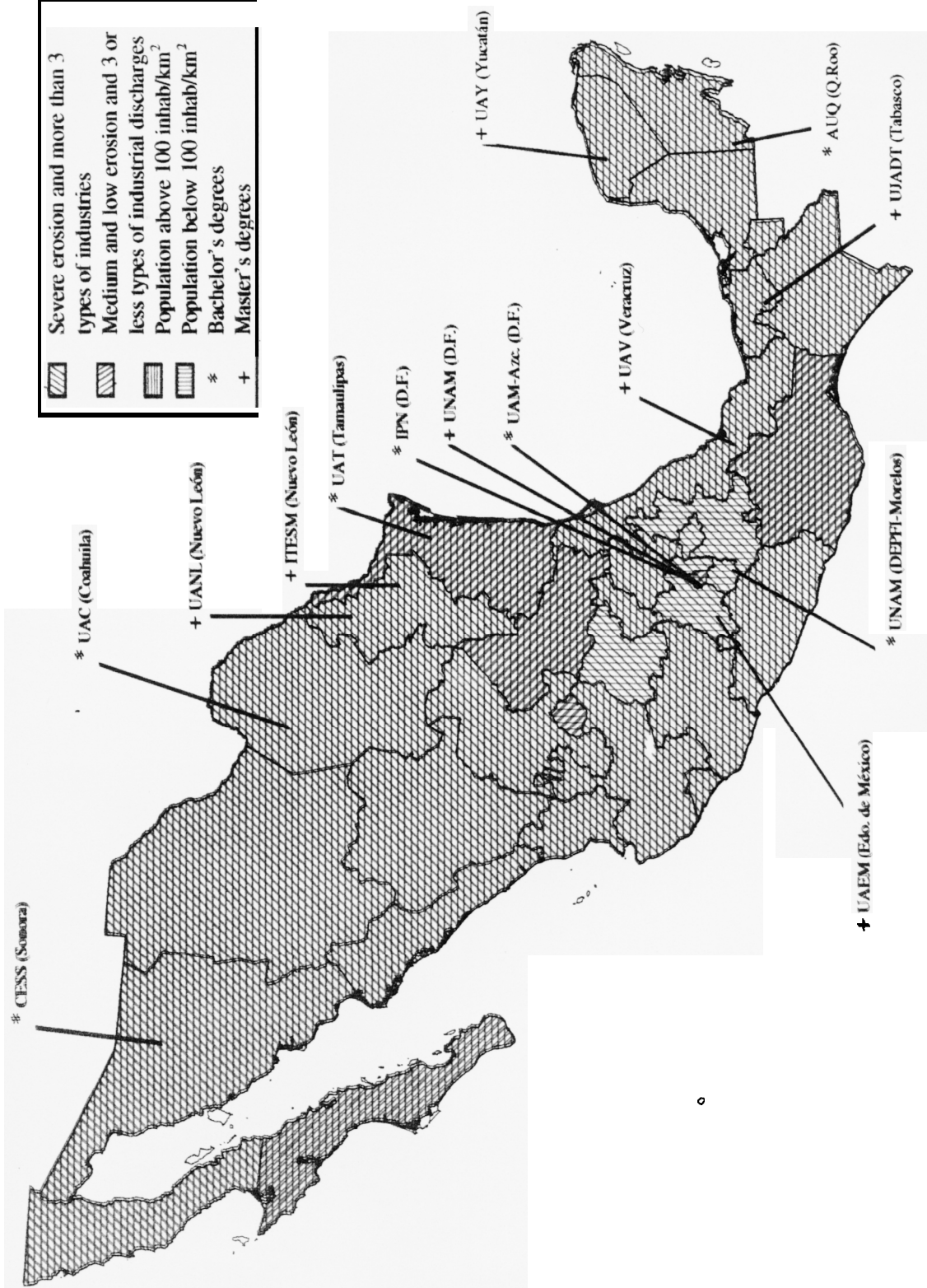


FIG 1 Distribution of some environmental problems in the as well as postgrad programs Environmental Engineering

Table 2. Bachelor's degrees in Environmental Engineering

Attribution area	University	Approach
Division of Basic Sciences and Engineering	Autonomous Metropolitan University	Water/air
Superior School of Engineering	Autonomous University of Coahuila ^a	Global
Professional Interdisciplinary Unit on Biotechnology (UPIBI)	National Polytechnic Institute (IPN)	Global
Academic Division on Biological Sciences	Juárez Autonomous University of Tabasco ^b	Global
School of Environmental Engineering	University of Quintana Roo	Global
Western Department	University of the West	Global
Faculty of Agro-industrial Sciences	Autonomous University of Tamaulipas	Global
Superior School of Ecology	Superior Studies Center of Sonora ^c	Global

^a without admittances nowadays; ^b called Environmental Civil Engineering; ^c called Ecological Engineering

Table 3. Masters's degrees in Environmental Engineering

Attribution area	University	Initial date
Faculty of Civil Engineering	Autonomous University of Nuevo León, Monterrey ^a	1974
Superior School of Engineering and Architecture	IPN, Mexico City	1980
Interdisciplinary Educational Unit on Sciences and Administration, Institute of Engineering	University of Veracruz, Veracruz	1980
Faculty of Engineering	Autonomous University of Yucatan	1977
Faculty of Engineering	Monterrey Institute of Technology and Advanced Studies (ITESM)	1961
Faculty of Engineering	National Autonomous University of Mexico (UNAM), Mexico City	1957 ^b
	Postgraduate Studies Division, Morelos	1992
Faculty of Engineering	Autonomous University of Ciudad Juárez	1992

^a also there is a Mastery in Public Health, initiated in 1984; ^b as Sanitary Engineering, in 1979 changed to Environmental Engineering



STRATEGY PROPOSED

It is important that the government should act as a coordinator between the organizations that give financial support and the universities and research centers. Also, it should coordinate and orient private enterprises to establish a link with universities and research centers on what are their needs. These relationships should serve as promoters of well designed educational programs oriented to the solution of specific pollution problems and with an adequate financial support.

Still, there will be a final problem to solve, and that is how to comprise all the fields that conform the environmental engineering in an actual context of scarcity of high level personnel that serves as forming personnel, combined with a lack of economic resources to finance such programs.

Again, the solution may be a very close link among the users of the forming personnel (to give financial support), the educational institutions that have high level personnel (in order to form new human resources) and the universities (to supervise, coordinate and be responsible of the education). A multi-sectorial and multi-institutional participation is indispensable, and there are some basic considerations that should be taken into account:

- 1) The educational programs in environmental engineering should be versatile enough as to permit changes and advances in a very flexible and easy manner. This can be achieved by a constant, permanent and effective contact among professionals, researchers, professors and pupils.
- 2) The definition of Environmental Engineering in Mexico and its implementation in several programs, requires the consideration of elements such as political, economic and international contexts of the country, and not only the purely technical aspect of the subject.
- 3) The development of an effective program for the formation of human resources must comprise formal and informal courses, research activities and technological development, function that must be coordinated by the government.
- 4) The educational programs, as well as research and technology development groups must be well distributed in the country, in order to attend and solve the regional problems with a wide knowledge of the surroundings.
- 5) Even though the need for environmental engineering is given in diverse fields, the one corresponding to water is the most developed, so it is necessary that the government promotes the growing of other sectors, such as hazardous wastes.
- 6) It is an obvious matter that there should be an articulation axis that coordinates the activities of teaching, research and technological development. And there is no doubt that this coordinator must be the government.
- 7) It is a urgent necessity to promote the participation of technical specialists in the environmental planning matters, in order to design better strategies with a maximum benefit/cost that lead to the solution and advance in pollution control.

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