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DESIGN OF A GENERAL METHODOLOGY FOR THE EVALUATION AND CATEGORIZATION OF AN ENVIRONMENTAL PROGRAM WITH SPECIAL REFERENCE TO COSTA RICA

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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

DESIGN OF A GENERAL METHODOLOGY FOR THE EVALUATION AND CATEGORIZATION OF AN ENVIRONMENTAL PROGRAM WITH SPECIAL REFERENCE TO COSTA RICA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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By

HARRY CASTILLO

Norman, Oklahoma

1982

DESIGN OF A GENERAL METHODOLOGY FOR THE EVALUATION AND CATEGORIZATION OF AN ENVIRONMENTAL PROGRAM WITH SPECIAL REFERENCE TO COSTA RICA

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DISSERTATION COMMITTEE

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ABSTRACT

The government of Costa Rica has stated through its Health Minister the need for a formal procedure for the evaluation and categorization of an environmental program. The present investigation's goal was to develop the general methodology that allowed the creation of this procedure.

Although this methodology was developed for use in environmental affairs planning in developing countries, there is a significant potential use in developed countries. Costa Rica was used as a test case, but the methodology could be used effectively for more beneficial budget balancing of major research programs such as cancer, heart, and other research areas.

This dissertation essentially consists of two parts. In the first part, which consists of five chapters, methodological studies were prepared to support as bases for the development of the general methodology at an adequate level for which the procedure of each government or institution can be deducted and implemented, after an adaptation. The results of this step are shown in Chapters I and II, which include an analysis of the evaluation concept reached through the systemic approach to its definition. The last

chapters of the first part covered an analysis of different techniques according to their contribution to the evaluation process. An important advantage of the Saaty method over the other methods is the fact that the comparative evaluation by pairs of objects is psychologically easier than the assignment of values to only one absolute object. The objective of the investigation and the study justification were determined from an analysis of the information presented in the second part, the Appendixes.

Consequently, in the first part was established the methodology which consists of two main parts:

* Evaluation of the environmental affairs by using Saaty technique
* Categorization of the environmental aspects by applying the methodology to the Costa Rican environmental affairs using outside and inside country experts' answers to questionnaires and using inside country experts' answers to questionnaires for the current status of the environmental aspects.

The second part includes the Appendixes where is shown the general information about Costa Rican institutions related to environmental affairs, descriptions of methods used, the tree construction for the Saaty technique, the computer program used in the evaluation process, results of the current status evaluation, the current scale and the final scale of categorization. Also in the Appendix are the questionnaires used and the list of experts.

With this research one goal corresponded to the profit and experience that came through developing it and contributing to research about environmental problems evaluation and categorization. It was concluded that the institutions analyzed do not have any procedure to minimize the difficulties and subjectivity in their evaluation and categorization process. The methodology developed in this research will hopefully bring beneficial impact on environmental affairs concerns in Costa Rica, and the success of it depends on the post-methodology activities and, with the government's active participation, an environmental affairs evaluation and categorization methodology has been created for a continuation of the process of exercising the priorities, adding new ones, and deleting no longer valid ones. As a result of this proposed methodology and the increasing recognition by the government of scientific input into public programs a Commission Office of Environmental Affairs, providing links between consumers, engineers, scientists, and the government, is recommended.

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CHAPTER I

INTRODUCTION

A. The Problem

The government of Costa Rica has stated through its Health Minister the need for a formal procedure for the evaluation and categorization of an environmental program.

The Costa Rican government has a Health and Industry Law[1] which establishes rules and regulations that contribute to the solution of environmental problems. It determines criteria and general procedures for determining category priority. A judgment commission evaluates the environmental program's antecedents. However, in the majority of the cases, this law is inefficacious, and many people do not completely understand it.

Costa Rica is located in Central America, bounded by

Nicaragua to the northeast, by Panama to the southeast, the Atlantic Ocean on the east, and the Pacific Ocean on the west. The population is approximately 2,250,000 inhabitants; around one third of these people (660,000) is concentrated in the capital city of San Jose. See Figure A.1*.

Costa Rica has been distinguished as an agricultural country with a tropical climate and rainy weather with a mean annual rainfall of 2484 mm. The vegetation shows a predominance of forest zones. See figure A.1*.

A very good resource that complements the surface water is the ground water. The Central Plain population is served by the country's most important Aquifer called Virilla. One of the biggest problems that affects the country today is the concentration of big and small industries in the Virilla zone between San Jose and Heredia. See Figure A.1*.

In Costa Rica the concentration of atmospheric pollution has been at acceptable levels, with very few exceptions resulting from problems in specific areas. However, a very fast and constant increment of these concentrations in the metropolitan area has been observed. This fact indicates the need for corrective actions soon, because the cost will be higher if delayed. The major problem that affects pollution is the emissions from automobiles. The excess of vehicles and the small and inadequate roads have increased the noise and

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*"A" refers to figures and tables in Appendix A.

the air pollution.

The Costa Rican rivers that traverse the country through the towns and those that border the cities are contaminated because they are utilized as disposal places for human and industrial wastes. Into these waters are disposed the sanitary drainage without any previous treatment--sometimes domestic solid waste, industrial liquid waste, agricultural solid waste, and the wastes from agricultural erosion fields. This situation is a big obstacle to the utilization of the hydrolic resources; furthermore, it causes deterioration of the environment with the consequent degradation of the population's quality of life. See Figure A.1*.

The soil pollution of the country is wide in urban areas and in agricultural areas because of the feces deposited through latrines and septic tanks and because of the daily use of pesticides in agriculture. Scientists have shown that pesticides contribute to the causes of leukemia and nervous illness.[2]

On the other hand, Costa Rica has been having a big problem with the industries that are located in La Uruca. They use water from the Virilla aquifer and dispose their wastes without any previous treatment directly into the river or onto the ground. Because of the erosion and rainfall, the infiltration process begins and contributes to the contamination of the ground water. This situation has been increasing in

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*Ibid.

all the countries that have a ground water resource. For example, in the United States the use is increasing at a rate of 25% per decade.[2] More than half of the Costa Rican population is served by ground water.

Waste disposal practice in Costa Rica has been affecting the safety and availability of ground water, but the overall usefulness has not been diminished on a national basis. In countries like the United States, almost every known instance of ground water source has been affected. Costa Rica has not yet made any study relating to the contamination of ground water sources.

Waste disposal practices of principal concern are those related to industrial and urban activities. Existing technology cannot guarantee that soil attenuation alone will be enough to prevent ground water contamination from a waste disposal source. In Costa Rica there are no institutional programs to address many of the sources of potential contamination, and neither is there any comprehensive protection of ground water. Legal action is seldom taken against a specific source of contamination because individuals, private organizations, and public agencies seldom have the resources required to prove that a specific source is the cause of the contamination.

The effective utilization of ground water is attainable only by the commitment of adequate manpower to prevent, or at least control, its pollution. The Ministry of Commerce, Industry and Economy of the Costa Rican government (MEIC) has started to worry about the problem of having no treatment for industrial wastes, especially with the industries located in La Uruca, because the industries are close to the Virilla aquifer, today's and tomorrow's source of water supply. The government decided to spread out the industries and to create industrial parks with different services and waste treatment. See Figure A.1*. Some of the parks are already in operation and others are projected for the future. This action shows that the government is concerned about the problem.

In Costa Rica there are institutions and laws related directly to environmental problems. The National Institute of Drainage and Aqueducts (INAA) is working with problems of water supply, treatment plants, distribution and delivery of water for domestic consumption, sewage treatment, and water for industry, irrigation, and recreation. The Ground Water National Service (SENAS), which is concerned with everything related to ground water, has undertaken the recharge of the Virilla acquifer. It has started to monitor some parameters to determine if there is contamination. Logically, there must be contamination because most of the industries around this place are using the aquifer water in their processes and are discharging their wastes directly into the river or onto the land without any previous treatment. The Municipality of San

*"A" refers to figures and tables in Appendix A.

Jose is concerned with solid waste collection and disposal, authorization for septic tank designs for new houses, and street sanitation. The Municipality of San Jose is studying this major problem of waste collection, the solution to which depends on educating the people in sanitary practices. The Ministry of Health through the Sanitation Department is in charge of such environmental problems as noise and air pollution. The Ministry of Commerce, Industry and Economy (MEIC) is concerned with industrial waste regulations related to discharge and treatment. The Costa Rican Electric Institute (ICE) is working with problems of aquatic plant pollution in dams. In the same way, other institutions such as the University of Costa Rica, through their independent goals, are contributing to the solution of the environmental problems.

Costa Rica also faces the environmental problem of planning the solid waste collection routes. San Jose has only one sanitary landfill, called Rio Azul. It does not function exactly as a sanitary landfill but more closely to an open dump. It does not operate under sanitary regulations, and it has bad odors, very bad appearance, and an increasing proliferation of mosquitoes that transmit sickness to the nearby population.

A new legislation and health law is necessary to protect the environment since the present law has not worked as the government had expected it to during recent years. Usually environmental problems cannot be isolated and studied alone because they are related each to the other. The lack of technicians, professionals, and specialists in these fields is another problem. Also there are problems in the collection of data and the maintenance of records. Furthermore, monitoring stations are insufficient in number and insufficient in operation. There is a need for inspectors to apply the law and for more research in these fields. It is true that environmental problems are international, but the solutions should be national and local.

The regulations, guide lines, and commentaries in all environmental programs create manpower demands in five major categories. These are: a) Planning and Coordination, b) Permitting and Licensing, c) Monitoring and Data Collection, d) Enforcement, and e) Research.

A national strategy of environmental protection will require a better understanding of the environmental, legal, technical, and economic complexities of dealing with the resources.[3] Better coordination of existing regulatory programs and a better understanding of the impact of all new regulatory actions on natural resources are necessary. Regulatory programs need to reflect the close relationship between land, air, ground water, and surface water. Furthermore, inventories of all these environmental problems are necessary to show such contaminant sources such as infiltrations as a consequence of the industrial waste disposal on land that have a significant impact on natural resources, and especially on ground water. Many sources are not included within the scope of institutions' protection programs, but may be addressed on a case by case basis.[4]

The most effective means for protecting natural resources is to control and monitor the potential source of contamination and not, for example, to control and monitor the aquifer in the point of withdrawal. New potential sources of contamination should be evaluated on a case by case basis. Existing potential contamination sources should be reviewed in order to develop control strategies that are instituted in accordance with local priorities. Increasing government regulations of surface water, air discharge, and ocean disposal may result in land disposal practices, particularly of sludges which could contaminate, for example, the ground water. At the present time, there does not exist a comprehensive government program for environmental problems, natural resource protection, and management.

B. The Objective

To protect the environment it is necessary to have regulations, administration, and order. The country relies on sanitary legislation and legal basis for the execution of its programs. Citizens must cooperate by complying with the regulations, and the government must cooperate by educating the citizens concerning sanitary problems.

One of the main points of this research was to amass information which may be useful to the government concerning environmental problems, and to suggest solutions to those problems.

Today some institutions have become concerned about environmental problems, as exemplified by the investigation made three years ago by the Ground Water National Service (SENAS) concerning bacteriological pollution of the Virilla aquifer[5] and as exemplified by the better care and vigilance of the sanitary landfill at Rio Azul by the Municipality of San Jose. The government has agreed with various regulations suggested by some institutions. Furthermore, the government approved new regulations, but at the moment of applying them many obstacles appeared. There was a lack of educated people in those fields to implement the regulations. Included in the National Plan of Development, prepared in 1974, the environmental program appeared as one of the most important fields needing attention. The universities have started to send people abroad to study these fields, so that when they return, they will be able to prepare other people. It has not been determined yet on which professional level the university needs to prepare for the present and future needs of the country. The present situation calls for more technicians than people with bachelor, master, and ph.d. degrees in environmental fields.

All the problems have worsened because of the lack of coordination among institutions. Often duplication of efforts causes loss of money, waste of time, and inefficient use of equipment. Frequently the commission designated by institutions to investigate certain problems are not composed of experts or experienced people. Those commissions proceed to evaluate and categorize the problem without any other guides than their own criteria and the actual law, and forget that the environmental problems are related to each other. These institutions sometimes compound their problems by taking the indices and coefficients that are used for other countries and applying them to their own country without observing that the conditions of the countries are totally different.

The preceding explanation shows the need to have an explicit and formal procedure that will identify which categories of activities most need to be considered. It also will determine the values of each category and then allocate them throughout the infrastructure by using an adequate and effective methodology to categorize and evaluate an environmental program. This procedure can then be applied to countries and institutions with similar needs. This procedure will be tested on Costa Rica.

CHAPTER II

PREVIOUS AND CURRENT INSTITUTIONAL BACKGROUND

A. Institutional Procedures

In general, environmental law considers the following aspects: potable water including domestic, industrial, irrigational and recreational; ground water; solid waste; aquatic weed pollution; noise and air pollution; and education in the fields. Although the primary responsibility for conducting these programs rests with the Ministry of Health, other institutions also undertake similar programs, resulting in duplication of efforts, waste of resources, and contradictory findings.

Analysis of data collected concerning institutional procedures related to the categorization and evaluation of environmental problems were essentially the same in each institution. Basically, decisions were made by a concensus of the members of an appointed commission. They determined the priority of projects based on their personal opinion, the results of which are shown in Appendix A-1.*

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*"A" refers to figures and tables in Appendix A.

The values for priorities such as research, conferences, meetings, seminars, publications, and others were calculated by considering a special factor which included the number of times the event had occurred.

The characteristic of the various forms or tabulations is that the maximum value possible in each of the activities being judged is limited. This situation exists in all but a few institutions, such as the Ministry of Health. In all the situations, the category assignment is made through the comparison of the total points assigned to a scale preestablished by the evaluation groups or to a scale borrowed from other countries.

B. Survey Analysis

The survey which yields the information for this research was made in the following governmental and non-governmental institutions: the Ministry of Health (MS); the Ministry of Industry, Commerce and Economy (MEIC); the Natioanl Institute of Aqueducts and Drainages (INAA); the Ground Water National Service (SENAS); the Costa Rican Electric Institute (ICE); the Municipality of San Jose (MJ); the University of Costa Rica (UCR); the National University (UNA); and the National Council of Science and Technological Research (CONICIT). The results of this survey showed that a formal procedure is not used by the Municipality of San Jose, the Ministry of Industry, Commerce and Economy, the National Institute of Aqueducts and Drainages, the Ministry of Health, the Ground Water National Service, and the University of Costa Rica. The people who compromise the boards of these institutions determine which environmental problems will receive attention. The decision to offer degrees in environmental engineering and environmental sciences at the university or to open a new department for research into environmental fields is made by a concensus of the board members.

The National University has a program in environmental sciences that stipulates the minimum requirements the student needs, but it does not prepare the people to deal with the realities and needs of the country.

CONICIT made an evaluation of the applicants for scholarships in order to determine the recipients. Even though the evaluation that CONICIT made did not concern environmental problems, this case constitutes a good example of evaluation and can be applied to the environmental problems case. Furthermore, CONICIT is considering giving scholarships to people in environmental fields. CONICIT has special forms, designed by special commissions, that are related to the concerned areas. Each member of the committee interviews, evaluates, and grades the applicant according to the application form. The sums of all members of the committee are totalled and averaged, obtaining in this way the total grade of the candidate. The final selection of scholarship recipients is based on these final grades.

A general criticism of the mentioned forms is that they have no theoretical bases, and this situation creates doubts about their validity. As it is difficult to define the fields that should be listed and the position they should occupy in the environmental scale, the validity of the fields and norms assigned is questionable. The lack of a theoretical basis leads to consideration of fields that do not correspond to relevant factors, or to the omission of some of them. An example is the lack of coordination between one institution and another because they do not see the situation as a dynamic system where everything is related to each other. In addition to these weaknesses, some factors are evaluated based on wrong criteria and on inconsistently assigned norms. An example of this is the laws utilized by the Ministry of Health and the Ministry of Industry, Commerce and Economy, which have equal or similar values for activities that are totally different in importance, time, or the required effort for their performance. They have produced norms without measuring the time and effort needed to establish and implement them. The other norms and laws shown in the Appendix A.1* have the same degree of development, and their mistakes are similar. Today some institutions have begun to take interest in doing research as an important part of their development, even though they lack a budget.

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*"A" refers to figures and tables in Appendix A.

The preceding explanation shows the need to have an explicit and formal procedure that will determine which factors need to be considered in order to deal effectively with an environmental program. This procedure will determine also the corresponding values of those factors.

C. Study Justification

The antecedents of this study lead to the conclusion that in the institutions the evaluation and categorization of the environmental problems are not based on a theoretical scheme. This failure constitutes the source of the problem, because of the irregularities and inefficiency among the institutions.

In Costa Rica there are some institutions that have a high degree of subjectivity in their decision making. The present procedures are not formal because they do not establish clearly the criteria for assigning the values.

In order to change this situation, it is necessary that the institutions have a formalized procedure prepared by specialists. In this way, based on the antecedents and the characteristics of the environmental problems, the corresponding category can be determined. However, it is suggested that it is not possible to have a general procedure with automatic application to each country and institution. It is necessary to take into account differences between countries and institutions. For example, it is advisable to consider characteristics associated with collection, treatment, transmission, distribution, pollution, and so forth, of the institutions concerned with potable water. In all the institutions where there is research, there should be a consideration of the organization and practice of the research.

The orientation of this study, in order to assign the general methodology, is supported by the scientific method in common use in research. In this approach through a deduction method, the solutions for particular problems are obtained from a general solution. It is necessary that the methodological paradigm support the procedure consistently for categorization of the environmental problems through the evaluation. The categorization itself is a second phase that will be determined by referring to the result obtained from a scale after the environmental problems are evaluated. Furthermore, the categorization is divided into two important aspects:

a. Evaluation of the environmental problems
b. Scale structurization where the corresponding category will be obtained

In summary, the problematic set up can be defined as the lack of a general methodology for the categorization and evaluation of the environmental problems, the design of which is the basic goal of this work. In other words, the problem is not the design of the procedure itself, but the development of a methodology to construct procedures in each institution.

CHAPTER III

THE CONCEPTUAL FRAMEWORK AND THEORETICAL BACKGROUND

A. Introduction

The material that is shown in this chapter constitutes the methodological base for construction of the evaluation procedure for environmental problems.

First, the material analyzes in detail the evaluation concept to arrive, with the help of the systemic approach, at its formal definition. The second and final section of the chapter presents some methods that, because of their characteristics, are studied as possible tools for the evaluation procedure. These are: KJ, Systemic Approach, Delphi, Delphi modifications by Rutherford and coauthors, and the Saaty method.

B. The Definition of the Principal Variables

Because of the great importance that the terms *value* and *evaluation* have in this research, and because of their diverse applications at the present time, it is necessary to analyze their meaning. According to the goals of this research, the following definition of the term value can be established: *Value* will be the numerical degree to which the specific group of factors, characteristics, and activities of the institution can contribute to the accomplishment of the institutional goals. Evaluation or valuation is used to indicate the procedure by which the numerical value is calculated. This procedure includes comparison and reflexion. Furthermore, the procedure according to its use in this research can be defined as:

a. The establishment of a hierarchy of the institution related to the environmental program

b. The determination of the absolute contribution of each element at one level of the hierarchy to the immediately superior level

c. The determination of the total contribution of the individual characteristics of the institutions through the various levels of the hierarchy and ultimately to the country's development

C. Infrastructure

The systemic approach is suggested for constructing the theorectical scheme. It considers the structure under study as a system that sustains relations with other systems, constituting what is called a suprasystem, and accomplishes goals and functions. See Figure 3.1. In the first step of the analysis, the objective being evaluated, which is part of the system, can be studied according to how much it contributes to the desired goals of the system. According to its contribution it will have a greater or a less value. From the systemic approach, by using a black box it is possible to predict the

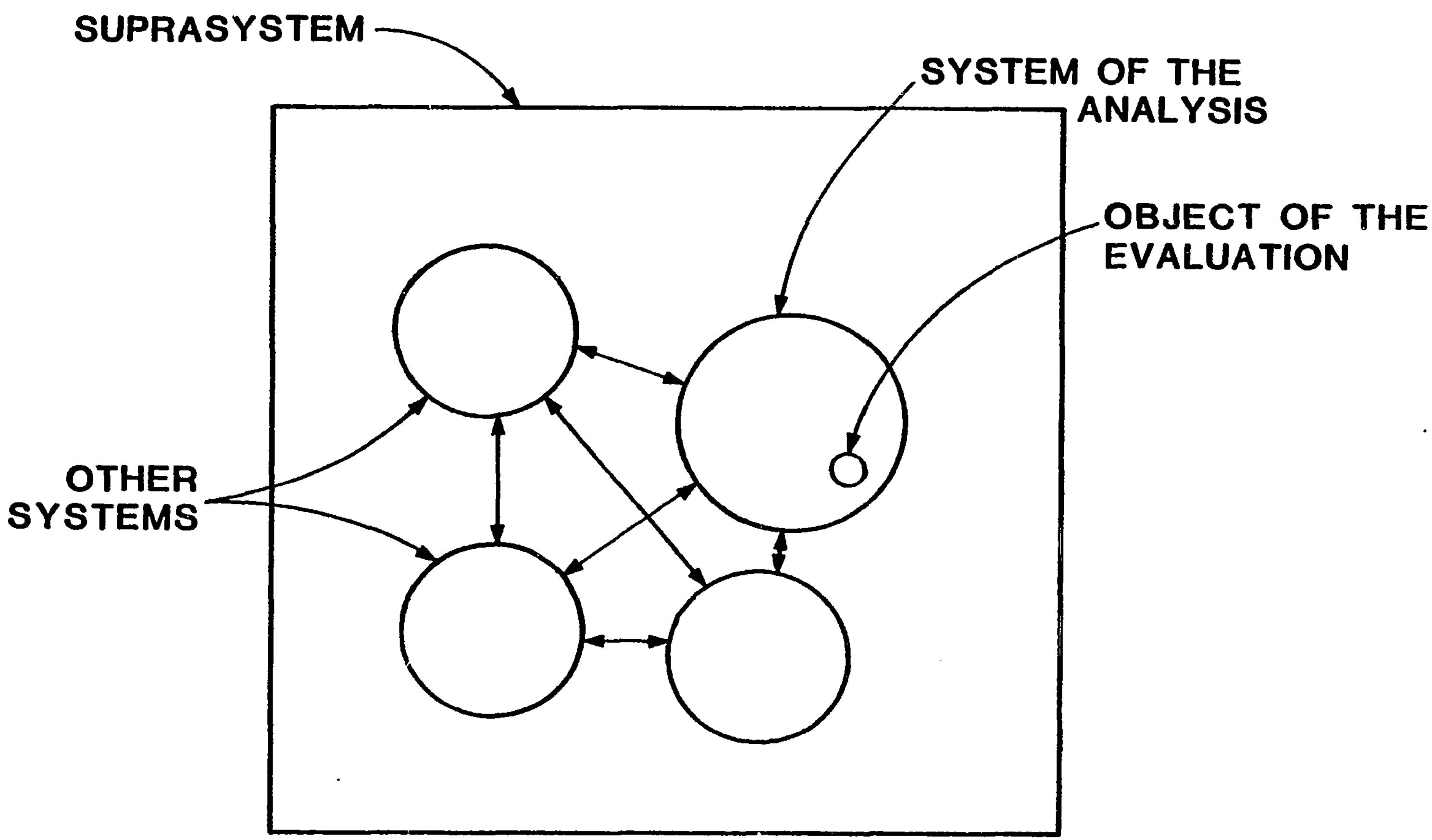

Figure 3.1 SYSTEMATIC APPROACH

contribution of the object's components to the system's goals. The components of the object are fed into the entrance of the box and the systemic goals are produced at the exit. According to the obtained scheme, the evaluation can be made in an objective or subjective manner.

In the first case we can assume there are some tools that will permit the direct measuring of the variations that result from obtaining the systemic goals so that the magnitude of the contributions can be quantified. If the characteristics of the system constitute an obstacle or make it impossible to apply the measuring tools, the evaluation should be made with the participation of one or more experts. They will assign values according to their subjective judgment. See in Figure 3.2 the first stage in the evaluation process.

In the last case, when the relation between the thing in evaluation and the system's goals is complex, it might be necessary to reduce the subjectivity of the process and to facilitate the experts' work in a second stage. This stage consists basically of a clear explanation of the black box illustrated in Figure 3.2. In other words, the system's structure in analysis will be specified in detail by considering how the thing in evaluation performs over each part of the system, or over each stage or level in its performance. As can be observed in Figure 3.3, the system performance to which the evaluation's goals belong can be decomposed into a determined number of levels that differ in each particular case, developing in this way the so-called "hierarchy tree."

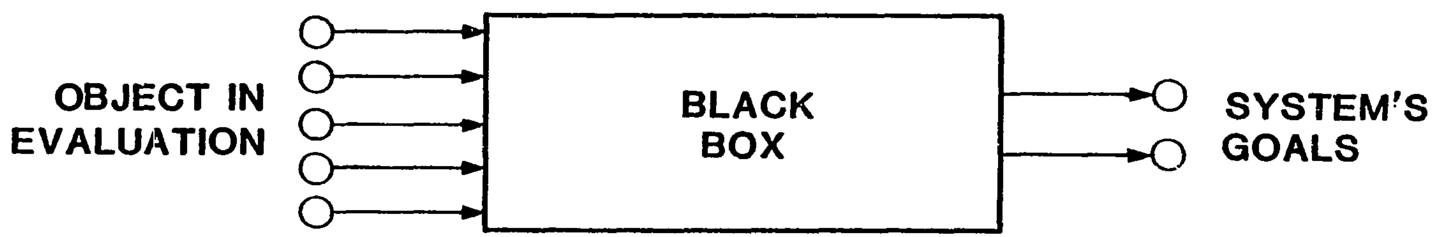

Figure 3.2 SCHEMATIZATION OF THE FIRST STAGE IN THE EVALUATION PROCESS

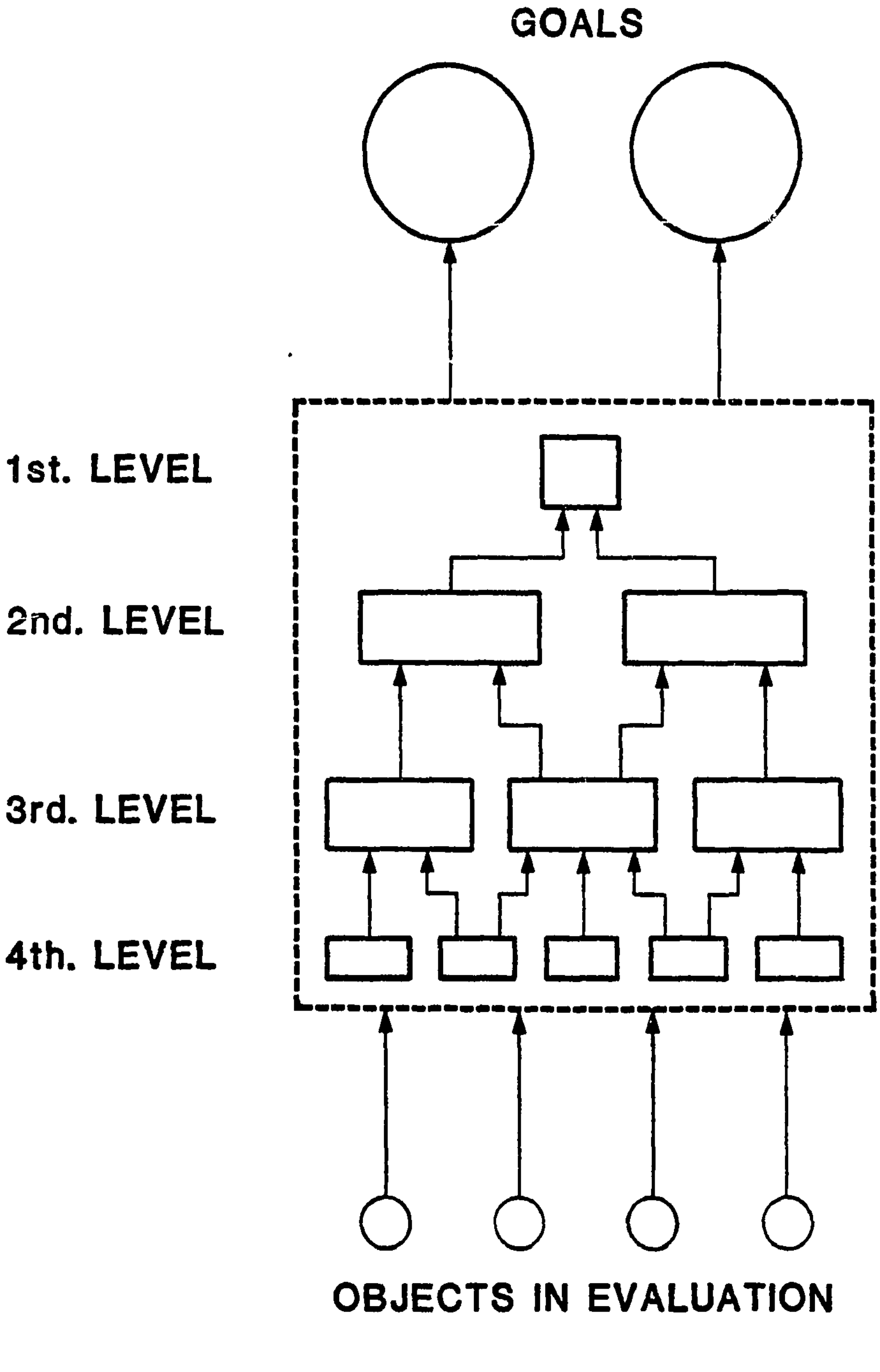

Figure 3.3 SCHEMATIZATION OF THE SECOND STAGE IN THE EVALUATION PROCESS

Therefore, the evaluation can be made in two consecutive steps: The first consists of evaluating the study's goals from the point of view of their contribution to the attainment of the base level's elements as defined by the experts. Then the contribution of these base elements will be evaluated, with respect to the elements of the immediately superior level, and so on until arriving, level by level, to the established maximum, the system's goals. The second step consists of considering all the absolute values already determined, level by level, and through a technique obtaining only one total value for each thing in evaluation that indicates the magnitude of its contribution to the system's goals.

D. Comparative Analysis of the Contribution of Some Techniques to the Evaluation Process

This section presents an analysis of techniques in order to choose the most adequate ones and/or their most convenient portions. Also, the possibility of creating new parts that are not in the described methods and that are indispensable is considered. The stages of this process have been given in the preceding section in the evaluation's concept definition. The steps in order to obtain the procedure are:

1. Construction of a factor's tree in order to express the functions and activities of the institution's environmental fields
2. Determination of the factor's weights in their hierarchical

contribution to the immediately superior level

3. Determination of each factor's weight limits contribution to the tree's highest level

The hierarchical concept of the first step is manipulated according to the following definition: hierarchy exists in a group of elements when they are organized in levels, and each level's elements are controlled by at least one element in the immediately superior level and controls at least one element of the immediately inferior level. Symetry of the control element with respect to the controlled element does not exist. If one element controls another, and this last controls a third, consequently, the first element controls the last one. So, a hierarchy is complete if each element of one level is controlled by any element of the next higher level. However, a finite group of elements that are in the base level are not controlled. The tree in Figure 3.4 shows that the elements of a group, represented by circles, are controlled by at least one element of the superior level and one element of it controls at least one in the inferior level. The dominance is expressed in the graph with arrows. Their directions show, in the beginning, the factor that controls and, at the end, the factor that is controlled.

The third also is postulated as a consequence of the following thesis: in order to determine the contribution of one factor to another that belongs to a higher level, it is

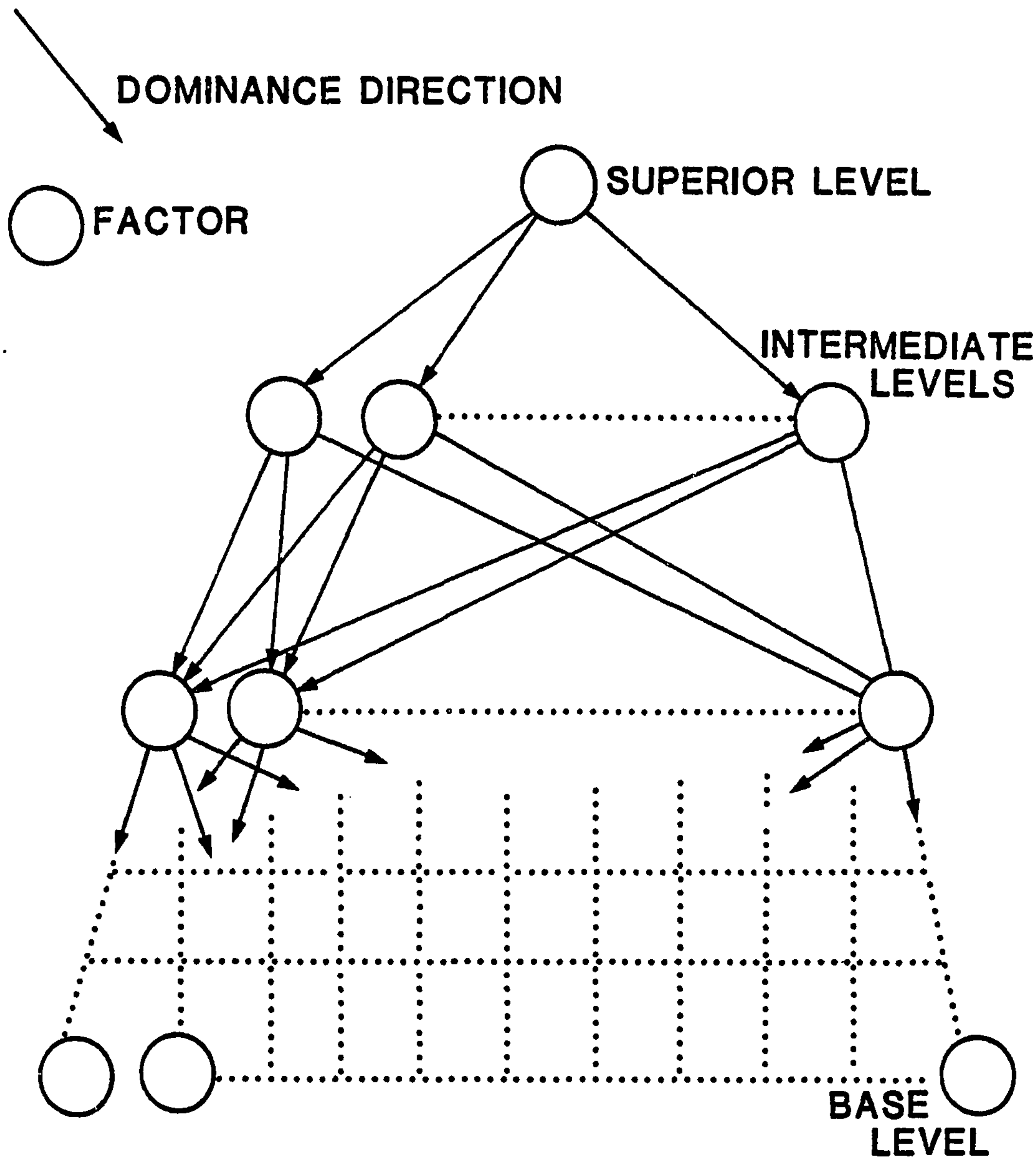

Figure 3.4 A HIERARCHICAL TREE WITH FACTORS

convenient to have the help of the intermediate factors. Some techniques that potentially can satisfy the construction of the developed procedure have been found in the general review of literature. These methods, which are described in the Appendix B*, are KJ, Systemic Approach, Delphi, Delphi modification by Rutherford and coauthors, and the Saaty method. The knowledge of how each works and the manner in which each one responds to the particular steps are explained. Table 3.1 shows a comparative analysis. Then, some advantages and disadvantages of the techniques are presented. Finally, a brief outline shows the elaborated procedure in Chapter IV.

The KJ technique can be used in the tree construction in the inductive manner by doing an aggregation of the elemental factors. However, it neither evaluates the factors weights nor includes a mechanism to determine the factors' contributions from inferior to superior levels.

The systemic approach can be used for the tree's factor's construction by doing a disaggregation of the suprasystem's goals so that the components involved contribute to the total system performance. This approach does not contribute to the evaluation of the factors' weights, nor does it calculate these factors' contributions in the higher levels.

The Delphi method formulates factors of only one level in an autonomous or individual manner, and with it a tree cannot

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*"B" refers to figures and tables in Appendix B.

be constructed. The weight evaluation is done in an absolutely private and autonomous form by the use of feedback in order to get concensus. It does not identify a possible process to assign the factors' contribution values from inferior to superior levels.

The Delphi modification by Rutherford and coauthors constructed a structure with two levels. This can be used to manufacture the tree by the aggregation of the factors belonging to a higher level. Then in a recursive manner and by discussion the remainder of the factors' levels are formulated. This method uses an absolute technique of evaluation, and constructs the terms of the superior level through a taxonomic process. The weight factors are evaluated in an absolute and collective manner. In order to get the contribution to the highest levels, it uses recursively a statistics mechanism.

The Saaty method does not construct the tree, and therefore the tree should be supplied by another method. The factor's weights are determined in a relative manner. By using a mathematical technique with matrices, the absolute weights of the factors of each level and their contribution to the factor in the immediately superior level are obtained. The contribution to factors of levels higher than the immediately superior one is determined by the successive multiplications of the matrices that contain the absolute values of their own level.

There are some advantages and disadvantages of the preceding methods. One advantage of the Delphi method is the way by which concensus of experts can be reached without creating conflicting situations among them. A disadvantage of this technique is related to the subjectivity that accompanies the experts' evaluation. Even though it is not possible to eliminate this subjectivity, it has to be reduced as much as possible.

The KJ method tends to reduce the subjectivity through the iterative form by which it groups the factors. However, the stages leading to these factors are longer and tiresome. Also, many special forms and a very good control of the collection of information are required. This information is the result of aggregations that are not done in rational form but on the basis of the experts' opinions.

The Delphi method, even though it tries to get the experts' concensus and their assigned absolute values to the involved factors, has a high degree of subjectivity because this designation is made on the basis of their individual judgment. For example, this method groups the factors inside a tree without having an organization of the factors. In conclusion, the values designation in the Delphi and the Delphi modified by Rutherford and coauthors is difficult and subjective. The subjectivity is reflected in some of the decisions taken by the experts in order to group and reduce the proposed factors. Also, as these methods have different stages, like goals, grouping, answers, answer editions, iterations in order to change opinions, and so on, they can consume too much time.

As indicated previously, the Saaty method requires another method to provide it with the hierarchy of factors that are to be evaluated, where levels are exhibited according to their individual factors as well as according to the interrelation between those levels. This method quantifies the feelings and experiences of some experts on the basis of comparisons between paires of the system's elements. Through the calculation of the characteristic values and vectors the absolute values of the importance of one factor for another level are obtained. The method's disadvantage is that some inconsistencies can appear. For example, the expression $a_{ij} * a_{jk} = a_{ik}$ cannot be conserved rigorously if it is not previously seen that the improvement can be obtained by the designation $a_j/a_i = 1/(a_i/a_j)$. As a consequence, the experts have assigned values to only one half of the judgment matrix. The components of the characteristic vector associated with the largest eigenvalue is a reflection of the relative importance of the various categories of the matrix. This technique is a well used procedure in multivariate analysis in deciding on combinations of variables which are most significant.

One important advantage of this method is the fact that the comparative evaluation through pairs of objects is psychologically easier than the assignment of values to only one object in an absolute. For example, when one man is asked to determine the temperature of an object without any tools or instruments, it is easier for him to make the comparison by deciding if one object is hotter than the other.

TABLE 3.1

TECHNIQUES AND THEIR ANSWERS TO THE PARTICULAR STAGES OF THE PROPOSED PROCEDURE*

	Stage #1	Stage #2	Stage #3
Method	Construction of the tree of factors.	Evaluation of the factors' weights for their contribution to the immediately superior level.	Determination of the contribution to a level higher than the immediately superior one.
KJ	Constructs the tree in an inductive manner, proposing elemental factors and doing an aggregation of them.	Does not evaluate weights.	Does not determine it.
Systemic Approach	Constructs the tree through a disaggregation of the suprasystem's goals, contemplating the complete systemic performance.	Does not evaluate weights.	Does not determine it.
Delphi	Formulates individual factors of only one level. It does not construct all the tree.	Evaluates the factors' weights in an absolute, private, and autonomous manner. Creates feedback to get concensus.	Does not determine it.
Delphi modified by Rutherford and coauthors	Constructs the levels of a structure that can be used to manufacture the tree in a collective form and with discussion.	Uses absolute evaluation techniques in a collective form. Experts discuss to get concensus.	Is done by a statistical mechanism between two levels but can get contributions from higher levels in recursive form.
Saaty	Does not construct the tree of factors.	Determines the factors' weights in a relative form, and the absolute weights are calculated using a matrix technique.	Multiplies the matrix that contains the absolute values obtained in stage #2.

*Refers to the techniques explained in Appendix B.

CHAPTER IV

METHODOLOGY PROCEDURE

A. Outline of the Evaluation and Categorization Methodology

In this subsection the general methodology is presented.

1. Construction of the hierarchical tree:
   a. Selection of the specialist group to evaluate how the situation should be and the current situation.
   b. Explanation to the specialists of the goal in this stage and the procedure for arriving at it.
   c. Construction of the hierarchical tree through questionnaires answered by the specialists group. The tree's highest point is the fundamental orientation of the system, and the goals and the activities are located in descending order.
   d. Ask the specialists group through the questionnaire to determine, first of all, the institution's goals; then, the functions needed to accomplish the preceding goals; and finally, the activities which will accomplish the different functions.
2. Evaluation of one hierarchical level with respect to the

immediately superior one and determination of the value that corresponds to each element of the lower level, the functions:

a. The specialists group assigns, according to the Saaty method, relative values to one element of the level in evaluation by comparing it to another of the same level, according to its contribution to the achievement of the goals of each element of the immediately superior level.
b. Construction of the judgment matrices with the information from the preceding point a.
c. Determination of the absolute values for each element of the level in evaluation, through the calculation of the characteristic vectors that correspond to the maximum characteristic vector of each matrix by using a computer program listed in Appendix C.
d. Determination of the total value that corresponds to each of the characteristics of the sections of the institutions through a process that is based on matricial algebra which consists of the evolution from the lowest to the highest level.

3. Determination of the values that correspond to the third level. There are some career factors that should be evaluated by a special commission and are shown in this chapter.

a. Development of special forms of evaluation to facilitate judgment procedure. See Appendix E.

b. Development of support tables, in which appear coefficients of the factors already calculated by the specialists group, in order to facilitate the determination of the values that correspond to the third level. See Chapter IV.

c. Evaluation of the third level by using the special forms and support tables.

4. After applying the evaluation procedure, construct the corresponding ranges that pertain to the environmental aspects on a scale. See final scales in Chapter V.

5. Application of the classification process by using a procedure resulting in:

   a. The current institutional scale.

   b. The final scale by comparison of the methodological scale with the institutional current scales through questionnaire's answers from the experts.

6. Based on the final scale, the corresponding categories for each environmental aspect are obtained. See final scales in Chapter V.

B. Tree Construction

The use of the systemic approach is the most adequate method for construction of the tree's factors. Because the government has the means, especially the financial resources to deal with the whole dimension of the problem, this dissertation turned to representatives of the institutions related to environmental fields to assess their attitudes concerning the environmental program.

The systemic approach was used through questionnaires circulated to experts from inside and outside the country. In Appendix G* is the list of panel members for the systemic approach method, the questionnaires, and the answers of them. After the fundamental goals are determined, a disaggregation in components is made, forming the hierarchical levels where the corresponding relations between these levels are established. The foregoing procedure supplies the factors' tree that the Saaty method requires for evaluations based on comparisons. The specialists will participate by giving their judgment of the relative importance between pairs of factors.

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*"G" refers to tables in Appendix G.

To know the absolute values, as mentioned in the preceding paragraphs, the characteristic vectors and values of the judged matrices are calculated using algorithms. Two groups normally participate in this procedure. One, which in this case is the researcher, conducts the stages of each assignment on the particular application, and the other group is the expertise or specialist group, which is the expert group from inside and outside the country. This second group, as its name indicates, has sufficient and necessary experience to indicate which factors should be included in the hierarchy.

In Chapter III of this study some methods were chosen according to their contribution to the evaluation process. In this chapter, in order to accomplish the study goals, the evaluation process of the environmental problems in Costa Rica will be specified. The main goal of this assignment is to obtain the basic guidelines that complete the general metholology. The results of this chapter will be considered from the point of view of their contribution to the construction of the general methodology but not from their specific test case application.

The institutions related to the environmental program through their goals are contributing to the country's development. They have goals to be accomplished and, at the same time, they help to accomplish the government's goals. Those institutions' goals constitute the first stage of the black box analysis explained in Chapter III. Because of the characteristics of the system in analysis and the evaluation of the environmental aspects and because there are no tools for adequate measurement, it is impossible to do an objective evaluation in this case. Therefore, it will be necessary to develop a second stage of the analysis--in other words, to define the corresponding hierarchical tree. With this goal and based on the scheme of Figure 3.2, it is possible to decompose the internal mechanism of the system in different performance stages, going from the development goal to the evaluation of the base elements, so that, after inverting, it is possible to judge the corresponding values of the aforesaid elements. Accordingly, the argument can be developed as follows:

1. The existence of institutions related to environmental aspects is justified because some goals are imposed by the government
2. Those institutions have to fulfill some functions that are oriented toward the attainment of the mentioned goals
3. The personnel of these institutions must develop activities to attain the mentioned functions
4. Each one of the activities of the personnel will contribute in varying degrees of importance to the development of the functions, to the attainment of the institutional goals, and to the development of the country

From the questionnaires sent to the group of experts a required scheme was derived as a tree with different levels ordered hierarchically from major to minor. The fundamental orientation of the government, which is the development of the country, should be placed in the major level of the hierarchy. In the following levels, the institutional goals related to environmental aspects appear first, then their functions, and finally the personnel characteristics. See Figure 4.1. In this tree each element of one level has relation with all of the elements of the immediately superior level.

C. Weights Determination

After the group of specialists had been selected, they answered the questionnaires and the researcher reviewed the answers and prepared the resulted information. In the normal case, this procedure would take place in work meeting of specialists (WMS). From that information the hierarchical tree was constructed. According to their judgment and experience, the specialists, by using the Saaty method, gave the relative weights of the nodes based on a series of comparisons between pairs of activities. First of all, the relative importance to the development of the country of pairs of institutional goals was compared. Then, pairs of functions to accomplish the goals were compared. Finally, pairs of activities to accomplish each function were compared. See Figure 4.1. and Appendix D.

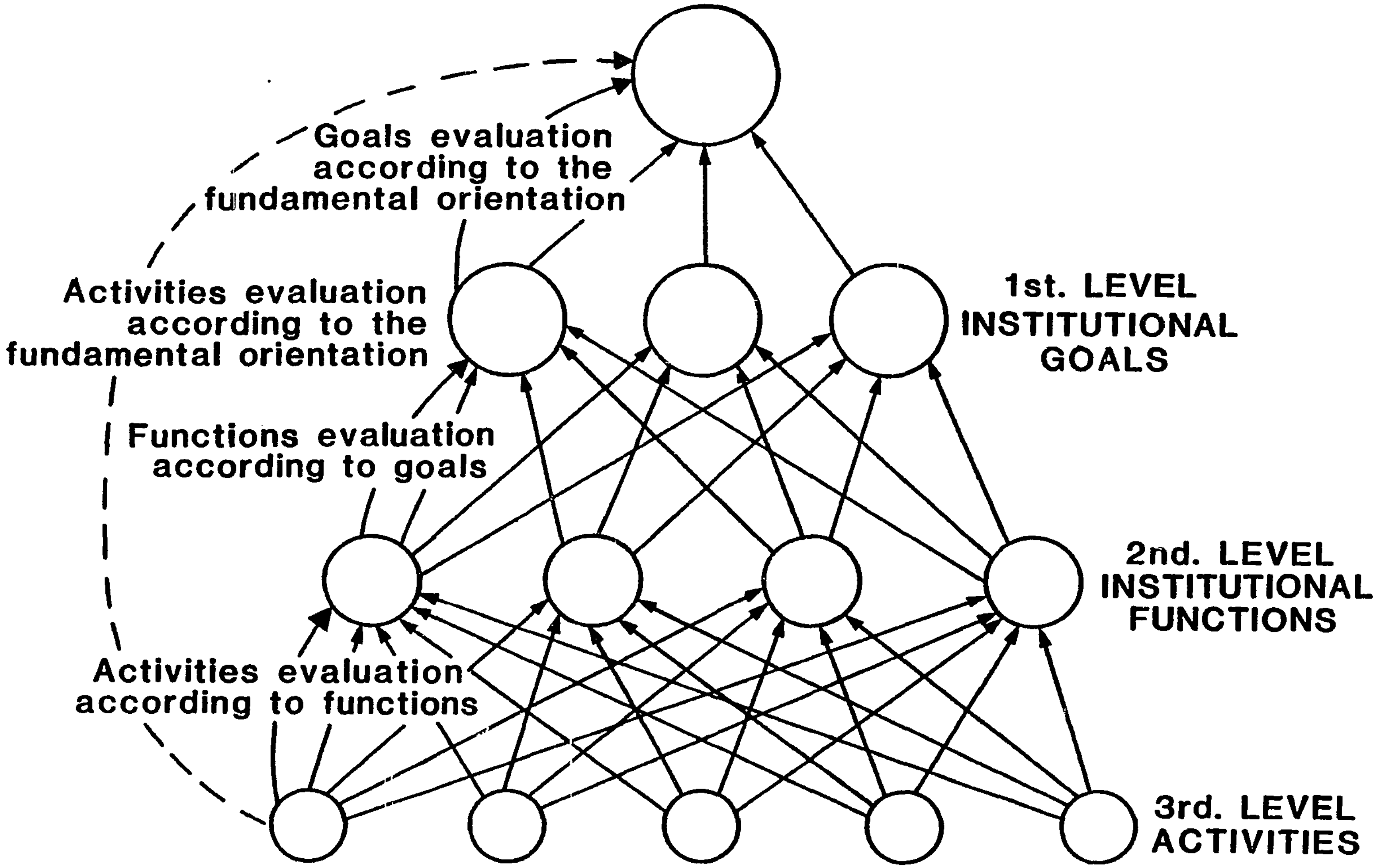

Figure 4.1 HIERARCHICAL TREE FOR THE DEVELOPMENT OF THE METHODOLOGY

To determine the weights' values, first the relative weights for all of the nodes in one level was obtained by constructing the judge matrix with the average values from the experts' comparisons of the pairs. Then, through the use of an algorithm which calculates the characteristic vectors and values of the nonsymetric matrices, the vector of maximum value was chosen and the values were normalized to one; in this way the absolute values are calculated. Finally, the weight of a factor (node) related to the contribution to the highest levels was determined, until arriving at the most superior level. In Appendix D* are shown the procedure and the results of this stage.

As is shown in the preceding paragraphs, the designation and determination of the numerical values of the factors that contribute to the tree were done using the following three steps:

I. Relative values designation

II. Absolute values calculation

III. Absolute values determination to a level higher than the immediately superior one

The scale proposed by Thomas Saaty[6] for the relative degree of importance between pairs of factors was used in the designation phase of the relative values. This scale was used by the specialists to grade the relative degree of importance of two factors to the contribution to the immediately superior

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*"D" refers to tables and information in Appendix D.

level. Thus, it is necessary to prepare cards like those shown in Figure 4.2, which contain on one side an explanation of the degree of importance between the two factors and on the other side a number between 1 and 9 that represents the experts' judgment matrix. Logically, the diagonal of this matrix has values of 1, because the boxes correspond to the combination of one factor with itself.

After phase I and the judge matrix are complete, phase II is done. See Appendix D. As is indicated by Saaty,[7] it is necessary to apply an algorithm for the calculation of the characteristic vectors and values of the nonsymetric matrices; this algorithm chooses the vector of maximum value and normalizes the values to one. This will give the absolute values. It is too tiresome to apply any algorithms by hand; for this reason it is necessary to resort to a computer program. Its use is shown in Appendix D. For convenience, the computer program should also determine the average from the relative designations given by the experts.

As was previously mentioned, the experts' designations can be easier if it is possible to have intermediate factors, thus leading to a higher degree of disaggregation. On the other hand, in phase II, only the absolute values toward the immediate level are obtained. The Saaty method established in implicit form the fact that to determine the degree of importance of one factor to a higher level, it is necessary to align the characteristic vectors from each factor of one level, in the

SAME IMPORTANCE

THE TWO ACTIVITIES CONTRIBUTE
EQUALLY TO THE GOALS.

(OBVERSE)

1

(REVERSE)

Figure 4.2a CARDS FOR THE RELATIVE EVALUATION BETWEEN PAIRS OF FACTORS.

WEAK IMPORTANCE

THE JUDGMENT FAVORS ONE ACTIVITY
OVER THE OTHER ONE,
BUT IT IS NOT CONCLUSIVE.

(OBVERSE)

3

(REVERSE)

Figure 4.2b CARDS FOR THE RELATIVE EVALUATION BETWEEN PAIRS OF FACTORS.

STRONGLY IMPORTANT

THE JUDGMENT STRONGLY FAVORS
ONE ACTIVITY OVER THE OTHER

(OBVERSE)

5

(REVERSE)

Figure 4.2c CARDS FOR THE RELATIVE EVALUATION BETWEEN PAIRS OF FACTORS.

DEMONSTRATED IMPORTANCE

CONCLUSIVE JUDGMENT OF THE IMPORTANCE OF ONE ACTIVITY OVER THE OTHER ONE.

(OBVERSE)

7

(REVERSE)

Figure 4.2d CARDS FOR THE RELATIVE EVALUATION BETWEEN PAIRS OF FACTORS.

ABSOLUTE IMPORTANCE

THE JUDGMENT FAVORS ONE ACTIVITY
OVER THE OTHER ONE IN
THE HIGHEST ORDER POSSIBLE.

(OBVERSE)

9

(REVERSE)

Figure 4.2e CARDS FOR THE RELATIVE EVALUATION BETWEEN PAIRS OF FACTORS.

columns of the matrix. This column is then multiplied by the matrix of the following level. This will reveal the absolute values of the factors toward levels higher than the immediately superior one. Thus far, the evaluation process as part of the methodology has been developed; later it will be explained how the classification process is developed and applied as a second part of the methodology. An example of the evaluation process is shown in the next subsection.

D. Application of the Evaluation Process

To show how the evaluation process works, it is applied to the Costa Rica case analyzing an example of only two levels that correspond to the institutional goals and activities according to their contribution to the development of the country.

Because the third level deals with human factors, in some cases a special evaluation commission is needed. Such factors as nature of employment responsibilities, the frequency and quality of publications, and research projects are assigned specific values. In this way the subjectivity is minimized and the procedure is more standardized.

Those factors that were evaluated from the experts' answers to questionnaires were selected as follows: first the development of the country was selected as the highest factor of the tree; next, institutional goals that contribute to the development of the country were considered one by one;

then those activities that contribute to the accomplishment of the institutional goals were considered one by one, and so on. The experts were asked to decide which factor in the pair was more important with respect to the contribution to the immediately superior level. Each expert announced the value that he assigned as a result of examining the cards' text which described the qualitative degree of importance of the pair of factors. Special forms, called judge matrices, were prepared to be filled out by the experts answers with their designated values. Those matrices were square with the number of rows equal to the number of columns. See Figure 4.3. The designated values were added and an average was obtained for each pair of comparisons. Those designated values were set up in the matrix as follows; the comparison was made between two factors; then the average was obtained favoring one of the factors. The average was written in the box that corresponded to the dominant factor, and directly across from the box, using as a reference the diagonal, the reciprocal of the average was written.

Under this approach a series of activities that are basic to the institutions related to environmental aspects was determined. See Appendix D. An absolute weight ($W_{i(i=1,n)}$) was assigned according to the activities' contributions to the final goal. This weight W_i can be a maximum weight only if the achievement of the institution related to the sections or activities were excellent. The degree of success and the

DATE: ________

LEVEL ____

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	CV*
C_1											
C_2											
C_3											
C_4											
C_5											
C_6											
C_7											
C_8											
C_9											
C_{10}											

*CV refers to characteristic vectors

λ max=________

Figure 4.3 JUDGMENT MATRIX FORMAT

CONTRIBUTORY FACTORS:

C_1 ____________________

C_2 ____________________

C_3 ____________________

C_4 ____________________

C_5 ____________________

C_6 ____________________

C_7 ____________________

C_8 ____________________

C_9 ____________________

C_{10} ____________________

DATE: Nov., 1981

LEVEL 0: COUNTRY DEVELOPMENT

	C_1	C_2	C_3	C_4	C_5	C_6	CV*
C_1	1	65/13	55/13	65/13	63/13	65/13	.437
C_2	13/65	1	24/13	55/13	263/13	65/13	.263
C_3	13/55	13/24	1	60/13	81/13	50/13	.155
C_4	13/65	13/55	13/60	1	43/13	55/13	.00736
C_5	13/63	13/263	13/81	13/43	1	39/13	.0377
C_6	13/65	13/65	13/50	13/55	13/39	1	.0346

*CV refers to characteristic vectors.

λ max= 7.1665

Figure 4.4 First Level Iteration

CONTRIBUTORY FACTORS:

C_1: Development and service of water supply (INAA)

C_2: Development and services of solid waste collection and disposal (MSJ)

C_3: Preparation of human resources at postgraduate level (UCR)

C_4: Development and services of industrial solid waste treatment and disposal (MEIC)

C_5: Development of a national program of natural resource protection (SENAS)

C_6: Noise and air pollution control (MS)

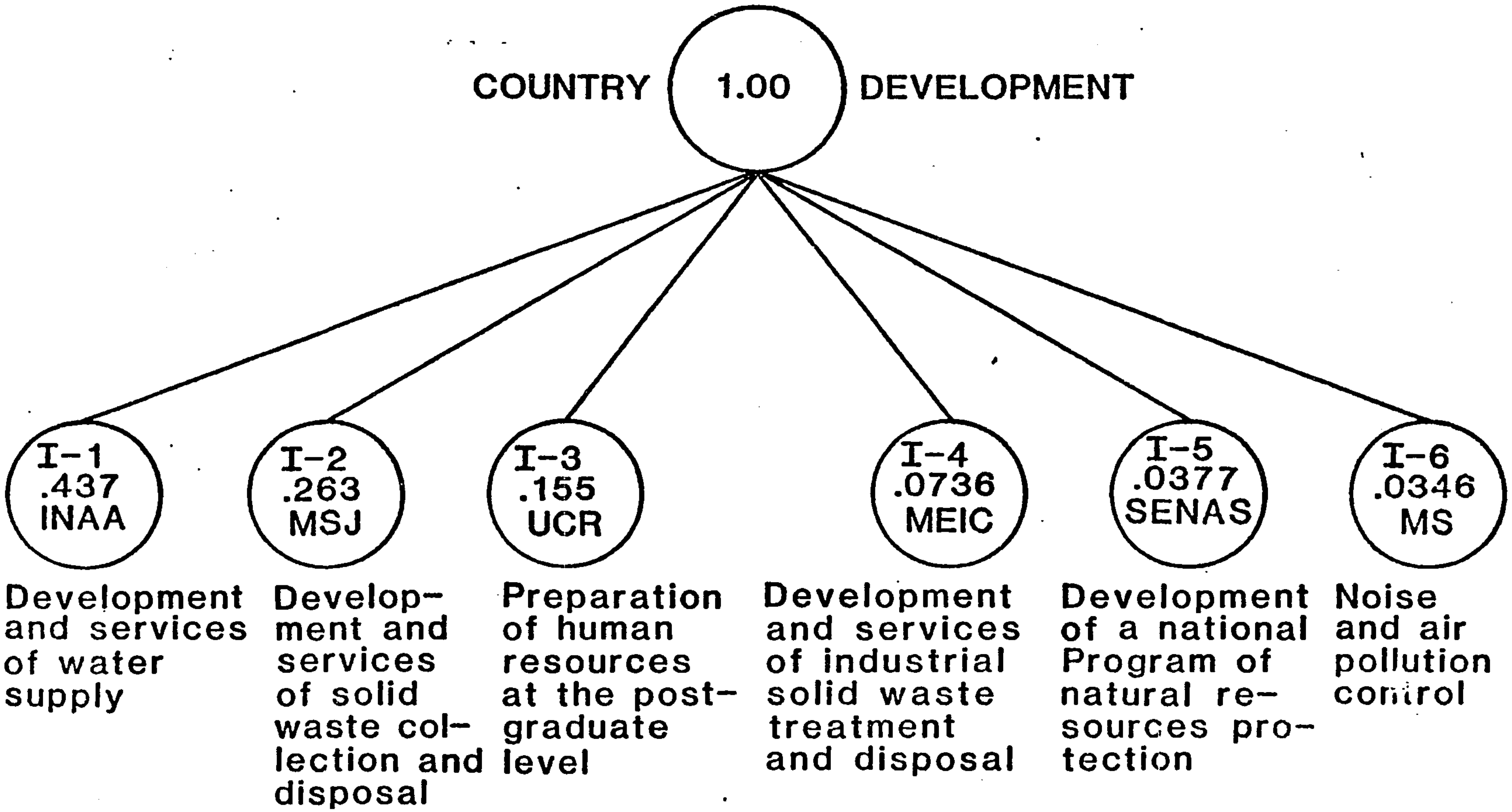


Figure 4.5 AN EXAMPLE OF HOW THE FACTORS EVALUATION OF A HIERARCHICAL TREE WILL CORRESPOND TO THE FIRST LEVEL ACCORDING TO THE FUNDAMENTAL ORIENTATION OF THE SYSTEM. THE ABSOLUTE VALUES ARE SHOWN.

DATE: Nov., 1981

LEVEL II-1: DEVELOPMENT AND SERVICES OF WATER SUPPLY (INAA)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	34/13	13/32	13/24	60/13	.197
C_2	13/34	1	13/44	13/26	42/13	.114
C_3	32/13	44/13	1	34/13	68/13	.412
C_4	24/13	26/13	13/34	1	50/13	.226
C_5	13/60	13/42	13/68	13/50	1	.0514

*CV refers to characteristic vectors

λ max= 5.1896

Figure 4.6 Level I-1 Iteration

CONTRIBUTORY FACTORS:

C_1: Administration and inspection (II-1)

C_2: Research (II-2)

C_3: Designing, standardizing, monitoring, sampling (II-3)

C_4: Dissemination, collection of information, and teaching (II-4)

C_5: Assistance (II-5)

DATE: Nov., 1981

LEVEL II-2: DEVELOPMENT AND SERVICE OF SOLID

WASTE COLLECTION AND DISPOSAL (MSJ)

	C_L	$C_@$	$C_\#$	$C_\$$	$C_\%$	CV*
C_1	1	45/13	86/13	65/13	65/13	.488
C_2	13/45	1	65/13	50/13	13/37	.163
C_3	13/86	13/65	1	13/39	13/68	.0402
C_4	13/65	13/50	39/13	1	13/44	.0752
C_5	13/65	37/13	68/13	44/13	1	.234

*CV refers to characteristic vectors

λ max= 5.3833

Figure 4.7 Level I-2 Iteration

CONTRIBUTORY FACTORS:

C_1: II-1 Administration and inspection

C_2: II-2 Research

C_3: II-3 Designing, standardizing, monitoring and sampling

C_4: II-4 Dissemination, collection of information, and teaching

C_5: II-5 Assistance

DATE: Nov., 1981

LEVEL II-3 PREPARATION OF HUMAN RESOURCES AT POSTGRADUATE LEVEL (UCR)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/45	71/13	60/13	50/13	0.270
C_2	45/13	1	76/13	65/13	60/13	0.478
C_3	13/71	13/79	1	13/47	13/76	0.0380
C_4	13/60	13/65	47/13	1	13/42	0.0738
C_5	13/50	13/60	76/13	42/13	1	0.140

*CV refers to characteristic vectors

λ max= 5.5372

Figure 4.8 Level I-3 Iteration

CONTRIBUTORY FACTORS:

C_1: II-1 Administration and inspection

C_2: II-2 Research

C_3: II-3 Designing, standardizing, monitoring and sampling

C_4: II-4 Dissemination, collection of information, and teaching

C_5: II-5 Assistance

DATE: Nov., 1981

LEVEL II-4: DEVELOPMENT AND SERVICES OF INDUSTRIAL SOLID WASTE TREATMENT AND DISPOSAL (MEIC)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/42	65/13	50/13	50/13	.262
C_2	42/13	1	65/13	76/13	68/13	.487
C_3	13/65	13/65	1	13/34	13/29	.0521
C_4	13/50	13/76	34/13	1	13/55	.0707
C_5	13/50	13/68	29/13	55/13	1	.128

*CV refers to characteristic vectors

λ max= 5.4962

Figure 4.9 Level I-4 Iteration

CONTRIBUTORY FACTORS:

C_1: II-1 Administration

C_2: II-2 Research

C_3: II-3 Designing, standardizing, monitoring and sampling

C_4: II-4 Dissemination, collection of information, and teaching

C_5: II-5 Assistance

DATE: Nov., 1981

LEVEL II-5: DEVELOPMENT OF A NATIONAL PROGRAM OF NATURAL RESOURCES PROTECTION (SENAS)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/47	76/13	45/13	50/13	.242
C_2	47/13	1	91/13	68/13	81/13	.508
C_3	13/76	13/91	1	13/65	13/86	.0322
C_4	13/45	13/68	65/13	1	13/50	.0777
C_5	13/50	13/81	86/13	50/13	1	.140

*CV refers to characteristic vectors

λ max= 5.6869

Figure 4.10 Level I-5 Iternation

CONTRIBUTORY FACTORS:

C_1: II-1 Administration and inspection

C_2: II-2 Research

C_3: II-3 Designing, standardizing, monitoring and sampling

C_4: II-4 Dissemination, collection of information, and teaching

C_5: II-5 Assistance

DATE: Nov., 1981

LEVEL II-6 NOISE AND AIR POLLUTION CONTROL

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	71/13	65/13	13/45	71/13	.281
C_2	13/71	1	13/27	13/68	21/13	.0618
C_3	13/65	37/13	1	13/81	34/13	.0939
C_4	45/13	68/13	81/13	1	97/13	.514
C_5	13/71	13/21	13/34	13/97	1	.0449

*CV refers to characteristic vectors

λ max= 5.3686

Figure 4.11 Level I-6 Iteration

CONTRIBUTORY FACTORS:

C_1: II-1 Administration and inspection

C_2: II-2 Research

C_3: II-3 Designing, standardizing, monitoring and sampling

C_4: II-4 Dissemination, collection of information, and teaching

C_5: II-5 Assistance

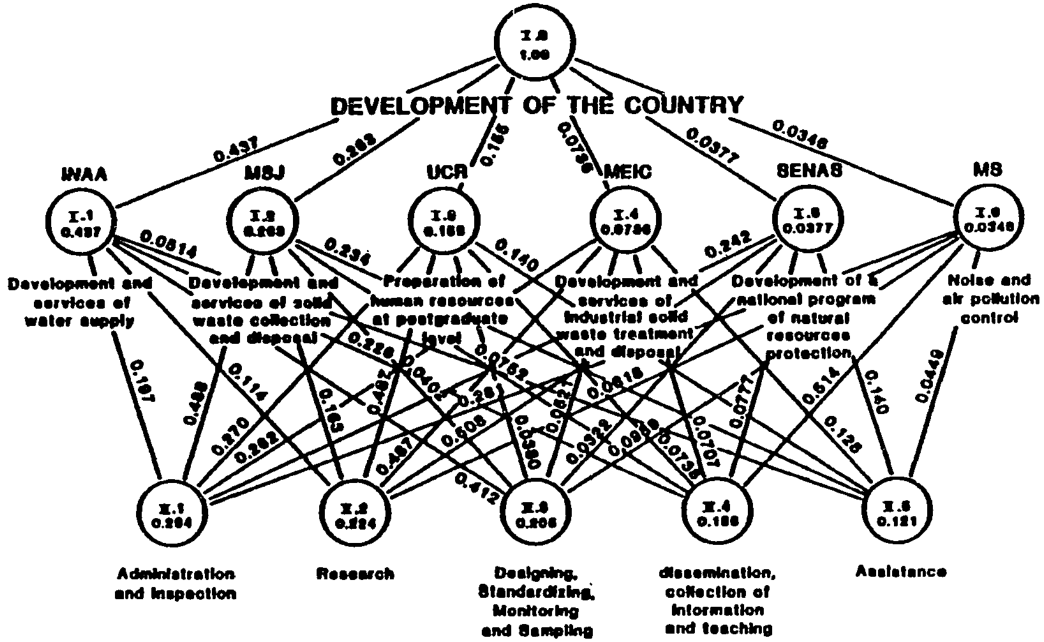
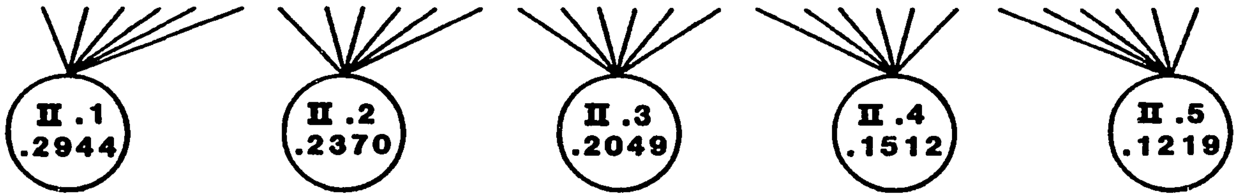


FIGURE 4.12 EVALUATION PROCESS OF THE SECOND LEVEL WITH RESPECT TO THE FIRST LEVEL. THE ABSOLUTE VALUES ARE SHOWN.



Administration and inspection	Research	Designing, standardizing, monitoring and sampling	Dissemination, collection of information and teaching	Assistance
0.197 x 0.437 = 0.086089	0.062928	0.18004	0.09876	0.02246
0.488 x 0.283 = 0.128340	0.042869	0.01057	0.01977	0.06154
0.270 x 0.155 = 0.041850	0.074090	0.00589	0.01144	0.02170
0.262 x 0.0736 = 0.019283	0.035843	0.00383	0.00052	0.00942
0.242 x 0.0377 = 0.009123	0.019151	0.001214	0.002929	0.00528
0.281 x 0.0346 = 0.004722	0.000214	0.003421	0.01778	0.00155
0.2944	0.2370	0.2049	0.1512	0.1219

CALCULATIONS FOR Figure 4.12

efficiency in accomplishing the goals will be affected, of course, by such factors as the experience of the institution with past problems and the amount and quality of the training of its personnel.

According to the preceding explanation, the expertise group considered the possible value determination of the environmental aspects in the institution's antecedents, thus arriving at the values W_i composed of two factors: one that considers, in joint form, the most important environmental problem and knowledge of the problem F_{mep}, and another that considers the institutional experience F_{ie}. In this way, the value P_i that is given to a specific activity in accordance with the institution's background is given by the following equation:

$$P_i = W_i * F_{mep} * F_{ie} \qquad (4.1)$$

where P_i = Real value of the activity i

W_i = Maximum value of the activity i

F_{mep} = Combined factor of the maximum environmental problem and knowledge of the problem $0 < F_{mep} < i$.

F_{ie} = Institutional experience factor, and $0 < F_{ie} < 1$.

The F_{mep} value was determined by the expertise group's consideration of the educational level of the institutional employees in such environmental problems as solid waste collection and disposal, water supply, waste water treatment, industrial waste water treatment, noise and air pollution, and so on, and the language knowledge of the employees. The F_{ie} value, which was determined by the degree of knowledge concerning these problems, was designated as excellent, satisfactory, fair, regular, or poor. The knowledge grades were considered by the expertise group as the most important factor from the technical and academic point of view.

For the quantification of the factor F_{mep} a tree with the educational level aspects and the language's knowledge was built with the experts questionnaire answers as is shown in Figure 4.4. Then, through the Saaty method, the judge matrices and the respective characteristic vectors were obtained. In other words, the absolute values corresponding to each educational level services VE_i, and each language knowledge grade VK_i was considered. The value of the combined factor F_{mep}, in the case that the institution has personnel with knowledge of only one language, will be obtained by multiplying each VE_i by VK_i, in other words:

$$F_{mep_{ij}} = VE_i * VK_i \qquad (4.2)$$

where $F_{mep_{ij}}$ = Combined factor of the primary environmental problem i and the knowledge grade j.

VE_i= Value of the educational service level i.

VK_i= Value of the language knowledge grade j.

In case an employee of the institution has knowledge of more than one language, the combined factor F_{mep} is obtained by:

$$F_{mep} = VE_i \ (\Sigma VK_i) \qquad (4.3)$$

where the sum $\Sigma(VK_i)$ is used only for the language knowledge grades (j) that the institution has. To illustrate the preceding explanation, the expertise group elaborated the tree evaluation of Figure 4.4. The judgment matrices obtained are shown in Tables 4.1 and 4.2, and the results are shown in Tables 4.3 and 4.4.

To facilitate the evaluating commission's job, the values of F_{mep}, for all i and for all j are shown in Table 4.5, called the "Table of Support." In case an institution's personnel has knowledge of various languages, F_{mep} will be the summation of the values obtained from the interception of his maximum educational level and the languages he knows.

The following shows how the institutional experience factor F_{ie} was determined. In the first case, when the activities are not a function of time or the number of times that the activities were done, the F_{ie} is obtained as a result of the judgment of the evaluating commission members; each one will evaluate the activities according to the institution's background experience with each environmental aspect. Each experience is classified as excellent, satisfactory, fair, regular, or poor. This judgment of the commission members is qualitative; therefore, it is necessary to convert the classification into a numerical value. The expertise group in the answers to their questionnaires agreed to use a numerical scale similar to the one in Table 4.6.

To determine the institutional factor F_{ie} when some activities are a function of time (t) (e.g., administrative tasks, participation on committees and commissions, and so

DATE: January, 1982

INSTITUTION'S EFFICIENCY EMPLOYEES' EDUCATION LEVEL

	C_1	C_2	C_3	C_4	C_5	C_6	CV*
C_1	1	40/8	56/8	58/8	68/8	72/8	0.517
C_2	8/40	1	40/8	45/8	56/8	62/8	0.252
C_3	8/56	8/40	1	21/8	42/8	43/8	0.105
C_4	8/58	8/45	8/21	1	28/8	32/8	0.067
C_5	8/68	8/56	8/42	8/28	1	20/8	0.034
C_6	8/72	8/62	8/43	8/32	8/20	1	0.024

*CV refers to characteristic vectors

λ max= 6.767

Table 4.1 JUDGMENT MATRIX FOR INSTITUTIONAL EMPLOYEES' EDUCATION LEVEL

CONTRIBUTORY FACTORS:

C_1: Post Doctoral Services

C_2: Doctor's Degree Services

C_3: Master's Degree Services

C_4: Bachelor's Degree Services

C_5: Vocational Training Services

C_6: Pre-University Services

DATE: January, 1982

INSTITUTION'S EFFICIENCY EMPLOYEES LANGUAGE KNOWLEDGE

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	29/8	52/8	72/8	68/8	0.544
C_2	8/29	1	34/8	53/8	42/8	0.258
C_3	8/52	8/34	1	26/8	24/8	0.101
C_4	8/72	8/53	8/26	1	10/8	0.050
C_5	8/68	8/42	8/24	8/10	1	0.047

*CV refers to characteristic vectors

λ max= 5.444

Table 4.2 JUDGMENT MATRIX FOR EMPLOYEES' LANGUAGE KNOWLEDGE

CONTRIBUTORY FACTORS:

C_1: English

C_2: Spanish

C_3: French

C_4: Russian

C_5: German

Educational Level Service	Matrix Value	Normalized Value
Post Doctoral Services	0.517	1
Doctor's Degree Services	0.252	0.487
Master's Degree Services	0.105	0.203
Bachelor's Degree Services	0.067	0.129
Vocational Training Services	0.034	0.066
Pre-University Services	0.024	0.046

Table 4.3: VALUES FOR EDUCATIONAL LEVEL SERVICES

Note: In order for the unit to correspond to the maximum, educational level services are divided by 0.517.

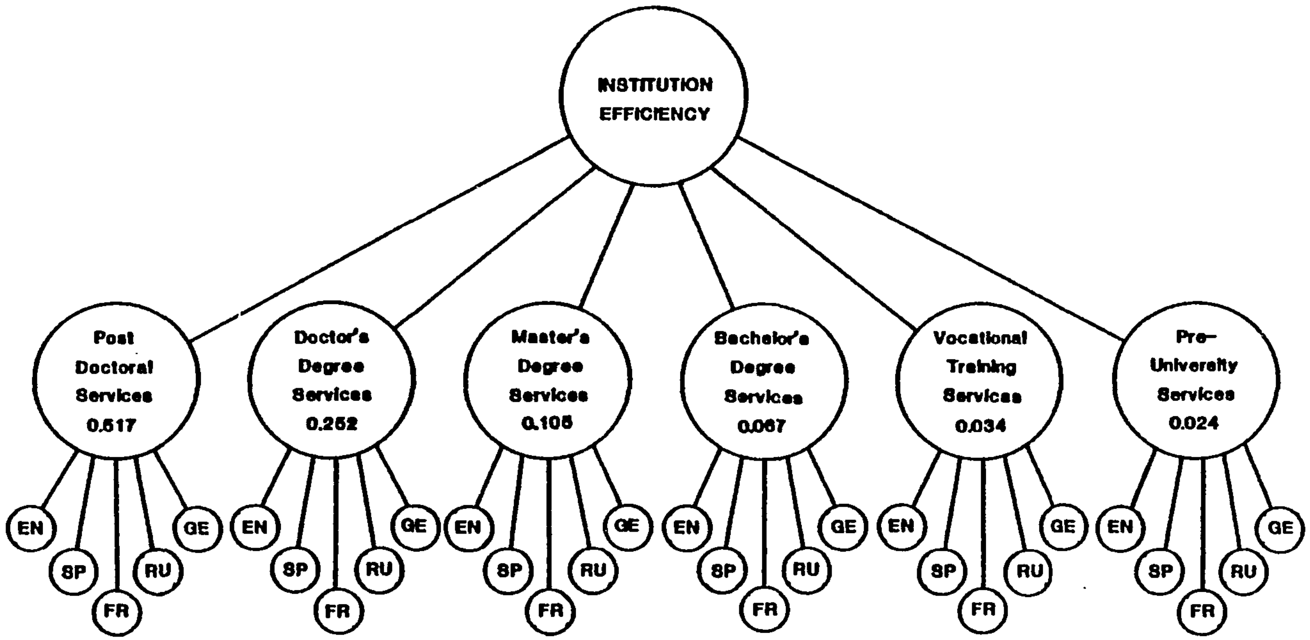


Figure 4.3 Tree resulting from the experts questionnaire answers to construct the factor Fmep's Support Table

Note: EN=ENGLISH=0.554 FR=FRENCH=0.101 GE=GERMAN=0.047
From Table 4.2: SP=SPANISH=0.258 RU=RUSSIAN=0.050

Languages	Matrix Value
ENGLISH	0.554
SPANISH	0.258
FRENCH	0.101
RUSSIAN	0.050
GERMAN	0.047

Table 4.4: Values for Language Knowledge

Languages	Educational Level Service					
	Post Doctoral	Doctor's Degree	Master's Degree	Bache-lor's Degree	Vocational Training	Pre-University
ENGLISH	0.554	0.2698	0.1125	0.0715	0.0365	0.0255
SPANISH	0.258	0.1256	0.0524	0.0333	0.0170	0.0119
FRENCH	0.101	0.0492	0.0205	0.0130	0.0067	0.0046
RUSSIAN	0.050	0.0243	0.0101	0.00645	0.0033	0.0023
GERMAN	0.047	0.0229	0.0095	0.00606	0.0031	0.0022

Table 4.5: Table of Support for the Assignation of the Factor F_{mep}.

Institution's Environmental Affairs Experience	
Qualitative Value	Quantitative Value
Poor	0
Regular	0.25
Fair	0.50
Satisfactory	0.75
Excellent	1.00

Table 4.6: Values Obtained from the Experts' Answers to Questionnaires for the Institutional Experience Factor (F_{ie})

on) or a function of the number of times (n) that the activity was performed (e.g., publication of articles, registration of patents, and so on), the following equations are used:

a. When the time (t) was considered:

$$F_{ie} = t/T \qquad (4.4)$$

where T = Maximum period of time that the evaluating commission estimated sufficient in order for F_{ie} to obtain the value of 1.0.

b. When the number of times (n) was considered:

$$F_{ie} = n/N \qquad (4.5)$$

where N = Number of times that the evaluating commission estimated sufficient in order for F_{ie} to obtain the value of 1.0.

The factor F_{ie} for the rest of the activities was determined in the manner explained in the first case. In order to illustrate the use of the preceding cases, the factor F_{ie} is calculated either by using the scale from Table 4.6 in some cases or the equations t/T and n/N in other cases.

E. Support Forms for the Evaluation Commission

It is necessary to have adequate evaluation forms that permit as much standardization as possible in the evaluation of each institution and that avoid as much as possible the omission of some important factors. The design of the support forms was developed in accordance with the Costa Rica case.

The mentioned forms are shown in Table F.1 in Appendix F. These forms, according to the answers given by the expertise group, consider the following five general areas of activities: administration and inspection; research; designing, standardizing, monitoring and sampling; dissemination, collection of information, and teaching; and assistance. The tables in Appendix F illustrate the concepts thus far presented.

F. Classification Process

After applying the evaluation process, a series of values on a scale for each institution, their activities, and their functions were obtained according to their contribution to the first level, the development of the country. Since each institution already had its own scale, it was necessary to do a comparison between its scale and the scale derived through the evaluation methodology to arrive at equivalences on a final classification scale. Because each institution had its own scale, it was necessary to arrive at a single scale through a process compilation as follows:

1. A representative sample of the background of the institution was taken
2. A similar analysis of the obtained values was made in order to determine their ranges in the scale. At this point, because there was a small number of samples, the interpretation of the results was done by the same methodology adequated by the specialists.

This part of the procedure consists of:

a. Sampling

b. Evaluation of each background

c. Determination of the ranges of the values' scale that will correspond to each category. See Appendix F.

d. Interpretation of the results and establishment of the categorization scale. See Chapter V.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSION

The proposed methodology is recommended to be used as a base to develop the procedure of categorization and evaluation of environmental problems for any country or institution with similar conditions. With repeated use the methodology will be a refined design. The materials shown in this report should be discussed by the scientific community with the goal of improving and disseminating the proposals.

Although this methodology was developed for use in environmental affairs planning in developing countries, there is a significant potential use in developed countries. For example, it could be used effectively for more beneficial budget balancing of major research programs such as cancer, heart and other research areas.

Implicit in the overall goals of the research, which is the development of an adequate methodology, is the incident goal of gaining experience from interaction with the expertise group in the defining and resolving of the problems.

The list of priorities resulting from the developed methodology on environmental affairs and their definition in terms of local objectives should generate coordinated government activities--namely, a science and technology policy. Rather than developing environmental activities as individual and institutional interests, the mission has become achieving recognized country goals.

Obviously, the proposed methodology itself has limits, but through the institutions' post-developed methodology activities, and with the government's active participation, an environmental program methodology has been created for a continuation of the process of exercising these priorities, adding new ones, and deleting no longer valuable ones. As a result of this methodology an Office of Environmental Affairs, providing links between consumers, engineers, scientists, and the government should be established soon. Officialdom should have ready access to the research community and vice-versa, and such an office will provide this. The government of Costa Rica today is increasingly recognizing the value of scientific input into public programs as scientists are discovering their usefulness in attacking real-world problems.

By establishing six specific areas for concentration of effort on environmental priority, the methodology identified activities needed for the country of Costa Rica.

B. METHODOLOGY RESULTS

According to Table 5.1 the goal "Development and Services of Water Supply" was the first and still is the first in the final scale according to the experts' opinion. But currently sixty percent has been dedicated for this purpose, which makes clear not enough has been dedicated to other environmental affairs. The final scale advises 43.7% be dedicated to this goal

TABLE 5.1 Final Scale for the Environmental Program Goals

INSTITUTIONAL GOALS	CURRENT STATUS W_i x 100	SCALE	EXPERTS JUDGMENT W_i x 100	FINAL SCALE
Development and Services of water supply	60	I	43.7	I
Development and Services of solid waste collection and disposal	13.5	II	26.3	II
Preparation of human resources at postgraduate level	15.7	III	15.5	III
Development and services of industrial solid waste treatment and disposal	2.56	V	7.36	IV
Development of a national program of natural resources protection	5.79	IV	3.77	V
Noise and air pollution control	2.48	VI	3.46	VI

since in natural resources related to water supply and quality management the following are included:

* surface water
* country planning for water resources
* fresh groundwater aquifers
* land management
* land reclamation and stabilization

At the same time for the goal "Development and services of solid waste collection and disposal" according to Table F.3 in the current status was the second goal with 13.5%, which remains the second goal in the final scale but with 26.3%. This situation is explained because of the lack of many activities in the current situation.

"Preparation of human resources at postgraduate level" in the current status appears as a third goal with 15.7%. In the experts' judgment final scale this also appears as a III goal but with 15.5%, a smaller percentage because it is not known exactly yet what kind of professional level should be the best educational program.

"Development and services of industrial solid waste treatment and disposal" in the current status appears as goal V with 2.56%, and goal IV is "Development of a national program of natural resources protection with 5.79%. In the final scale, "Development and services of industrial solid waste treatment and disposal" appears as goal IV with 7.36% and as goal V with 3.77% "Development of a national program of natural resources protection." The reason for this situation is that industrial development has been improving and the lack of law that can enforce treatment of the wastes.

Finally, the "noise and air pollution control" appears in the current status scale as goal VI with 2.48% and in the final scale also as goal VI but with 3.46%, which indicates the need to improve studies and activities in this environmental field.

To achieve all these goals, activities to accomplish the entire environmental program must be developed. Activities needed, according to Table 5.2 in the final scale, are: I. Administration and inspection with 29.4%; II. Research, with 22.4%; III. Designing, standardizing, monitoring and sampling with 20.5%; IV. Dissemination, collection of information, and teaching, with 15.6%; and V. Assistance, with 12.1%. The substantial changes are in Research which in the current status was number IV with 7.56% and in Assistance that even as number V in both cases received only 4.22% in the current status. Consequently, all the activities are necessary to develop and integrate an environmental program, but must be set up with emphasis in Research and Assistance.

C. INCIDENTAL GOALS

The categorization process of the environmental program was divided into two stages:

1. Evaluation of the environmental program, and
2. Construction of a scale with values which correspond to each category.

TABLE 5.2 Scale for the Environmental Program Activities

INSTITUTIONAL ACTIVITIES	CURRENT STATUS W_ix100	SCALE	EXPERTS JUDGMENT W_ix100	FINAL SCALE
Administration and Inspection	51.3	I	29.4	I
Research	7.56	IV	22.4	II
Designing, standardizing, monitoring and sampling	22.10	II	20.5	III
Dissemination, collection of information and teaching	14.82	III	15.6	IV
Assistance	4.22	V	12.1	V

The lack of a general methodology for the categorization of environmental problems is obvious from the antecedents of this study. In other words, the problem is not the design of the procedure itself, but the development of the methodology to construct procedures in each institution.

The concepts of value and evaluation, according to this research, were defined as follows:

Value is the measure of the degree in which the object in evaluation contributes to the accomplishment of the goals of the system to which it belongs.

Evaluation is the procedure by which the value is determined. It is obtained through the systemic approach, and it consists of:

* Establishment of a hierarchical tree
* Determination of the contribution of the factors of each level to the immediately superior level
* Determination of the contribution of the activities in evaluation to the highest level of the tree.

An important advantage of the Saaty method over the other methods is the fact that the comparative evaluation by pairs of objects is psychologically easier than the assignment of values to only one absolute object.

In the specification stage of the evaluation procedure of environmental problems for the Costa Rica case, the hierarchical tree was constructed on the systemic approach using a consensus of the questionnaires' answers given by the expertise group. From this approach the tree configuration was as follows: the first level corresponded to the development of the country; the second level corresponded to the institutional goals; and the third level corresponded to the activities and functions of the institutions.

The weights of the factors were determined by the following procedure:

* Assignation of the relative value of the factors, applying the Saaty method
* Construction of the judgment matrices and determination of the absolute values of the nodes based on the characteristic vectors.
* Determination of the factors' contribution to the succeeding levels, arriving finally at the highest level.

For the evaluation of the third level, the absolute weight (W_i) was affected by two factors: (1) F_{mep}, which signifies the educational preparation level of the personnel working in the environmental problem; and F_{ie} which signifies the degree experience.

The procedure for the environmental program categorization proposed in this research is as follows:

* Survey of the institution's backgrounds related to the environmental problems
* Evaluation of each background
* Determination of the scale values that will correspond to each category considered
* Specific application to the Costa Rica case

The backgrounds of Costa Rica institutions should contain sufficient information in order to make an adequate evaluation through the methodology herein developed.

The general methodology for the categorization and evaluation of environmental problems can be summarized in the following steps:

* Establishment of the hierarchical tree
* Evaluation of the factors of a level in their contribution to the immediately superior level.
* Determination by the evaluation commission of the lowest level values in the tree
* Determination of the final scale by applying the methodology proposed using the experts' answers to questionnaires with reference to Costa Rica and also apply the proposed methodology to the current status of environmental affairs in Costa Rica through the experts' answers to questionnaires about current status, and comparison of the scales.
* Categorization of the environmental goals and activities based on the final scale obtained from the experts' answers to questionnaires with reference to Costa Rica.

D. RECOMMENDATIONS

It is recommended that some action be taken to head off the collision course between the extractive industries and those individualsand goals, I. Development and service of water supply, II. Development and services of solid waste collection and disposal, and IV. Development and services of industrial solid waste treatment and disposal. Therefore, the need to plan together for an orderly development of Costa Rican resources in a multiple planning concept is of singular importance. Adequate environmental management for Costa Rica requires a definition of environmental quality goals, goals which reflect the needs and desires of Costa Ricans. These Goals must be regularly re-examined and revised as necessary.

Also, it is important in goal V, "Development of a national program of natural resources protection," and "Preparation of human resources at postgraduate level" to analyze the basic needs not only in the city but of rural people of Costa Rica to improve social and economic opportunity. Locate and define rural environmental priorities and determine the causes and feasible solutions. The government's environmental institutions should give maximum contribution to viable rural communities. Also, the goal of "National program of natural resources protection" should include:

* Conservation of water during storage and conveyance including evaporation and seepage control.
* Development of management practices, plant varieties and environmental requirements to make efficient use of soil water through the various stages of plant growth
* Development of alternative techniques for reducing water loss from soil surface which will not significantly reduce crop yield

* Development of soil surface and profile modification or management practices to enhance water infiltration, transmission, and storage.
* Development of improved control practices that will reduce erosion from land and forest land that will be feasible and compatible with modern agriculture
* Development of a means to reduce pollution of water from agricultural sources through better management of pesticides and fertilizers and animal wastes

A study of the potential social and economic problems where pollution control pressures are likely to close industries is needed, as well as development of solutions to pollution problems for small and marginal industries.

Goal IV, "Development and services of solid waste collection and disposal," should include:

1. Development of methods of recycling animal waste and plant residues into animal feeds or other useful products
2. Development of economical systems for the collection, transport, and disposal of solid waste.
3. Development of methods for the disposal of animal waste through the soil _in situ_ with minimum air and water pollution.

In the goal III, "Preparation of human resources at postgraduate level," the impact of communication on education both in the classroom and in the home must start receiving greater attention at the country level because of its greater potential. The legal environmental educational programming should receive proper priority and incentives. Concurrently, educational innovation must be encouraged and a curriculum on environmental affairs and degree programs must be developed to adapt the educational environmental affairs process to the capabilities of the medium.

Also, a data communication network linking institutions and universities through remote terminals should be considered to exploit a time-plan computing and environmental affairs data processing system. The possibilities for linking a number of institutions to one central computer should be investigated as to the benefits in terms of increased capability and environmental service and possible reductions in cost. Ways in which computer services can be extended to more remote areas of the country to bring more services to both business and country institutions should also be evaluated. Also, in education should be:

1. Request that the country delegate one person within the institutions to develop a curriculum of environmental affairs which is comprehensive and can be integrated at all levels throughout the country.
2. Request the Costa Rican Environmental Sciences Association to develop a task force of environmental affairs, to implement environmental education in the school system.
3, Development of an environmental affairs educational program adapted to the medium, for higher education levels or vocational and technical schools.

A statement of Costa Rica's environmental quality, noise and air pollution control, goal VI, is needed to serve as a baseline for determining the success or failure of the environmental quality management system. The statement should be sufficiently broad to cover the many aspects of the environment which affect quality of life and should include specific indicator parameters such as the mass of various pollutants discharged into the air, water, and soil of Costa Rica, land use changes, and diversity of indigenous life. Related to the goal of "Development of a national program of natural resources protection," a mechanism is needed to force environmental quality considerations into both public and private decision-making processes. Irreversible commitments of resources may be occurring which do not reflect the best long-term interest of Costa Rica. Consideration of alternative action is necessary to secure the widest range of beneficial uses and to fulfill responsibilities to succeeding generations. The Health Ministry should make and implement environmental law and serve as an advocate for environmental quality. An inventory of ecologically valuable land and water resources is needed. This should include a detailed characterization of the composition of the air and water media. An assessment of the ability of Costa Rica's environment to assimilate wastes is highly desirable.

One activity that needs to be developed with more emphasis in all environmental affairs is research and assistance.

Environmental research and assistance in all the environmental goals should be given to:

1. Development of new techniques to solve environmental quality problems, matching unique, potentially reclaimed resources with industrial disposal needs.
2. Development of methods for reduction of airborne particulate matter from natural and agricultural sources as well as particulate emissions from vehicle sources.
3. Reduction in unit water use and further methods for water re-use.

Research and assistance to support all the environmental goals should include:

1 Improve the quality of the environment
2. Develop a variety of methods to improve management and cultural practices and a higher environmental program efficiency.
3. Develop design and operational specification for equipment. The transfer of a proper technology to control environmental quality
4, Identify educational systems that will help in environmental affairs

Regeneration and recycling of resources such as water and energy should be developed. At the least, resource consumption must be minimized. In addition, the quality of community life must be upgraded through new concepts in planning. Proper land use is a basic consideration.

Also recommended is the creation of an Environmental Affairs Ministry which would have the mission of establishing and maintaining an environmental program consistent with other aspects of the total environment, which would facilitate the safe and high quality of the environment within and among the cities and towns of the country. The Environmental Affairs Ministry should not be an enlargement of existing institutions' environmental sections, but rather it should be a new ministry oriented toward environmental affairs and integration of environmental affairs nodes.

Finally, because of the flexibility of the proposed methodology, it is recommended that it be applied to different fields and with different purposes.

FOOTNOTES

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APPENDIX A

CURRENT INFORMATION ABOUT COSTA RICA INSTITUTIONS RELATED TO ENVIRONMENTAL AFFAIRS

1. Costa Rica's Maps and Information
2. Industrial Parks already Consolidated
3. Industrial Parks Proposed
4. Current Evaluation Procedures and Forms of the Institutions

APPENDIX A

1. Costa Rica Maps and Information

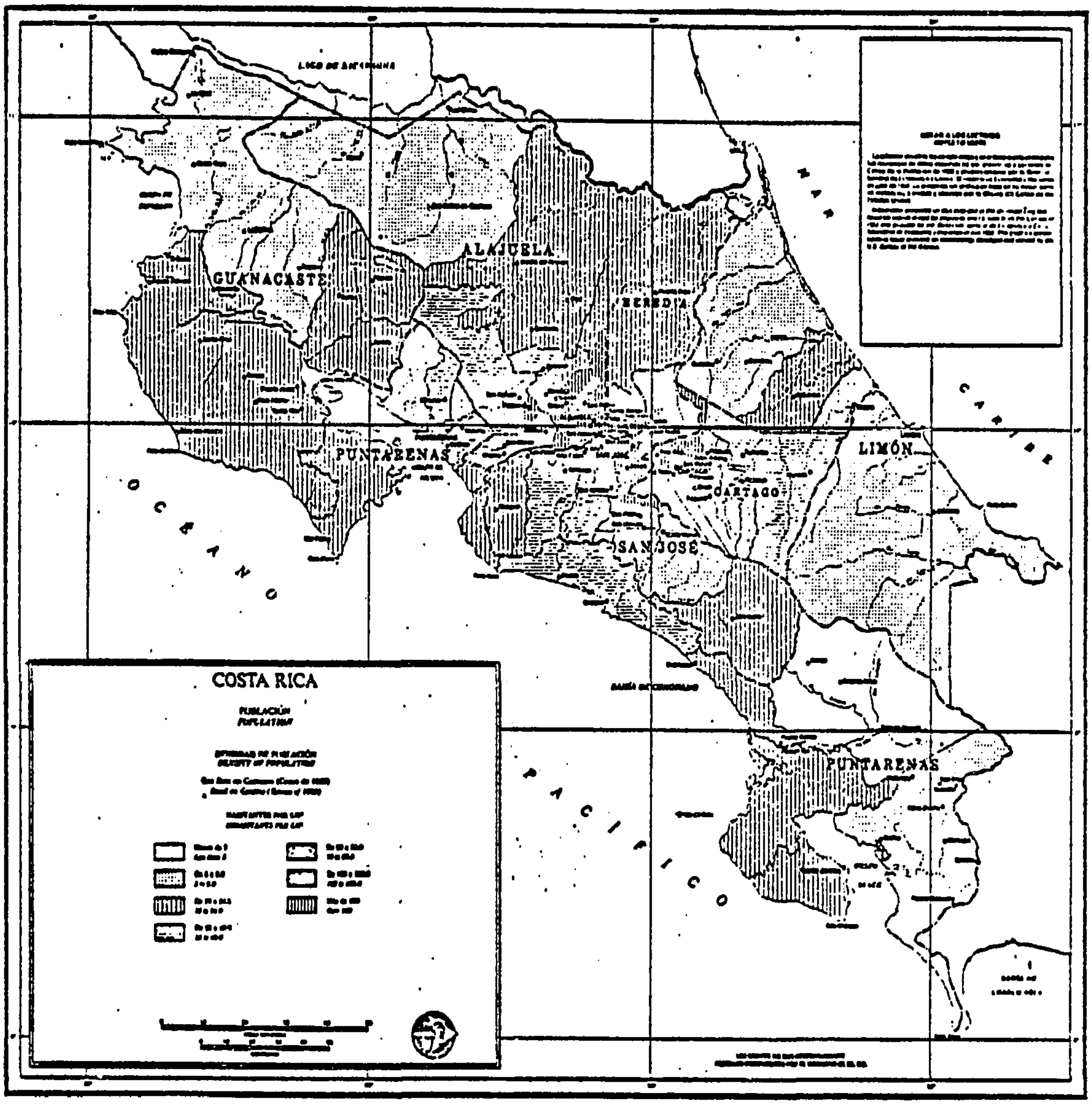


Figure A.1 COSTA RICA POPULATION MAP

Source: Engineer Agency of Resources Inventories, Regional Analysis of Physical Resources in Costa Rica (Washington, D.C.: Agency for International Development, 1965)

Figure A.2 COSTA RICA DRAINAGE MAP

Source: Ibid.

Figure A.3 COSTA RICA CLIMATE MAP

Source: Ibid.

Figure A.4 COSTA RICA SURFACE WATER RESOURCES MAP

Source: Ibid.

RECURSOS DE AGUAS SUPERFICIALES
SURFACE WATER RESOURCES

[illegible]

Table A.1 COSTA RICA SURFACE WATER RESOURCES

Source: Ibid.

Figure A.5 COSTA RICA VEGETATION MAP

Source: Ibid.

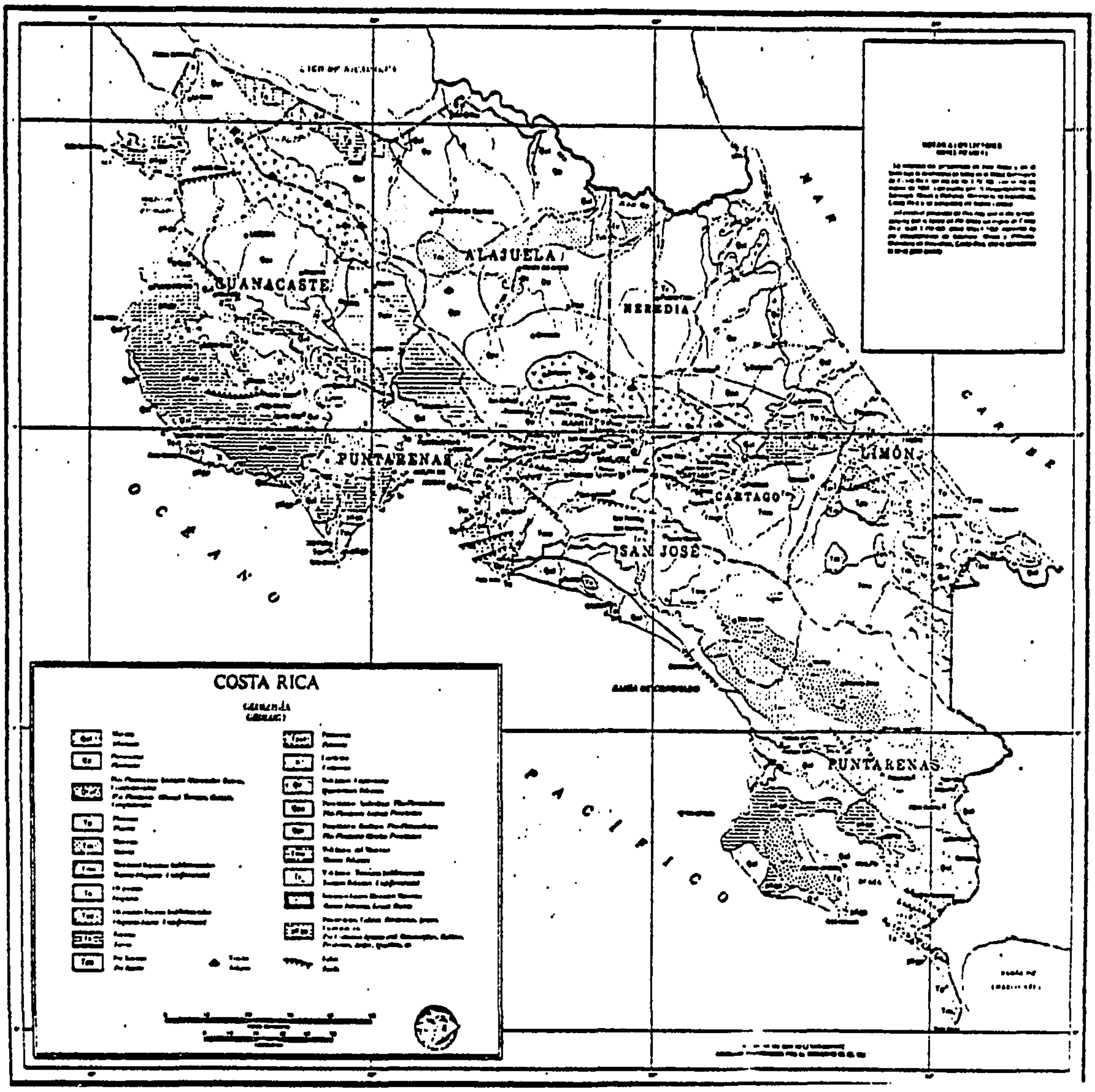


Figure A.6 COSTA RICA GEOLOGY MAP

Source: Ibid.

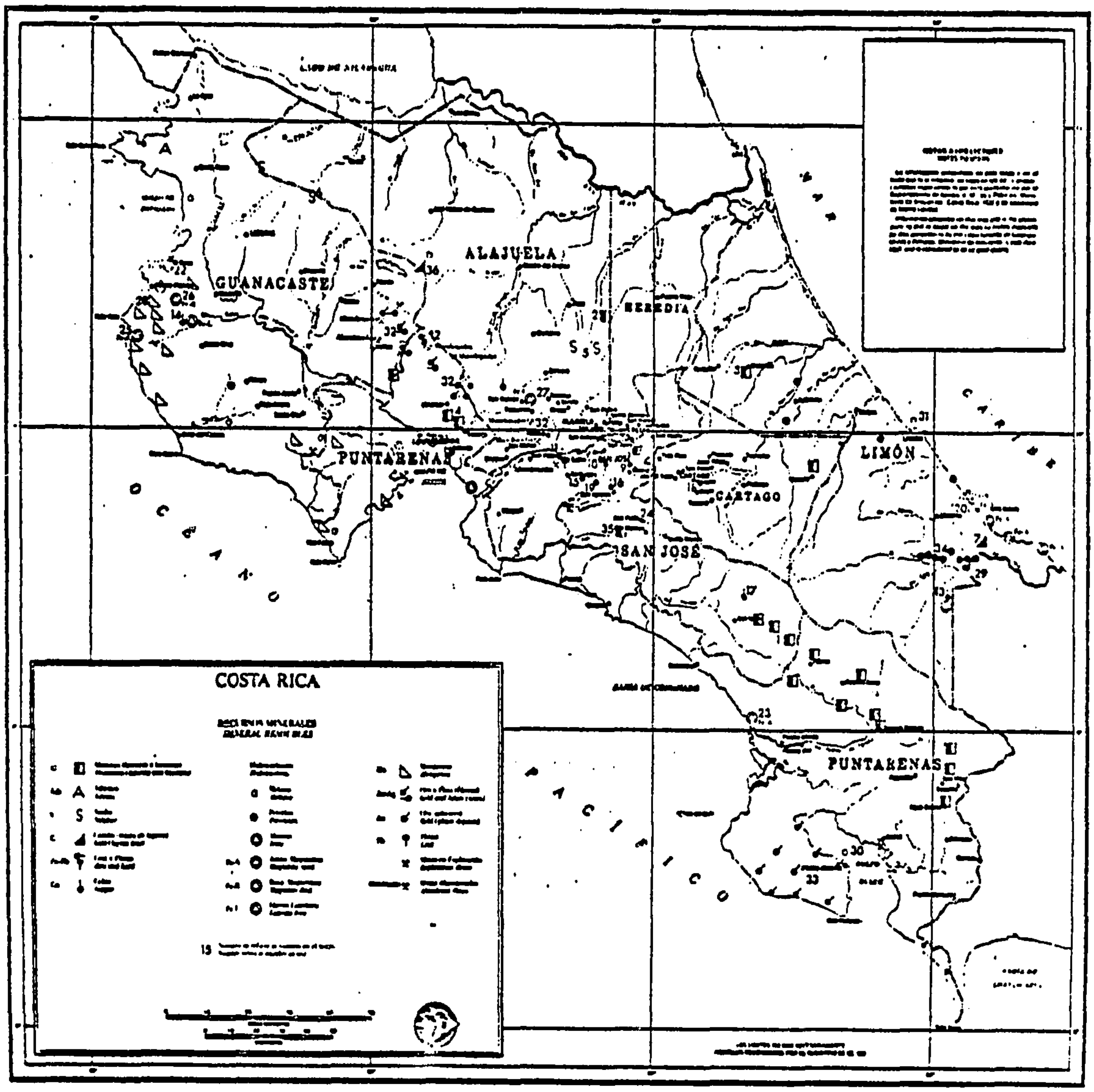


Figure A.7 COSTA RICA MINERAL RESOURCES MAP

Source: Ibid.

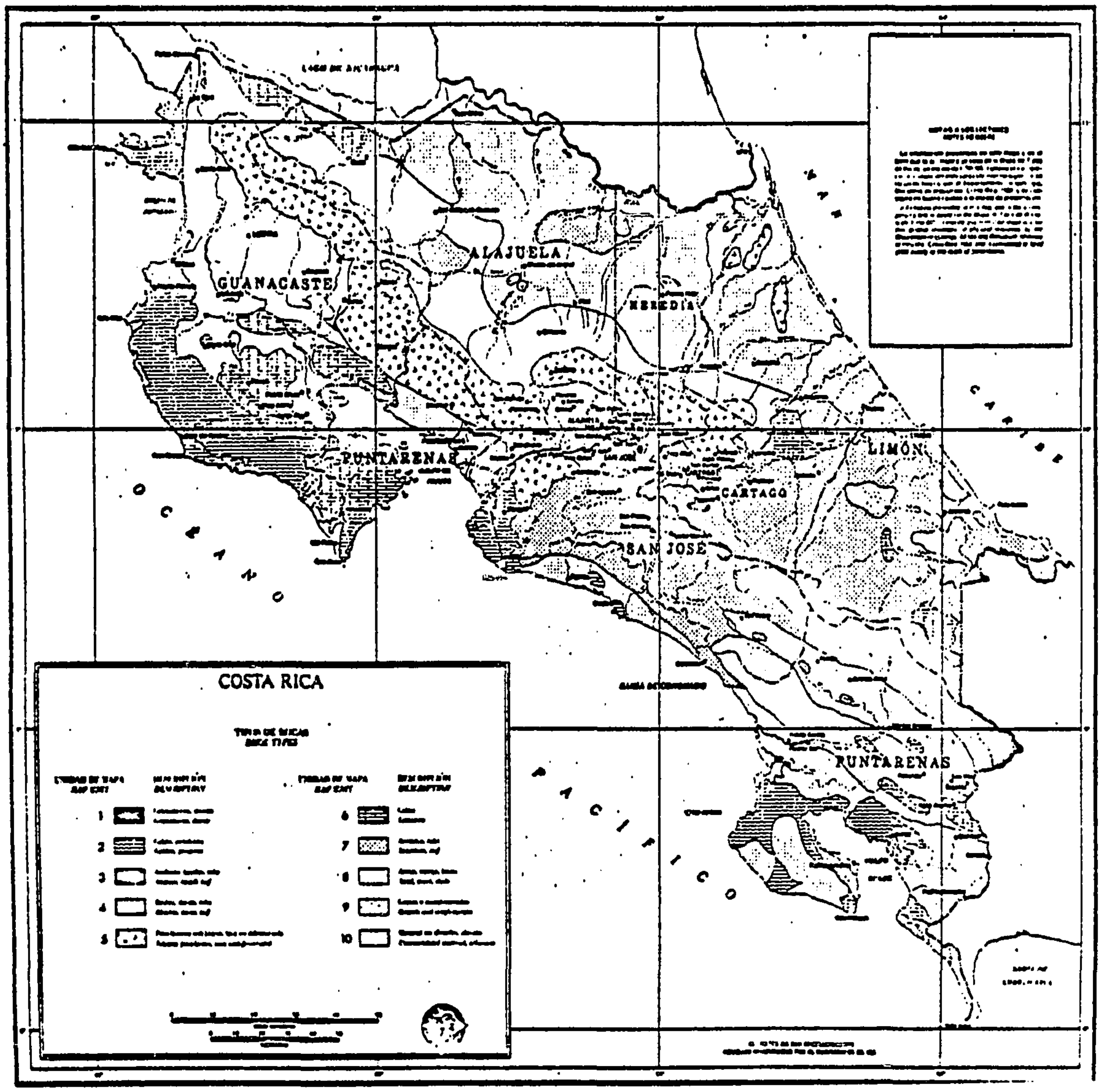


Figure A.8 COSTA RICA ROCK TYPES MAP

Source: Ibid.

Figure A.9 COSTA RICA GROUND WATER RESOURCES MAP

Source: Ibid.

RECURSOS DEL AGUA SUBTERRANEA
GROUND WATER RESOURCES

[illegible]

UNIDAD DE MAPA	PROCEDENCIA Y PROFUNDIDAD	CANTIDAD	CALIDAD	DESARROLLO
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

The wet season is from early May through October, but the effect is ... in wells. The water table is generally highest in October or November and lowest in April or May. Ground water from shallow sources is generally bacterially contaminated.

MAP UNIT	SOURCES AND DEPTH	QUANTITY	QUALITY	DEVELOPMENT
1	Shallow wells in lenses of sand and gravel in plains and river valleys.	Moderate to large quantities available all year.	Moderately hard, clear; generally biologically contaminated.	Siting difficult because of locally soft ground and dense vegetation. Drilling or digging of wells easy in soft alluvium.
2	Shallow to moderately deep wells in sandstone to limestone; in lenses of sand and gravel in river valleys.	Moderate quantities available all year.	Moderately hard, clear; shallow wells generally biologically contaminated.	Siting difficult because of dense vegetation and locally soft ground. Drilling moderately difficult in soft rock.
3	Fracture zones in andesite, limestone and granite; zones of permeable tuff, sandstone, and conglomerate, interbedded with basalt and shale; sources at varied depth. Artesian springs in andesite and lava flows interbedded with impermeable tuff, especially in an east-west belt chiefly in the Central Valley.	Small to moderate quantities from wells, generally moderate to large quantities from springs. Zones of great local differences. Structural geology determines amount.	Moderately hard to soft and clear. May be hot and acid or sulfurous near volcanoes. Locally biologically contaminated near settlements.	Siting difficult because of vegetation and locally steep slopes. Drilling difficult in hard rock.
4	Shallow wells in lenses of sand and gravel underlying coastal swamps.	Meager quantities of fresh water locally available above predominantly saline ground water. Large quantities of saline water available.	Generally brackish to saline.	Siting difficult because of soft ground.

Qualitative Terms:

saline - Contains more than 2,500 p.p.m. total dissolved solids; generally impotable.

brackish - [illegible]

fresh - [illegible]

Quantitative Terms Per Well:

large - more than 5,000,000 liters/day.

moderate - 500,000 to 5,000,000 liters/day.

small - 50,000 to 500,000 liters/day.

meager - less than 50,000 liters/day.

Table A.2 COSTA RICA GROUND WATER RESOURCE

Source: Ibid.

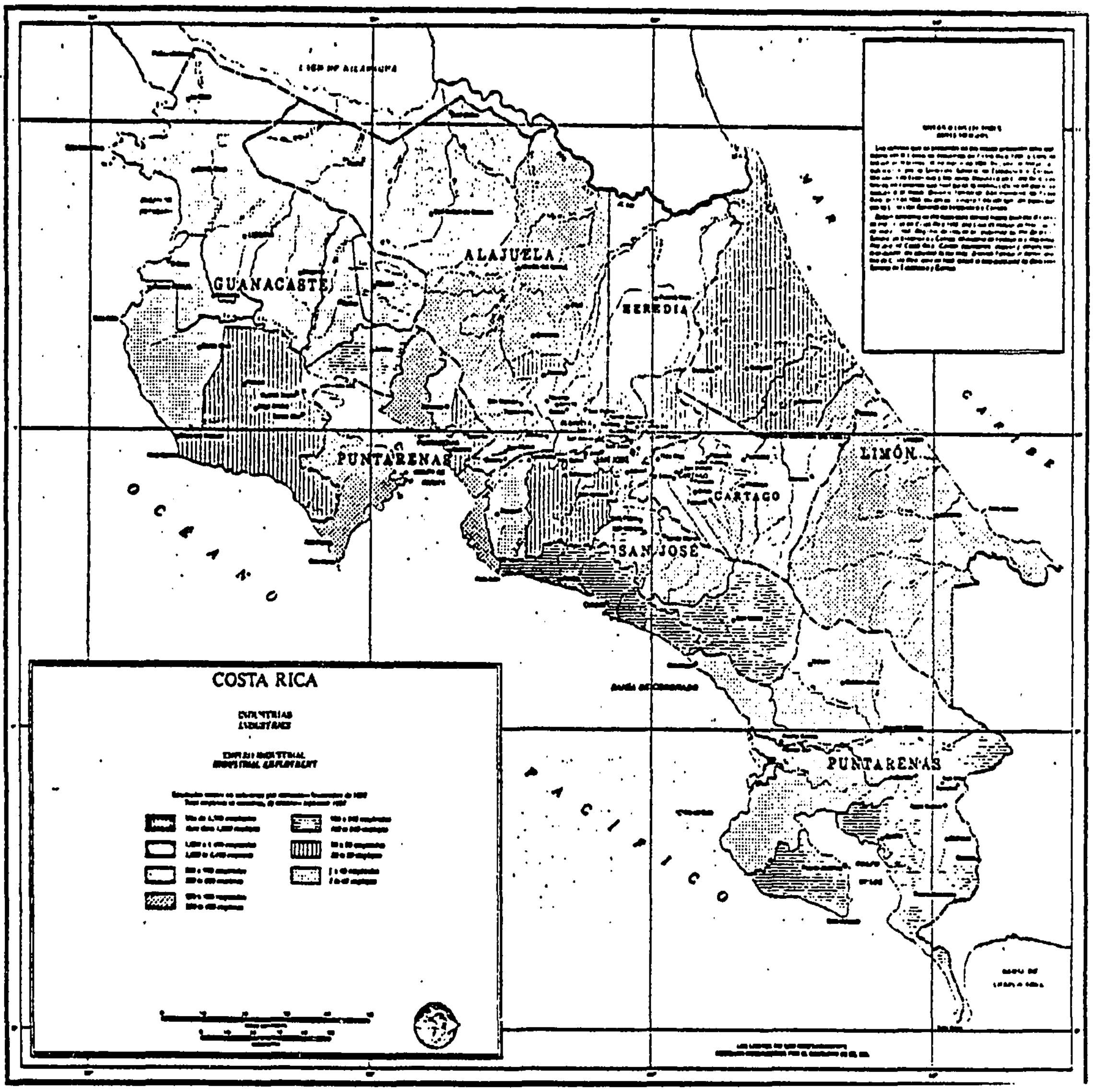


Figure A.10 COSTA RICA INDUSTRIES MAP

Source: Ibid.

Figure A.11 COSTA RICA INDUSTRIES TYPES AND DISTRIBUTION MAP

Source: Ibid.

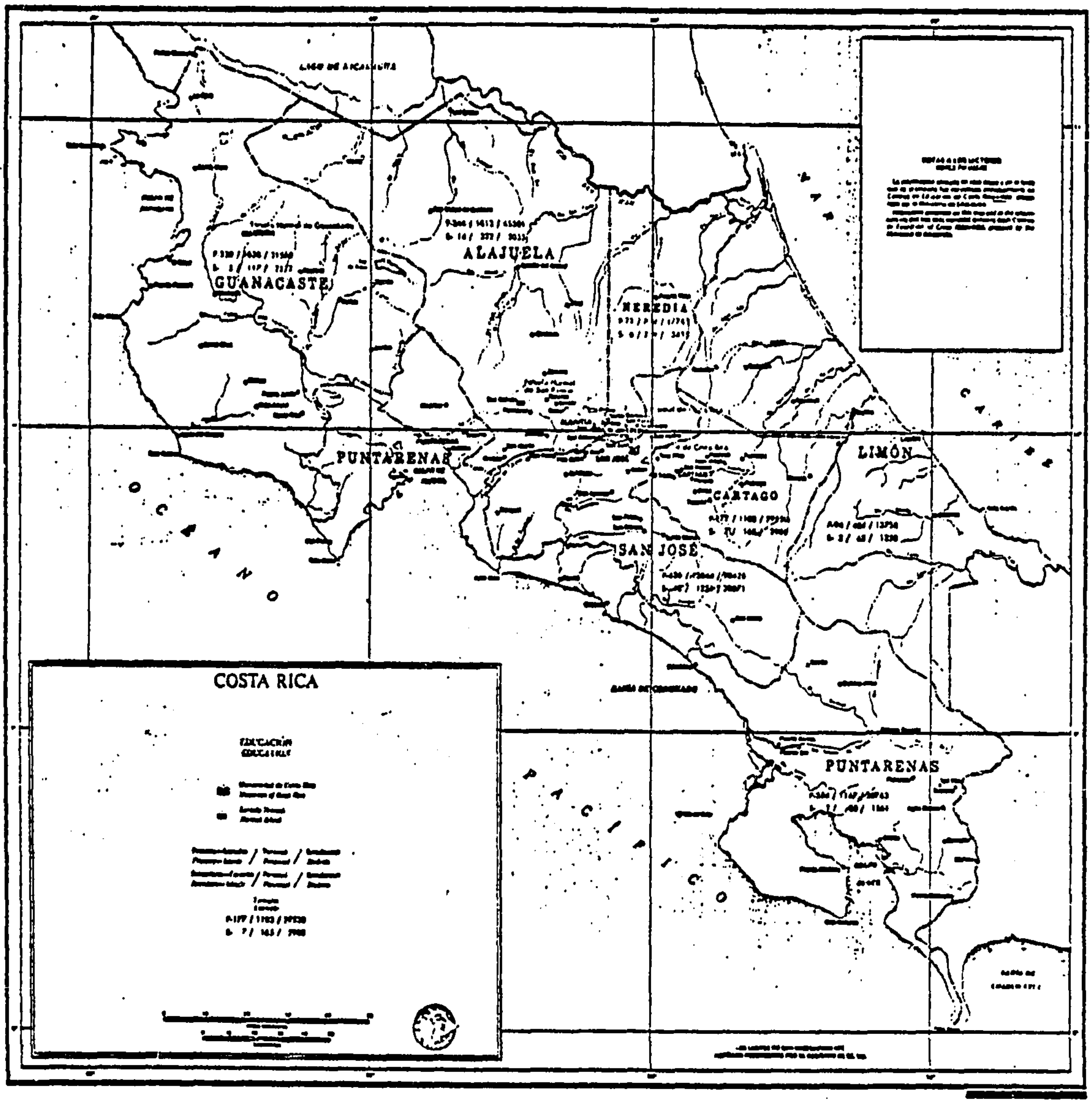


Figure A.12 COSTA RICA EDUCATION MAP

Source: Ibid.

EDUCACION
EDUCATION

T 24

Table A.3 EDUCATION IN COSTA RICA, URBAN

Source: Ibid.

EDUCACION
EDUCATION

Table A.4 EDUCATION IN COSTA RICA, RURAL

Source: Ibid.

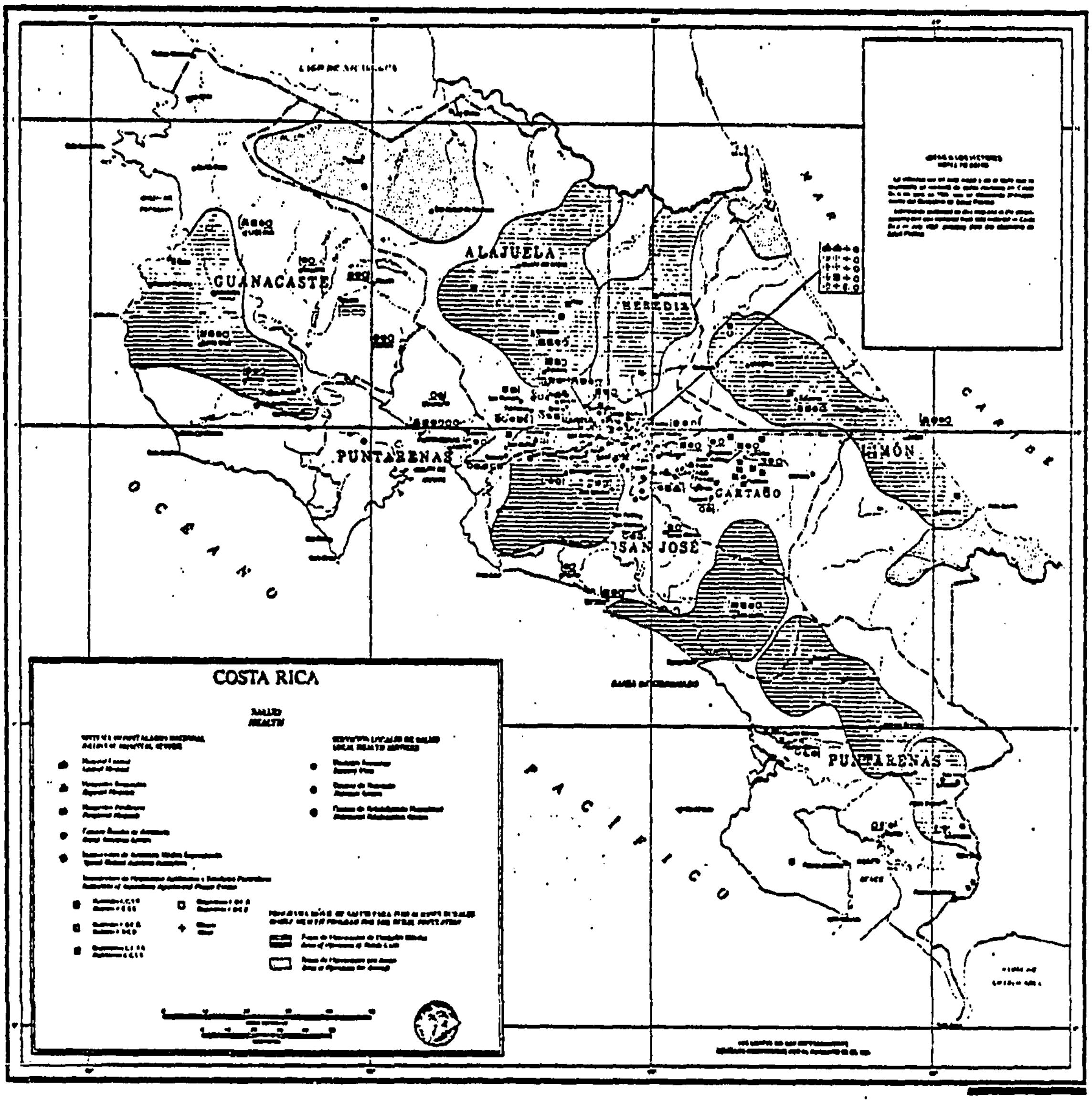


Figure A.13 COSTA RICA HEALTH MAP

Source: Ibid.

SALUD
HEALTH

[illegible]

T 26

Table A.5 COSTA RICA HEALTH INFORMATION--MEDICAL PERSONNEL

Source: Ibid.

SALUD
HEALTH

PROVINCIA / PROVINCE	Total Occupied Dwellings	Piped	Well and Other	None	Sewer	Septic Tank	Pit Privy (Concrete Slab)	Pit Privy (Timber Slab)	Other	None
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alajuela	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cartago	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Heredia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

T 25

Table A.6 COSTA RICA HEALTH INFORMATION --SANITARY SERVICES

Source: Ibid.

Figure A.14 COSTA RICA ELECTRIC POWER MAP

Source: Ibid.

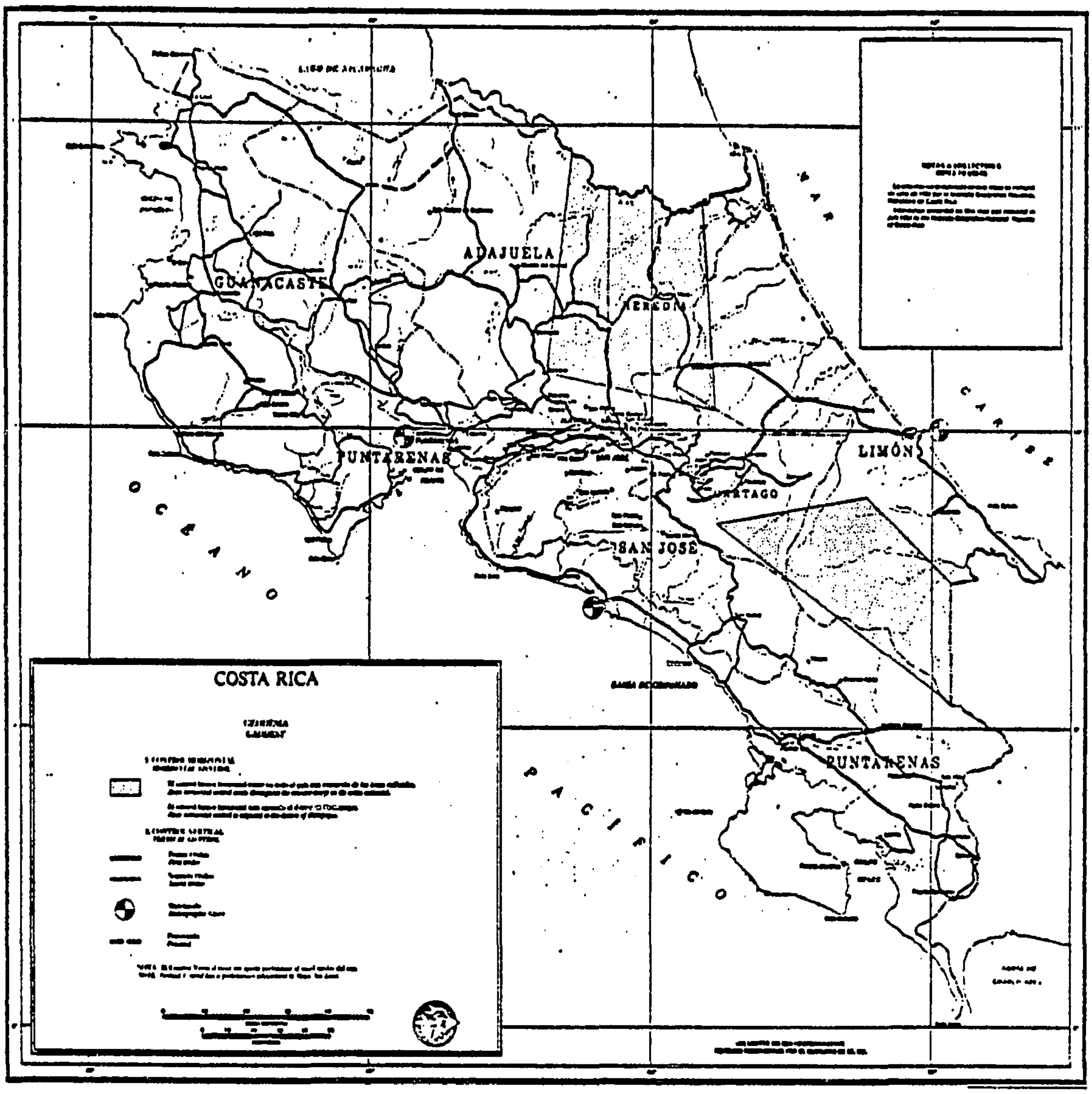


Figure A.15 COSTA RICA GEODESY MAP

Source: Ibid.

APPENDIX A

2. Industrial Parks already Consolidated

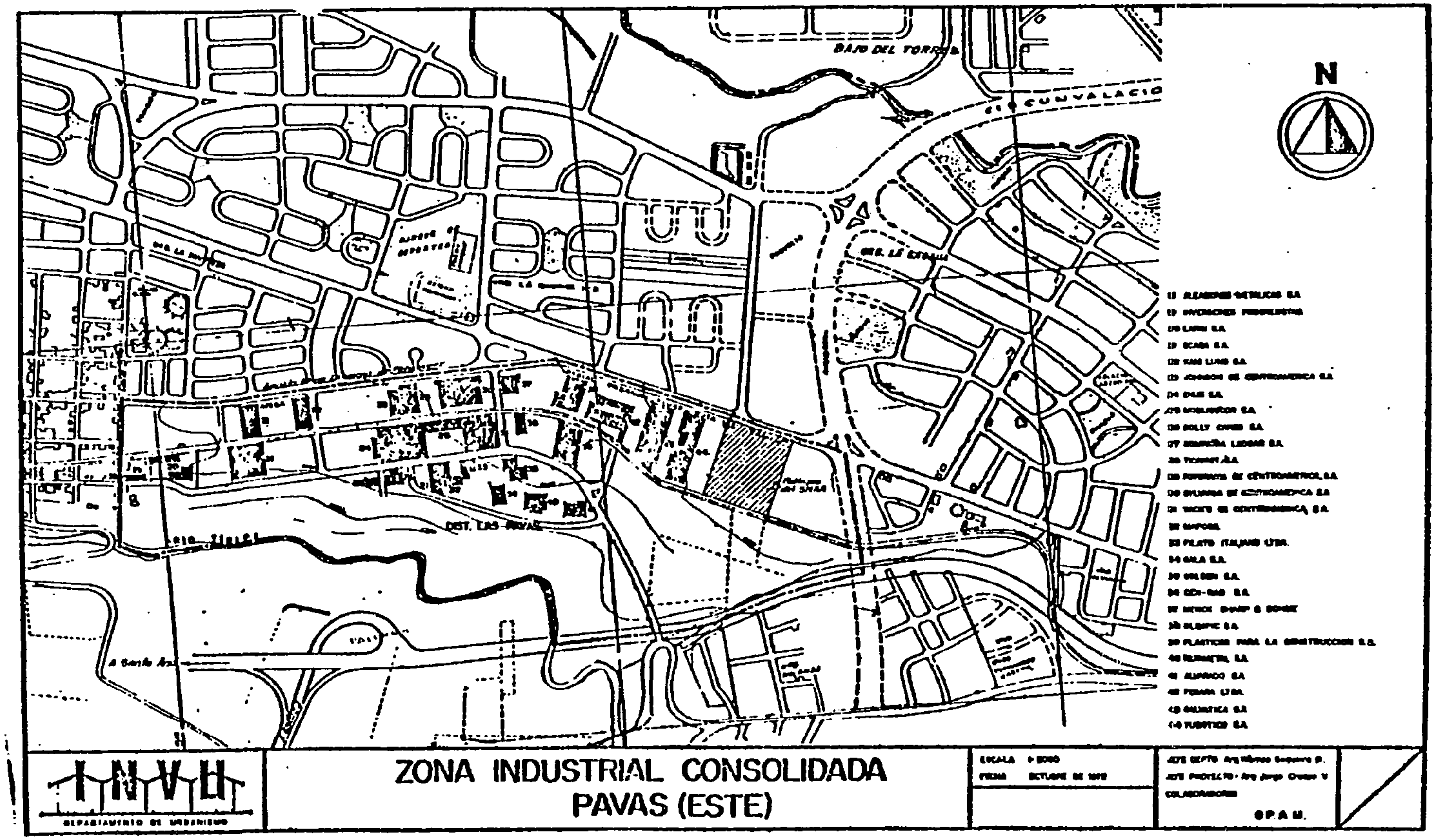


Figure A.16 PAVAS EAST, CONSOLIDATED INDUSTRIAL ZONE

Source: Government of Costa Rica, La Gaceta, Official Newspaper, No. 29, Year CII, 1980

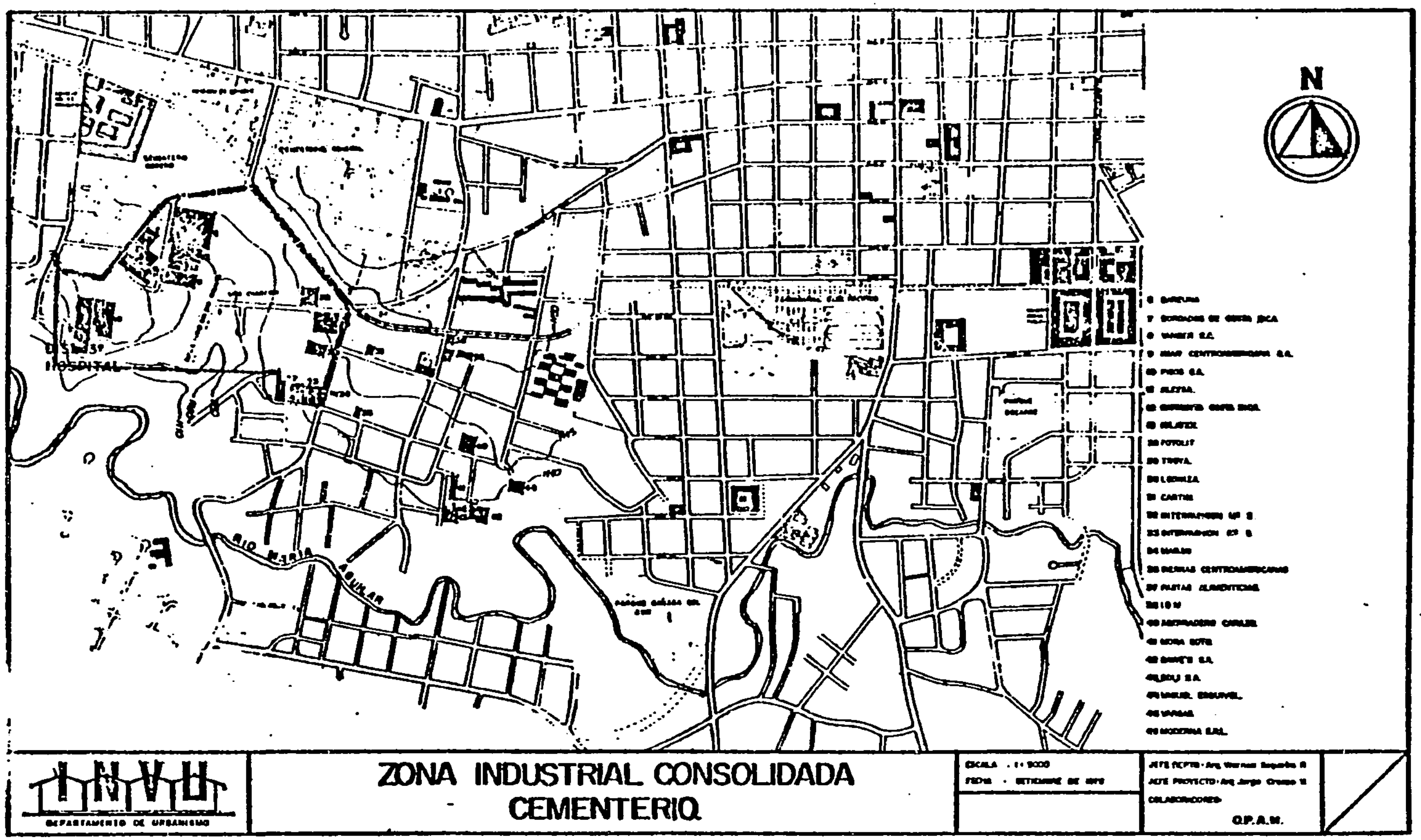


Figure A.17 CONSOLIDATED INDUSTRIAL PARK IN LA SABANA, SAN JOSE

Source: Ibid.

APPENDIX A

3. Industrial Parks Proposed

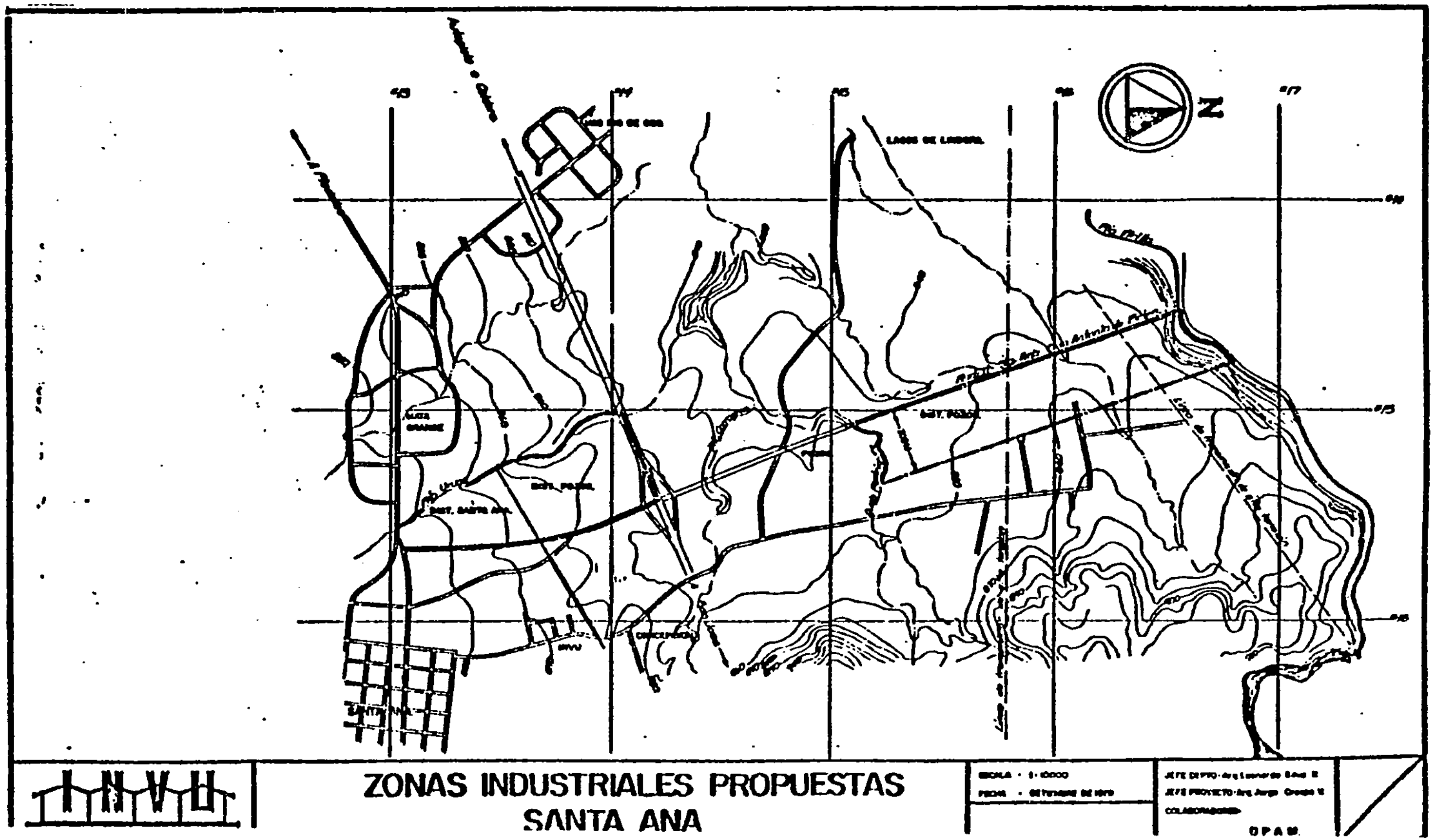
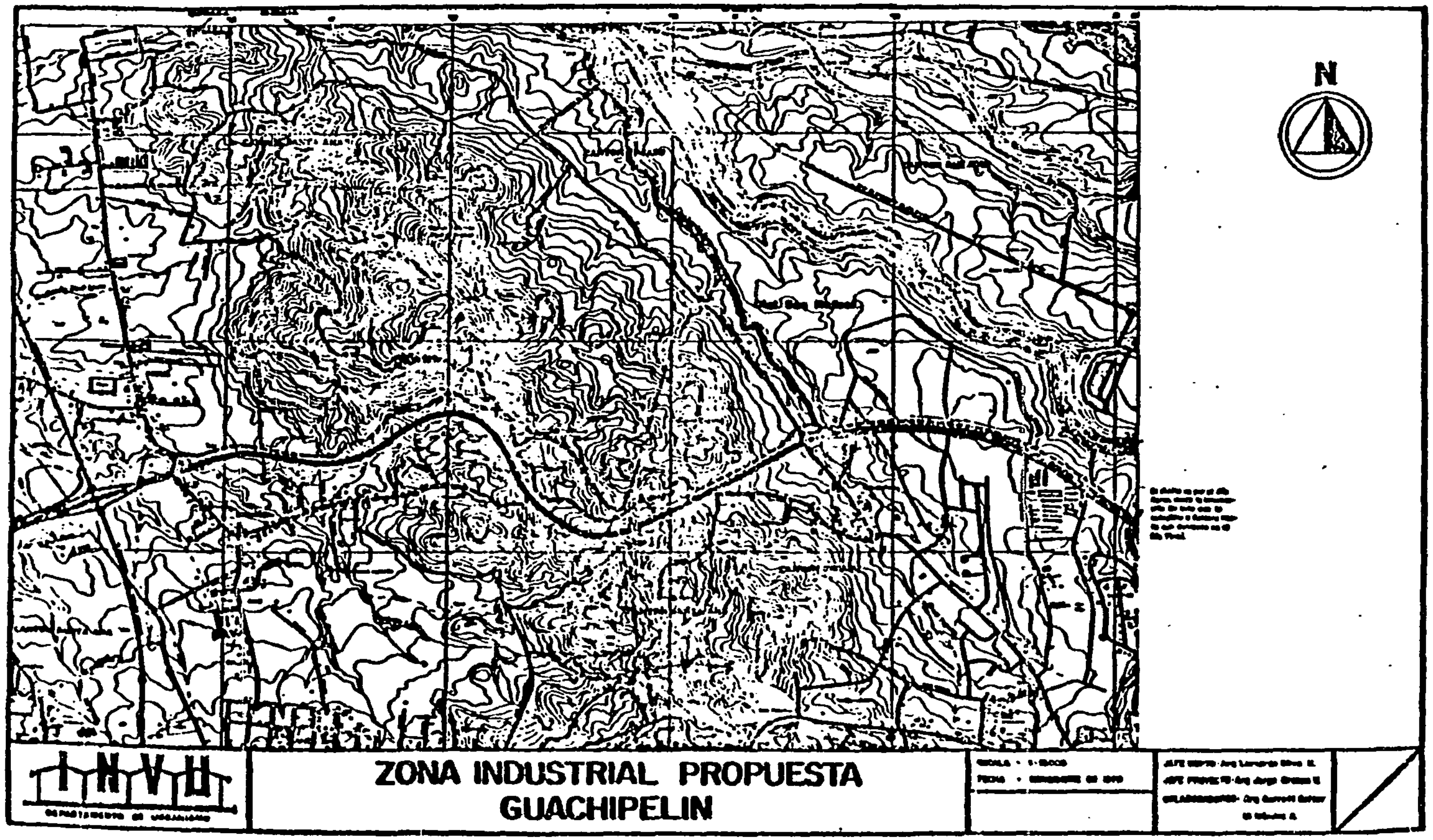


Figure A.18 PROPOSED SANTA ANA INDUSTRIAL PARK

Source: Ibid.



Dado en San José, a los diecinueve días del mes de noviembre de mil novecientos setenta y nueve.—Dalia Ma. Pacheco Fonseca, Secretaria General.—(Orden de servicio Nº 76.056).

POR UNA COSTA RICA MEJOR PARA TODOS

IMPRENTA NACIONAL

Figure A.19 PROPOSED GUACHIPELIN INDUSTRIAL PARK

Source: Ibid.

4. CURRENT EVALUATION PROCEDURES AND FORMS OF THE INSTITUTIONS

The original evaluation forms collected from all the institutions are presented in this appendix.

As can be observed, some of the forms show only the evaluation criteria while others include the explanation for the application of the criteria but never show the basis for that criteria. Background formats used by the institutions are also presented here. In all cases, with the exception of the University of Costa Rica, the institutions use the government's format, which comes from the Ministry of Health.

Nº 5395

LA ASAMBLEA LEGISLATIVA DE LA REPUBLICA DE COSTA RICA,

DECRETA:

La siguiente

LEY GENERAL DE SALUD

DISPOSICIONES GENERALES

Artículo 1º—La salud de la población es un bien de interés público tutelado por el Estado.

Artículo 2º—Es función esencial del Estado velar por la salud de la población. Corresponde al Poder Ejecutivo, por medio del Ministerió de Salud, al cual se referirá abreviadamente la presente ley como "Ministerio", la definición de la política nacional de salud, la normación, planificación y coordinación de todas las actividades públicas y privadas relativas a salud, así como la ejecución de aquellas actividades que le competen conforme a la ley. Tendrá potestades para dictar reglamentos autónomos en estas materias.

Artículo 3º—Todo habitante tiene derecho a las prestaciones de salud, en la forma que las leyes y reglamentos especiales determinen y el deber de proveer a la conservación de su salud y de concurrir al mantenimiento de la de su familia y la de la comunidad.

Artículo 4º—Toda persona, natural o jurídica, queda sujeta a los mandatos de esta ley, de sus reglamentos y de las órdenes generales y particulares, ordinarias y de emergencia, que las autoridades de salud dicten en el ejercicio de sus competencias orgánicas y tiene derecho a ser informada debidamente por el funcionario competente sobre las normas obligatorias vigentes en materias de salud.

Artículo 5º—Toda persona, física o jurídica, está obligada a proporcionar de manera cierta y oportuna los datos que el funcionario de salud competente le solicite para los efectos de la elaboración, análisis y difusión de las estadísticas vitales y de salud y demás estudios especiales de administración, para la evaluación de los recursos en salud y otros estudios especiales que sea necesario hacer para el oportuno conocimiento de los problemas de salud y para la formulación de las medidas de soluciones adecuadas.

Artículo 6º—Todo habitante del país que no esté justamente impedido, tiene la obligación de concurrir al llamamiento de las autoridades sanitarias para declarar en cualquier asunto relacionado con la salud pública. Asimismo, debe prestarles auxilio cuando fuere requerido por la autoridad competente.

Table A.7: Costa Rica Health Law related to Environmental Affairs

Source: Ministerio de Salud, Ley General de Salud, Imprenta Nacional, San Jose, Costa Rica, 1979.

MINISTERIO DE SALUD

LEY GENERAL DE SALUD

Y

LEY ORGANICA DEL MINISTERIO DE SALUD

1974
IMPRENTA NACIONAL
San José, Costa Rica

c) La capacidad o potencia de cosméticos o de sistemas de operaciones especiales para modificar o mantener la apariencia física de las personas, sin la debida autorización o en disconformidad a la autorización obtenida.

d) El ofrecimiento de servicios profesionales en ciencias de la salud por personas sin título para hacerlo, o no autorizadas debidamente para ejercer tales profesiones, especialidades u oficios.

Artículo 261.—Todo establecimiento de educación primaria y media, público o privado, deberá destinar horas de sus programas, para la enseñanza de tópicos y normas obligatorias relativas a la salud personal y de trascendencia para la salud de terceros.

Asimismo los medios de comunicación colectiva (prensa, radio, televisión y otros medios no convencionales) quedan obligados a destinar el espacio necesario para incluir programas referentes a la enseñanza de tópicos y normas obligatorias relativas a la salud personal y de trascendencia para la salud de terceros.

Las autoridades de salud y educación elaborarán y revisarán anualmente los programas de enseñanza a fin de que se incluyan en éstos los tópicos de salud cuya enseñanza y divulgación se estimen necesarias y de actualidad científica.

TITULO III

De los deberes de las personas para la conservación y acondicionamiento del ambiente y de las restricciones a que quedan sujetas en sus actividades en beneficio de su preservación

Artículo 262.—Toda persona, natural o jurídica, está obligada a contribuir a la promoción y mantenimiento de las condiciones del medio ambiente natural y de los ambientes artificiales que permitan llenar las necesidades vitales y de salud de la población.

Artículo 263.—Queda prohibida toda acción, práctica u operación que deteriore el medio ambiente natural o que alterando la composición o características intrínsicas de sus elementos básicos, especialmente el aire, el agua y el suelo, produzcan una disminución de su calidad y estética, haga tales bienes inservibles para algunos de los usos a que están destinados o cree éstos para la salud humana o para la fauna o la flora inofensiva al hombre.

Toda persona queda obligada a cumplir diligentemente las acciones, prácticas u obras establecidas en la ley y reglamentos destinadas a eliminar o a controlar los elementos y factores del ambiente natural, físico o biológico y del ambiente artificial, perjudiciales para la salud humana.

CAPITULO I

Del agua para el uso y consumo humano y de los deberes y restricciones a que quedan sujetas las personas en la materia

Artículo 264.—El agua constituye un bien de utilidad pública y su utilización para el consumo humano tendrá prioridad sobre cualquier otro uso.

Artículo 265.—Se entiende por agua potable para los efectos legales y reglamentarios, la que reúne las características físicas, químicas y biológicas que la hacen apta para el consumo humano de acuerdo con los patrones de potabilidad de la Oficina Panamericana Sanitaria aprobados por el Gobierno.

Artículo 266.—Los abastecimientos de agua del país deberán llenar los requisitos de estructura y funcionamiento fijados por las normas y especificaciones técnicas que el Poder Ejecutivo dicte, en consulta con el Servicio Nacional de Acueductos y Alcantarillado.

Artículo 267.—Todo sistema de abastecimiento de agua, destinada al uso consumo de la población, deberá suministrar agua potable, en forma continua, cantidad suficiente para satisfacer las necesidades de las personas y con presi necesaria para permitir el correcto funcionamiento de los artefactos sanitarios uso.

Artículo 268.—Todo abasto de agua potable, sin excepción, queda suje al control del Ministerio en cuanto a la calidad del agua que se suministre a l población y para velar porque los elementos constitutivos del sistema, su funci namiento y estado de conservación garanticen el suministro adecuado y segun pudiendo ser intervenido por el Ministerio si hubiera peligro para la salud de l habitantes.

Artículo 269.—Los administradores o encargados de todo abasto de ag potable deberán permitir la toma de muestras de agua y las inspecciones qu realicen los funcionarios del Ministerio, debidamente identificados.

Artículo 270.—La construcción de pozos privados y la utilización d sistemas privados de abastecimientos de agua para el uso y consumo humano e las áreas del país donde existe acueducto público en funciones, deberá ser autori zado por el Ministerio conforme al reglamento respectivo.

Los pozos existentes al entrar en vigencia esta ley, podrán ser clausu rados, sellados y mantenidos en reserva cuando así lo determine el Ministerio d común acuerdo con la administración del Servicio Nacional de Acueductos Alcantarillado.

Artículo 271.—En las regiones del país, donde no hubiere abastos públic de agua potable y en tanto éstos se establecen, los habitantes deberán utilizar lo sistemas de abastecimiento de agua para el consumo y uso doméstico que el Mi nisterio señale y las autoridades locales deberán colaborar en difundir la informa ción sobre los métodos para obtener o purificar el agua que se destine a la bebida

Artículo 272.—Las personas, o empresas particulares que se ocupen d abastecer de agua para la bebida o para usos domésticos a una población o resi dencias aisladas, a establecimientos mineros o industriales o a cualquier lugar local destinado a la permanencia transitoria de personas, en lugares donde n hubiere abastecimientos públicos, deberá solicitar permiso del Ministerio some tiéndose a las disposiciones reglamentarias y a las exigencias especiales que es administración pudiere hacer en cada caso.

Artículo 273.—Se prohibe contaminar los abastos de agua, así como dañar obstruir parcial o totalmente, los sistemas de abastecimiento de agua potable destinada a la población. Se presume de pleno derecho la contaminación del agu por el simple hecho de agregarle cualquier cosa o elemento extraño, excepto aquellos que mejoren la calidad del agua, en proporciones científicamente acep tables y con fines específicos en la prevención de enfermedades.

Artículo 274.—Las personas, naturales o jurídicas, deberán utilizar en los establecimientos de su propiedad, administración u operación, agua que reúna las calidades exigidas por el Ministerio para el tipo específico de actividades que desarrollan, especialmente las que digan relación con la producción de alimentos o de materias primas para alimentos; la elaboración de alimentos; la operación de balnearios, establecimientos crenoterápicos, piscinas y de establecimientos si milares.

Artículo 275.—Queda prohibido a toda persona natural o jurídica conta minar las aguas superficiales, subterráneas y marítimas territoriales, directa o indirectamente, mediante drenajes o la descarga o almacenamiento, voluntario o negligente, de residuos o desechos líquidos, sólidos o gaseosos, radiactivos o no radiactivos, aguas negras o sustancias de cualquier naturaleza que, alterando las características físicas, químicas y biológicas del agua la hagan peligrosa para la salud de las personas, de la fauna terrestre y acuática o inservible para usos domésticos, agrícolas, industriales o de recreación.

Artículo 276.—Sólo con permiso del Ministerio podrán las personas naturales o jurídicas hacer drenajes o proceder a la descarga de residuos o desechos sólidos o líquidos u otros que puedan contaminar el agua superficial, subterránea, o marítima, ciñéndose estrictamente a las normas y condiciones de seguridad reglamentarias y a los procedimientos especiales que el Ministerio imponga en el caso particular para hacerlos inocuos.

Artículo 277.—Se prohibe a toda persona natural o jurídica las acciones que puedan producir la contaminación o deterioro sanitario de las cuencas hidrográficas que sirvan a los establecimientos de agua para el consumo y uso humano.

CAPITULO II

De las obligaciones y restricciones relativas a la recolección y eliminación de residuos sólidos

Artículo 278.—Todos los desechos sólidos que provengan de las actividades corrientes personales, familiares o de la comunidad y de operaciones agrícolas, ganaderas, industriales o comerciales, deberán ser separados, recolectados, acumulados, utilizados cuando proceda y sujetos a tratamiento o dispuestos finalmente, por las personas responsables a fin de evitar o disminuir en lo posible la contaminación del aire, del suelo o de las aguas.

Artículo 279.—Queda prohibido a toda persona, natural o jurídica arrojar o acumular desechos sólidos en lugares no autorizados para el efecto, utilizar medios inadecuados para su transporte y acumulación y proceder a su utilización, tratamiento o disposición final mediante sistemas no aprobados por el Ministerio.

Artículo 280.—El servicio de recolección, acarreo y disposición de basuras, así como la limpieza de caños, acequias, alcantarillas, vías y parajes públicos estará a cargo de las municipalidades las cuales podrán realizarlo por administración o mediante contratos con empresas o particulares, que se otorgarán de acuerdo con las formalidades legales y que requieran para su validez la aprobación del Ministerio.

Toda persona, queda en la obligación de utilizar dicho servicio público y de contribuir económicamente a su financiamiento de conformidad con las disposiciones legales y reglamentarias pertinentes.

Artículo 281.—Las empresas agrícolas, industriales y comerciales, deberán disponer de un sistema de separación y recolección, acumulación y disposición final de los desechos sólidos provenientes de sus operaciones, aprobado por el Ministerio cuando por la naturaleza, o cantidad de éstos, no fuere sanitariamente aceptable el uso del sistema público o cuando éste no existiere en la localidad.

Artículo 282.—Los propietarios de terrenos desocupados en áreas urbanas están obligados a mantenerlos cerrados y en buenas condiciones higiénicas.

Quedarán obligados, asimismo, a realizar las prácticas u obras, dentro del plazo que la autoridad de salud les ordene, cuando tales terrenos constituyen un foco de contaminación ambiental.

Artículo 283.—Queda prohibida la recuperación de desechos y residuos sólidos en lugares no aprobados por la autoridad de salud para tales efectos.

Las personas, naturales o jurídicas, que se ocupen de la recuperación, apr vechamiento, comercio o industrialización de tales materias, deberán solicit permiso previo a la autoridad de salud y ésta podrá otorgarlo, cuando se comprue que los trabajos de selección, recolección y aprovechamiento de los desechos residuos no impliquen peligro de contaminación del ambiente o riesgos para l salud de las personas que trabajan en tales faenas o de terceros.

Artículo 284.—La autorización a que se refiere el artículo anterior dura un año y podrá ser cancelada en cualquier tiempo cuando el titular no cumplie las disposiciones reglamentarias pertinentes o no realizare las prácticas y obr especiales que la autoridad de salud le imponga como requisitos necesarios pa resguardar la salud de las personas, o el saneamiento de la operación.

CAPITULO III

De las obligaciones y restricciones para la evacuación sanitaria de excretas y aguas servidas y negras

Artículo 285.—Las excretas, las aguas negras, las servidas y las pluviale deberán ser eliminadas adecuada y sanitariamente a fin de evitar la contaminació del suelo y de las fuentes naturales de agua para el uso y consumo humano, l formación de criaderos de vectores y enfermedades y la contaminación del air mediante condiciones que atenten contra su pureza o calidad.

Artículo 286.—Toda persona, natural o jurídica, está obligada a realiz las obras de drenaje que la autoridad de salud ordene a fin de precaver la for mación de focos insalubres y de infección, o de sanear los que hubiere en predio de su propiedad.

Si el propietario fuere renuente en el cumplimiento de tales órdenes, l autoridad de salud podrá hacerlos a costa del omiso.

En los casos en que el interés público, la naturaleza y envergadura de la obras de drenaje lo justificare, todo propietario de inmueble está obligado a cons tituir servidumbre en favor del Estado para que la autoridad de salud construya tales obras pudiendo decretarse la expropiación del terreno cuando la servidumbr fuere incompatible con su utilización.

El mantenimiento y operación, si procedieren, estará a cargo de los bene ficiarios de tales obras.

Artículo 287.—Toda persona, natural o jurídica, propietaria de viviendas de establecimientos o edificios en que las personas desarrollen sus actividades responderá de que tales bienes dispongan de un sistema de disposición de excreta y de aguas negras y servidas aprobado por el Ministerio y los usuarios de vivien das, establecimientos o edificios estarán obligados a mantener dicho sistema e buenas condiciones de funcionamiento.

Artículo 288.—Todo propietario queda obligado a conectar el sistema de eliminación de excretas de aguas negras y servidas de su propiedad al alcantarillado sanitario en los lugares en que éste estuviera en funcionamiento, salvo en los casos de excepción que los reglamentos pertinentes reconozcan como procedentes.

Artículo 289.—Todo sistema de alcantarillado, quedará bajo el control téc nico del Ministerio y del Servicio Nacional de Acueductos y Alcantarillado y las personas de derecho privado o público que los construyan, administren y operen se sujetarán a las normas que el Poder Ejecutivo, en consulta con el Ser vicio Nacional de Acueductos y Alcantarillado, dicte para condicionar su cons trucción, funcionamiento y la evacuación y tratamiento final de los fluentes.

Artículo 290.—Se prohibe a toda persona destruir o dañar los sistemas de desagües públicos o privados u obstruir su funcionamiento.

Artículo 291.—Queda prohibido, descargar residuos industriales y de establecimientos de salud en el alcantarillado sanitario sin autorización previa de la autoridad de salud y sin cumplir las instrucciones que ésta pueda ordenar para hacerlos inocuos, a fin de precaver cualquier daño al sistema de desagüe, o evitar la contaminación de las fuentes o cursos de agua; del suelo y del aire, o cualquier otro riesgo para la salud humana que se derive de la evacuación final inadecuada de los desagües.

Artículo 292.—Queda prohibido, en todo caso la descarga de las aguas negras, de las aguas servida y de residuos industriales, al alcantarillado pluvial. El Ministerio queda facultado para restringir, regular, o prohibir la eliminación de productos sintéticos no biodegradables a través de los sistemas de recolección de excretas, aguas negras y servidas.

CAPITULO IV

De los deberes y restricciones a que quedan sujetas las personas para evitar la contaminación del ambiente

Artículo 293.—Toda persona, natural o jurídica, queda obligada a emplear el máximo de su diligencia en el cumplimiento de las disposiciones legales y reglamentarias o de los pedidos especiales que ordene la autoridad competente, a fin de evitar o controlar la contaminación atmosférica y del ambiente de los lugares destinados a la vivienda, trabajo o recreación.

Artículo 294.—Se entiende por contaminación de la atmósfera para los efectos legales y reglamentarios, el deterioro de su pureza por la presencia de agentes de contaminación, tales como partículas sólidas, polvo, humo, vapor, gases, materias radiactivas y otros, que el Ministerio defina como tales, en concentraciones superiores a las permitidas por las normas de pureza del aire aceptadas internacionalmente y declaradas oficiales por el Ministerio.

Se estima contaminación del aire, para los mismos efectos, la presencia de emanación o malos olores que afecten la calidad del ambiente, perjudicando el bienestar de las personas.

Será asimismo considerada como contaminación atmosférica la emisión de sonidos que sobrepasen las normas aceptadas internacionalmente y declaradas oficiales por el Ministerio.

Artículo 295.—Queda prohibido a toda persona, física o jurídica, la descarga, emisión o emanación de contaminantes atmosféricos de naturaleza y en proporciones prohibidas, resultantes de sus actividades personales, domésticas, industriales, comerciales o de cualquier otra índole que cause o contribuya a la contaminación atmosférica.

Artículo 296.—Todo propietario o administrador, de una construcción o edificio será responsable de que el inmueble cuente con los medios y sistemas para evitar descargas, emisiones o emanaciones que causen o contribuyan a la contaminación atmosférica.

Los fabricantes y vendedores, de bienes muebles o artefactos que por su naturaleza, construcción o uso puedan producir descargas o emanaciones que causen o contribuyan a la contaminación del aire, deberán incluir en esos bienes muebles, un sistema específicamente diseñado para el control de emisiones, de acuerdo con las normas aceptadas internacionalmente.

En todo caso, en tanto los fabricantes como los importadores de bienes quedan sujetos al cumplimiento de las exigencias y restricciones qu Ministerio imponga, a fin de evitar o reducir la contaminación atmosférica.

Del mismo modo los propietarios de tales bienes muebles en especial híículos automotores quedan obligados a mantenerlos y usarlos de modo de e o reducir la contaminación del aire.

Para el cabal cumplimiento de las disposiciones de este artículo el Minis hará determinaciones periódicas de la calidad de los combustibles cuyo uso p producir o contribuir a la contaminación atmosférica.

Artículo 297.—Queda prohibido el funcionamiento de toda fábrica o e blecimiento industrial o comercial en edificios que no dispongan de los elem o sistemas necesarios para evitar que las descargas, emisiones, emanacion sonidos producto de tales actividades industriales o comerciales, causen o tribuyan a la contaminación atmosférica de la región en que se encuentran cados y que no dispongan en la organización de sus actividades o faenas, de mentos o sistemas para evitar la contaminación del ambiente interior con ri o peligro para la salud y el bienestar de su personal y de terceros.

CAPITULO V

De los deberes y restricciones a que quedan sujetas las actividades industri

Artículo 298.—Toda persona, que opere establecimientos industriales berá obtener la correspondiente autorización del Ministerio para su instalació la debida aprobación de éste para iniciar su funcionamiento, así como para am o variar, o modificar en cualquier forma la actividad original para la que autorizado.

Artículo 299.—Ninguna autoridad, podrá conoceder patentes o perm para el funcionamiento de establecimientos industriales, sin que medie la pr autorización de funcionamiento del Ministerio.

Artículo 300.—Para obtener autorización de instalación, los interes deberán acreditar ante el Ministerio, que el sitio elegido se encuentra en z permitida según la correspondiente reglamentación vigente, que cuenta con elementos de saneamiento básico y que dispone de los elementos o sistemas s tarios adecuados para la eliminación de desechos, residuos, o emanaciones, a de no causar o contribuir a la contaminación del suelo y del agua destinad uso y consumo humanos, ni del aire y para no constituir problema sanitario o molestia para la población.

A falta de un plan regulador de desarrollo urbano el Ministerio determin las zonas permitidas para los establecimientos industriales, la autorización a q se refiere el presente artículo, podrá ser cancelada, suspendida o modificada, se el caso, temporal o definitivamente, cuando varíen las condiciones existente concederla.

Artículo 301.—Se entiende por establecimiento industrial, para los efe de la presente ley y su reglamentación, todo lugar descubierto o cubierto destin a la transformación, manipulación o utilización de productos naturales, o a elaboración, manipulación, transformación o utilización de productos artifici mediante tratamiento físico, químico o biológico, manualmente o por medio máquinas o instrumentos.

Quedan incluidos en tal consideración para los mismos efectos antes alu dos, los sitios destinados a recibir o almacenar los artefactos, instrumentos utensilios, materiales y materias primas que se emplearán en las tareas o fae y todos los anexos de la fábrica o taller. Igualmente, se considerarán como ta las estaciones y terminales de transporte.

Artículo 302.—Ningún establecimiento industrial, podrá funcionar si constituye un elemento de peligro, insalubridad o incomodidad para la vecindad, ya sea por las condiciones de mantención del local en que funciona, por la forma o sistemas que emplea en la realización de sus operaciones, por la forma o sistema que utiliza para eliminar los desechos, residuos o emanaciones resultantes de sus faenas, o por los ruidos que produce la operación.

Artículo 303.—Los propietarios o administradores de establecimientos industriales deberán, cumplir diligentemente todas las normas técnicas que el Ministerio por sí o de acuerdo con el Ministerio de Trabajo, dicten para proteger la salud de su personal.

Artículo 304.—Los establecimientos industriales, que funcionen antirreglamentariamente o que constituyan peligro, incomodidad o insalubridad para su personal o la vecindad, podrán ser clausurados por la autoridad de salud y en todo caso, sus propietarios y administradores quedan obligados a cumplir las órdenes o instrucciones que la autoridad de salud les ordene para poner fin o mitigar la insalubridad o molestia que producen a causa de su operación, debiendo suspender tal operación hasta tanto no hayan cumplido los requisitos reglamentarios o los exigidos por el Ministerio.

Artículo 305.—Todo campamento de trabajo y finca rural, deberá estar provisto de los elementos de saneamiento básico para proteger la salud y bienestar de sus trabajadores y para evitar la constitución de focos de infección, o de contaminación del ambiente.

Artículo 306.—Se entiende por campamento de trabajo toda instalación destinada a albergar a los trabajadores de explotaciones agrícolas, mineras o ganaderas o de obras públicas o privadas en construcción.

Artículo 307.—Toda persona natural o jurídica queda sujeta a las normas técnicas que el Ministerio dicte, estableciendo las condiciones de saneamiento básico de los campamentos de trabajo y fincas agrícolas. En todo caso, ninguna persona podrá iniciar la construcción de instalaciones destinadas a ser utilizadas como campamentos de trabajo sin la autorización del Ministerio.

CAPITULO VI

De los deberes y restricciones relativos a las urbanizaciones y salubridad de la vivienda

Artículo 308.—En la formación de nuevas ciudades o poblaciones y apertura de nuevas calles, no se podrán trazar ni orientar éstas sin la aprobación del Ministerio.

No se podrá tampoco construir edificios en las nuevas calles si no se han hecho previamente los trabajos necesarios de saneamiento, como la construcción de desagües, alcantarillados, instalación de cañerías de agua potable y los rellenos o nivelación de los terrenos para evitar los estancamientos de agua de cualquier clase.

Sin perjuicio de las facultades de otras autoridades o entidades competentes en la materia, toda persona que se ocupe de la urbanización de terrenos y de la construcción de edificios para la vivienda, deberá cumplir las disposiciones de las normas sanitarias que sobre la materia dicte el Ministerio en resguardo de la salud de las personas.

Artículo 309.—Las personas, naturales y jurídicas, que se ocupen de la urbanización de terrenos deberán presentar a la autoridad de salud competente para su estudio previo el anteproyecto correspondiente y sólo podrán iniciar sus trabajos una vez aprobado el proyecto definitivo.

La aprobación será concedida si el proyecto de urbanización está ubica en área permitida por la reglamentación vigente o en su defecto por el Ministe y dispone de sistemas sanitarios adecuados de suministro de agua potable, desagüe de aguas pluviales, de disposición de excretas, aguas negras y agu servidas.

Artículo 310.—Queda prohibida la construcción de viviendas en nue urbanizaciones o loteos de predios mayores cuyos servicios y sistemas sanitarios cumplan con las disposiciones legales y reglamentos vigentes.

Artículo 311.—Las mismas reglas establecidas en los artículos anterior se aplicarán a la formación de nuevas ciudades o poblaciones.

Artículo 312.—Toda persona, requerirá permiso del Ministerio para pa ceder a la construcción, reparación o modificación de cualquier edificación des nada a la vivienda permanente o transitoria de las personas y tal permiso só le será concedido cuando acredite, con los planos respectivos, que dará cump miento a las normas sanitarias dictadas por el Poder Ejecutivo, respecto de l requisitos que la edificación deberá llenar, según su naturaleza y destino, a fin resguardar la seguridad y la salud de sus habitantes.

Las edificaciones a que este artículo se refiere no podrán ser ocupad en parte o totalmente, sin la previa autorización del Ministerio.

Artículo 313.—Toda vivienda individual, familiar o multifamiliar, debe cumplir con los siguientes requisitos sanitarios:

1. Localización en áreas que no ofrezcan peligro para la salud y el bienes de los ocupantes.
2. Orientación adecuada, a fin de aprovechar las circunstancias naturales artificiales del ambiente, en beneficio de la salud y bienestar de los oc pantes.
3. Construcción con materiales adecuados que ofrezcan estabilidad, segurida y buenas condiciones sanitarias.
4. Distribución interior adecuada, a fin de hacerla funcional y conforme uso para el cual se destine.
5. Dimensiones mínimas y áreas adecuadas de compartimientos.
6. Iluminación natural y artificial adecuadas.
7. Ventilación natural o artificial adecuadas.
8. Medios de saneamiento básico:
   a) Abastecimiento continuo de agua potable, en cantidad y presión sufi cientes, accesibles a todos los ocupantes.
   b) Sistemas adecuados de eliminación de excretas, de aguas negras, ser vidas y pluviales aprobados por la autoridad de salud.
   c) Artefactos sanitarios primarios mínimos.

Artículo 314.—Toda persona, tiene obligación de velar por la higiene seguridad de su vivienda personal o familiar y deberá realizar las prácticas espe ciales de limpieza, desinfección y desinsectización que haya menester, cuidando d cumplir las instrucciones y órdenes que para tales efectos imparta la autoridad de salud.

Podrá por tanto, recurrir a los servicios especializados de salud para soli citar información acerca de los sistemas y medios más apropiados para procede en buena forma y sin peligro para las personas, o pedir, cuando sea prudente que la desinfección, desinsectización o destrucción de roedores u otros animale dañinos sea practicada por los servicios aludidos.

Toda persona, además deberá mantener en forma higiénica las basuras en su casa hasta que sean entregadas a los servicios de recolección y deberá cuidar que los servicios de agua potable y disposición de aguas negras y servidas de ésa, se mantengan en buenas condiciones de funcionamiento.

Artículo 315.—Los propietarios y administradores de viviendas y locales de alquiler, están en la obligación de dotar a sus inmuebles de las condiciones, instalaciones y servicios exigidos por las normas sanitarias reglamentarias a fin de ofrecer a los arrendatarios y ocupantes, condiciones de sanidad y seguridad adecuados.

Artículo 316.—Cuando la autoridad de salud lo ordene, los propietarios, administradores o encargados, procederán a la desinfección, desinsetización, desratización o reparación, según proceda, de los edificios destinados a vivienda permanente o transitoria, incluidos anexos y patios interiores, que por su estado o condición amenacen la salud o seguridad de sus habitantes. El inmueble afectado por cualesquiera de estas medidas sanitarias ordenadas, no podrá ser ocupado hasta que no se hayan remediado sus defectos o haya desaparecido el riesgo para la salud y la seguridad de los ocupantes y podrá ser clausurado por la autoridad de salud si el peligro fuere inminente.

Artículo 317.—Ninguna autoridad podrá conceder permiso o patente a los propietarios o administradores de cualquier local o establecimiento destinado a la vivienda transitoria o permanente de personas, tales como hoteles, pensiones, hospederías, internados y similares que no reúnan los requisitos exigidos por las normas sanitarias que dicte el Poder Ejecutivo.

Los administradores o encargados deberán mantener el edificio en buenas condiciones de seguridad y saneamiento y tales establecimientos no podrán funcionar si no cumplen con los requisitos mínimos establecidos para la vivienda.

Artículo 318.—Todo arrendatario o usuario de un inmueble a cualquier título, responderá de su estado de limpieza, evitando que se convierta en fuente de infección o en criadero o albergue de fauna nociva y está en la obligación de cuidar y hacer buen uso de las instalaciones y servicios sanitarios del inmueble ocupado.

Artículo 319.—Cuando un inmueble se constituyere, por su condición o estado, en peligro para la salud o seguridad de los ocupantes o de los vecinos, la autoridad sanitaria podrá ordenar al dueño que realice las obras necesarias o tome las medidas que hubiere menester dentro del plazo perentorio que fije y si el responsable no lo hiciere, la autoridad sanitaria podrá ejecutar directamente la acción correctiva a costa del causante.

Artículo 320.—Serán declarados inhabitables por la autoridad de salud las habitaciones y edificios que por su estado ruinoso o que por existir en ellos una fuente de infección permanente constituyan un peligro para la salud y la seguridad de sus moradores o sus vecinos.

De igual manera serán declaradas insalubres las que no reúnan los requisitos que indican los reglamentos sanitarios y de construcciones.

Artículo 321.—Calificada de inhabitable o de insalubre una habitación o edificio, se comunicará al propietario o encargado, fijándole un plazo dentro del cual debe proceder al desalojamiento, demolición o reparación, según el caso. Si no se cumpliere la orden dada se procederá a desalojar, por medio de la guardia civil si fuere necesario, a los moradores o a quienes permanezcan en la casa, edificio o local y se dispondrá que se clausuren éstos por la misma guardia, o que se practiquen las reparaciones o demolición por el Ministerio.

CAPITULO VII

Requisitos y restricciones para la construcción y operación de otros establecimientos de interés sanitario

SECCION I

Artículo 322.—Los edificios o instalaciones, no destinados a la vivien pero que sean ocupados por personas en forma permanente, como en el caso oficinas u otros similares o en forma transitoria, como en el caso de igle lugares de recreación, esparcimiento o diversión y otros similares, deberán dispo de las condiciones sanitarias y de seguridad reglamentarias que garanticen la sal y bienestar de sus asistentes u ocupantes y del vecindario.

Artículo 323.—Toda empresa particular o pública o persona, que de iniciar una edificación de las aludidas en el artículo anterior o que desee desti para los mismos fines una ya construida, deberá solicitar permiso previo al M nisterio.

Al terminar la obra y antes de ocuparla o de entrar en funciones, debe acreditar ante la autoridad de salud que ésta dispone de todos los requisitos exigi por las normas técnicas dictadas por el Ministerio.

Las personas responsables deberán mantenerlas en buenas condiciones seguridad y saneamiento mientras esté en funciones.

Artículo 324.—Toda persona, natural o jurídica, que opere piscinas, sit de recreación, similares, bajo techo o al aire libre, baños públicos o establecimien crenoterápicos, deberá requerir permiso previo del Ministerio para su instalaci

Sin esta autorización ninguna autoridad podrá otorgar patente comer u otros permisos requeridos para su funcionamiento. No podrá permitirse tampo su apertura al servicio público sin la debida aprobación para operar, otorga por el Ministerio.

La autorización se concederá por dos años a menos que defectos de func namiento o repetidas infracciones que hagan peligrar la salud de los concurren o que les conviertan en focos de infección, ameriten su clausura o la suspensi temporal de sus actividades.

Quedan excluidas de esta obligación únicamente las piscinas ubicadas e casas particulares para el uso de los miembros del hogar.

Artículo 325.—En todo caso la autoridad sanitaria podrá clausurar cual quier edificación o instalación de las aludidas en el presente capítulo, cuand constituyere peligro para la salud pública o el bienestar de sus ocupantes, visitant o vecinos.

Artículo 326.—Son responsables de las infracciones sanitarias que se co metan, los propietarios o administradores de tales edificaciones, instalaciones establecimientos, quienes están obligados a cumplir con las medidas técnicas espe ciales que la autoridad de salud les señale, a fin de impedir que esas edificacione instalaciones o establecimientos se conviertan en fuente de infección o de insalu bridad ambiental o de peligro para la salud de los que concurren a trabajar e ellos.

SECCION II

De los cementerios, inhumaciones y exhumaciones de cadáveres

Artículo 327.—Los propietarios y administradores de cementerios, quedan obligados a mantenerlos en condiciones de higiene y salubridad y a cumplir con las disposiciones reglamentarias pertinentes.

Artículo 328.—Las personas, naturales y jurídicas, que operen funerarias deberán solicitar permiso a la autoridad de salud para los efectos de su instalación y operación.

Artículo 329.—La inhumación y cremación de cadáveres y de restos humanos, sólo podrá efectuarse en cementerios y crematorios, respectivamente, autorizados por la administración de salud y previo cumplimiento de todas las exigencias reglamentarias.

Las exhumaciones de cadáveres, deberán asimismo, ser autorizadas por la autoridad de salud competente, salvo cuando se debe proceder por orden judicial.

Artículo 330.—Ningún cadáver podrá permanecer insepulto por más de treinta y seis horas contadas a partir del deceso a menos que la autoridad de salud lo autorice u ordene, o que haya necesidad de realizar alguna diligencia judicial, o que se encuentre en instalaciones debidamente acondicionadas para su conservación.

La autoridad de salud podrá ordenar la inhumación dentro de un plazo menor cuando las circunstancias y la causa de muerte lo haga procedente.

CAPITULO VIII

De los deberes de las personas relativos al control de la fauna nociva para el hombre

Artículo 331.—Toda persona, queda obligada a evitar o eliminar las condiciones favorables para la persistencia o reproducción de las especies de la fauna nociva para el hombre en los bienes de su propiedad o a su cuidado.

Deberá asimismo proceder al exterminio de esos animales ciñéndose a las normas que el Ministerio ordene y utilizando los productos aprobados o los servicios de personas autorizadas por la autoridad de salud para tales efectos.

Artículo 332.—Sólo las personas, físicas o jurídicas, debidamente autorizadas por la autoridad de salud podrán dedicarse al exterminio comercial de la fauna nociva al hombre y para obtener tal autorización deberán acreditar que disponen del personal adiestrado, de los equipos adecuados y que los productos o mezclas de productos y los métodos que utilicen sean los aprobados por el Ministerio, asegurando la protección de su personal.

Artículo 333.—La autorización que el Ministerio conceda durará un año al cabo del cual los interesados podrán renovarla, salvo que las infracciones que hayan cometido o accidentes repetidos ameriten la cancelación de ésta en cualquier tiempo.

Artículo 334.—Toda persona, queda obligada a permitir la entrada de los funcionarios de salud debidamente identificados a su domicilio o edificio de su propiedad o cuidado, para verificar si hay animales nocivos, o condiciones para su reproducción y persistencia, o para proceder a su exterminio si los hubiere.

Queda asimismo obligada, al cumplimiento de las prácticas o a la ejecución de las obras que el Ministerio ordene para evitar la presencia y persistencia de especímenes nocivos.

Artículo 335.—Todo propietario o administrador de fincas agropecuarias en zonas rurales deberá disponer de suero antiofídico en la forma y condiciones que determine el Ministerio.

Artículo 336.—Toda persona queda obligada a obtener el correspondiente permiso del Ministerio para mantener viveros o criaderos de animales con fines experimentales o científicos o para cualquier otro propósito para lo cual deberá acreditar que el local dispone de condiciones sanitarias y de seguridad adecuadas.

MINISTERIO DE SALUD

DIRECCION GENERAL DE SALUD
DIVISION DE SANEAMIENTO AMBIENTAL
DEPARTAMENTO DE CONTAMINACION INDUSTRIAL

1.0.0 INFORMACION GENERAL

1.1.0 [ ] 1.2.0 FECHA INICIAL ____________

FECHA FINAL ____________

1.3.0 RAZON SOCIAL ____________

1.3.1 ESTABLECIMIENTO ____________

1.3.2 TIPO DE ACTIVIDAD ____________

1.4.0 VISITADO POR ____________ 1.4.1 REV. ____________

1.5.0 LOCALIZACION DE LA PLANTA

PROV. ____________ CANTON ____________ DISTRITO ____________

CALLES ____________ AVENIDAS ____________ BARRIO ____________

OTRAS SEÑAS ____________

1.5.1 DIRECCION OFICINA PRINCIPAL ____________

APARTADO ____________ TELEFONO ____________

1.6.0 RAZON SOCIAL ANTERIOR ____________

1.6.1 FECHA DE INICIACION DE ACTIVIDADES ____________

1.6.2 PERMISO ____________ 1.6.3 OFICINA ____________

1.7.0 ATENCION EN FABRICA ____________

1.8.0 PERSONAL

	HOMBRES	MUJERES	TOTAL
OFICINAS			
FABRICA			
TOTALES			

1.8.1 TURNOS ____________

1.8.2 HORARIOS ____________

1.8.3 OBREROS POR TURNO ____________

2.0.0 DATOS SOBRE EL EDIFICIO

2.1.1 TIPO DE CONSTRUCCION ____________

	B	D
2.1.2 DISTRIBUCION DE MAQUINARIA		
2.1.3 DISTRIB. DE OPERACIONES Y PROCESOS.		
2.1.4 HACINAMIENTO	SI	NO

3.0.0 DESCRIPCION DEL PROCESO Y OPERACIONES

____

3.1.0 MATERIAS PRIMAS, SUBPRODUCTOS Y PRODUCTOS FINALES

____

Table A.8: Health Ministry Industrial Pollution Format

Source: Ministerio de Salud, Formatos de Contaminacion Ambiental Industrial, San Jose, Costa Rica, 1980

5.7.4 EQUIPO PARA TRANSPORTE ____________________

5.7.5 EQUIPO DE PRESION ____________________

5.7.6 HERRAMIENTAS ____________________

5.7.7 OTRAS PRACTICAS Y CONDICIONES INSEGURAS ____________________

5.8.0 PROTECCION PERSONAL

	SUFICIENTES		SUFICIENTES		SUFICIENTES
CASCOS	☐	RESPIRADOR	☐	PROT. AUDITIVA	☐
ANTEOJOS	☐	ROPA	☐	OTRAS	☐
GUANTES	☐	ZAPATOS	☐		☐

5.9.0 OBSERVACIONES ____________________

6.0.0 FACILIDADES SANITARIAS

6.1.0 ABASTECIMIENTO DE AGUA

	POTAB.	IND.
PUBLICO	☐	☐
POZO	☐	☐
SUPERFICIAL	☐	☐
OTROS	☐	☐

6.2.0 SERVICIOS SANITARIOS

	NOR.	SUF.		HAY
LLAVES	☐	☐	AGUA CAL.	☐
ORINAL	☐	☐	JABON	☐
INODORO	☐	☐	TOALLAS	☐
DUCHA	☐	☐	VESTIDOR	☐

6.2.1 CONDICION DE LOS SERVICIOS

EXCELENTES ____________________

BUENOS ____________________

DEFICIENTES ____________________

6.3.0 COMENTARIOS ______________________________

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____

____

6.4.0 RED DE DESAGUES INDUSTRIALES

PUBLICO ☐
PRIVADO ☐
NINGUNO ☐

6.5.0 TRATAM. DESECHOS LIQUIDOS INDUSTRIALES

T. SEPTICO ☐
PRE TRATAM ☐
PLANTA TRAT. ☐
NINGUNO ☐

6.5.1 DESTINO

CLOACA ☐
PLUVIAL ☐
INFILTRAC ☐
C. SUPER ☐

6.6.0 TRATAMIENTO DE ALBAÑALES

CLOACA ☐
T. SEPTICO ☐
P. TRATAMIENTO ☐
NINGUNO ☐

6.7.0 ELIMINACION DE RESIDUOS SOLIDOS INDUSTRIALES

	ENT.	INCI.	VAC.	S.MU	CLOA.	VENT.	TRAT.	OTROS
ORGANICO	☐	☐	☐	☐	☐	☐	☐	☐
INORGANICO	☐	☐	☐	☐	☐	☐	☐	☐

7.0.0 EXAMENES MEDICOS

7.1.0 TIPO DE EXAMENES

	ING.	EOR.	PER.	ESPEC.
CLINICOS	☐	☐	☐	☐
RAYOS X	☐	☐	☐	☐
LABORATORIO	☐	☐	☐	☐
OTROS	☐	☐	☐	☐

7.2.0 ATENCION EN PLANTA

	TEMP.	PERM.
MEDICO	☐	☐
DENTISTA	☐	☐
MICROBIOLOGO	☐	☐
ENFERMERA	☐	☐

7.3.0 INSTALACIONES

	CON.	INC.
BOTIQUIN	☐	☐

ENFERMERIA ______________________________

DISPENSARIO ______________________________

7.4.0 COMENTARIOS ______________________________

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8.0.0 CONCLUSIONES Y RECOMENDACIONES DE LA INSPECCION

9.0.0 SEGUIMIENTOS (NUMEROS Y FECHAS DE LAS VISITAS)

10.00 GRADOS DE CUMPLIMIENTO

11.00 PROCESO ADMINISTRATIVO

12.00 CALIFICACION

MINISTERIO DE SALUD
DIVISION DE SANEAMIENTO AMBIENTAL
DEPARTAMENTO DE CONTAMINACION INDUSTRIAL
REGISTRO DE FUENTES DE CONTAMINACION ATMOSFERICA

C.I.U. [ ] FORMULARIO DSA 01

RAZON SOCIAL DE LA INDUSTRIA O ESTABLECIMIENTO ____________

PROVINCIA ________ CANTON ________ DIRECCION ________ TEL ________ AÑO ________

1- NUMERO DE EMPLEADOS		5- MATERIA PRIMA CONSUMIDA			6- INFORMACION SOBRE EMISIONES								
MAXIMO ___ MEDIO ___ MINIMO ___		PRODUCTO	CANT./AÑO	UNIDAD MEDIDA	No. DE PUNTOS	1	2	3	4	5	6	7	8
2- TURNOS DE TRABAJO					FORMA								
No. DE TURNOS/DIA					ALTURA (M)								
HORAS FTO /DIA					VOL. GASES DE SALIDA M^3/MIN.								
DIAS FTO /SEMANA					TEMPERATURA SALIDA DE GASES °C								
SEMANAS FTO/AÑO					HUMEDAD GASES DE SALIDA %								
3- AREA OCUPADA					CONCENT. DE PARTICULAS (MICROG/M^3)								
AREA	M2				CONCENT DE SO_2 (MICROG/M^3)								
TOTAL CONSTRUIDO Y LIB.					CHIMENEA: DIAMETRO (CIRCULAR)								
CONSTRUIDA					CHIMENEA: SECCION ANCHO								
DISPONIBLE PARA EQUIP. CONTR					CHIMENEA: LARGO								

4- INFORMACION SOBRE COMBUSTIBLES UTILIZADOS						7- PRODUCTOS ELABORADOS			8- INFORMACION SOBRE EQUIPO DE CONTROL	
CLASE DE COMBUSTIBLE	KILOCAL/KILOGRAMO	CANTIDAD POR AÑO	UNIDAD DE MEDIDA	CONTENIDO DE AZUFRE %	CONTENIDO DE CENIZAS %	PRODUCTO	CANT./AÑO	UNIDAD DE MEDIDA	TIPO	EFICIENCIA %

OBSERVACIONES ____________

FIRMA Y CEDULA DEL REPRESENTANTE LEGAL ____________

Table A.9: HEALTH MINISTRY AIR POLLUTION SOURCE RECORD'S FORMAT

Source: Ministerio de Salud, Record de Fuentes de Contaminacion de Aire, San Jose, Costa Rica, 1980

R E G L A M E N T O

S O B R E

H I G I E N E   I N D U S T R I A L

Decreto N°3 del Poder Ejecutivo

del 11 de Julio de 1945

(Actualizado a Octubre de 1979)
DSA

Table A.10: Hygiene and Safety General Regulations of Costa Rica

Source: Ministerio de Salud, _Hygiene and Safety General Regulations of Costa Rica_, San Jose, Costa Rica, 1979

REGLAMENTO SOBRE HIGIENE INDUSTRIAL

Artículo 1° - Se considera bajo la denominación de establecimientos industriales, los locales destinados a cubierto o a descubierto, a la manipulación, transformación o utilización de productos naturales o artificiales, mediante tratamiento adecuado físico, químico, biológico, ya sea por medio de aplicación de maquinaria, instrumentos, o sin ellos.

Comprende también los sitios destinados a recibir o almacenar los utensilios de labor, los materiales que serán tratados o estén en laboración o sus productos; y todos los anexos de las fábricas o talleres que pongan o puedan poner en peligro la salud de los trabajadores y de los vecinos.

Artículo 2° - Los establecimientos industriales se clasifican en :

a) Inofensivos; b) Incómodos; c) Insalubres; y d) Peligrosos.

Artículo 3°- Se consideran como inofensivos los establecimientos industriales que no causen ni puedan causar, daños o molestias al vecindario, o a las personas que en ellos trabajan.

Estos establecimientos pueden instalarse en sitios poblados

Artículo 4°- Se denominan incómodos los establecimientos industriales que sin ser insalubres ni peligrosos por sí mismos, causen incomodidad manifiesta al vecindario, o a las personas que en ellos trabajen, por ruidos, trepidación, humos arrojados por las chimeneas o malos olores.

Esta clase de establecimientos podrán ubicarse en lugares poblados siempre que, sin detrimento de las condiciones higiénicas de los locales de trabajo, se supriman estos inconvenientes. De no ser así, sólo podrán establecerse en las zonas que indique el Departamento de Ingeniería Sanitaria.

Artículo 5° - Los establecimientos industriales y sus dependencias, pueden ser incómodos por la producción de sonidos, trepidaciones, cambios sensibles de temperatura, luces, polvo, chispas, humo, vapores.

Artículo 6° - Son incómodos por sonidos, cuando se perciben aquellos en las habitaciones vecinas con una intensidad mayor de sesenta y cinco decibeles de las ocho a las dieciocho horas, y mayor de treinta decibeles en el resto del día.

Artículo 7°- Son incómodos por trepidaciones cuando éstas se trasmiten a las habitaciones vecinas.

Artículo 8°- Son incómodos por cambios sensibles de temperatura, cuando modifican la de las habitaciones vecinas.

Artículo 9°- Son incómodos por luces, cuando siendo éstas constantes o intermitentes, iluminan el interior de las habitaciones vecinas.

Artículo 10°-Son incómodos por polvo, chipas, humo o vapores, cuando éstos penetran en las habitaciones vecinas o ensucian sus muros o techos.

Artículo 11°- Son incómodos por malos olores, cuando éstos invaden las habitaciones vecinas.

Artículo 12°- Las autoridades encargadas de velar por el orden público no permitirán que se causen a los vecinos las incomodidades a que aluden los artículos anteriores, y cuando ocurra cualquiera de esas molestias la harán cesar inmediatamente,por propia autoridad, sin perjuicio de reportarla al Departamento de Ingeniería Sanitaria y a la Agencia Principal de Policía Sanitaria respectiva, a efecto de que se dicten las medidas pertinentes y se proceda al respectivo juzgamiento, si fuere el caso.

Artículo 13°- Para evitar las molestias por l Departamento de Ingeniería Sanitaria ordenará que se adopten algunas de las siguientes medidas, en el establecimiento de que se trate:

a) Separar el establecimiento de las habitaciones vecinas por dobles muros, distantes entre sí diez centímetros cuando menos, para que medie entre ambos una cámara de aire. En casos especiales, cuando no pueda mediar cámara de aire, el Departamento de Ingeniería Sanitaria aceptará que se revista la superficie interior del muro del edificio, con material aislante y absorbente;

b) Construir los techos de material aislante o absorbente, sin dejar entre ellos y los muros espacios libres;

c) Instalar las máquinas bien cimentadas, niveladas, ajustadas y lubricadas;

d) Sustituir las grapas de las bandas, por correas o por cualquier otro dispositivo que impida el producido por aquéllas;

e) Proveer de llantas de hule a los vehículos usados dentro de los establecimientos; y

f) Disponer que las trasmisiones no se apoyen en las paredes colindantes, ni en otras que puedan trasmitir el a las habitaciones vecinas.

Artículo 14°- A fin de evitar las molestias por trepidaciones, el Departamento de Ingeniería Sanitaria ordenará que se adopten algunas o todas las medidas siguientes:

a) Que la cimentación de las máquinas no está ligada a la cimentación general de la construcción. En casos necesarios, se exigirá cimentaciones especiales sobre material aislante;

b) Que se excaven capas de veinte centímetros como mínimo, bajo el nivel de la línea de cimentación de las máquinas y se llenen aquéllas con material aislante de ; y

c) Que las flechas no se apoyen en los muros colindantes ni en otros que puedan trasmitir la trepidación a las habitaciones vecinas.

Artículo 15°- En los establecimientos incómodos por cambios sensibles de temperatura, los aparatos caloríficos o frigoríficos estarán separados de los muros colindantes por la distancia que fije en cada caso el Departamento de Ingeniería Sanitaria, y de no ser suficiente este alejamiento, se revestirá el muro colindantes o el aparato, con material aislante del calor. .

Artículo 16°- Para la construcción de un horno, hornillo o fragua, en un edificio, será indispensable el establecimiento de un contramuro, con espacio vacío intermedio entre aquél y el muro de separación en otra propiedad. El espesor del contramuro no será menor de catorce centímetros. El espacio vacío deberá acondicionarse de modo que circule por él libremente el aire, y tendrá sesenta centímetros de ancho como mínimo.

Artículo 17°- En los establecimientos incómodos por luces, el trabajo deberá efectuarse en los locales cerrados, cuyos claros de iluminación están provistos de vidrios despulidos.

En los trabajos efectuados en la vía pública con el arco voltaico para soldadura eléctrica o con sopletes, deberán adoptarse las precauciones necesarias para evitar los deslumbramientos.

Artículo 18°- El aire expulsado de establecimientos industriales que produzcan polvo deberá:

) No contener más de trescientos millones de partículas por metro cúbico, siempre que éstas no contengan más de cuarenta por ciento de sílice; y

) En casos especiales será sometido a los tratamientos sanitarios que determine el Departamento de Ingeniería Sanitaria.

Artículo 19°- Los establecimientos incómodos por humos o chispas se sujetarán a las siguientes disposiciones:

Los aparatos de combustión estarán provistos de implementos y accesorios suficientes para que la combustión sea completa. Además, tendrán chimeneas construídas hasta una altura de cinco metros, cuando menos, superior a la del edificio vecino más alto, en un radio de diez metros como mínimo, y tendrán en su extremidad superior rejillas de alambre o cedazo, con el fin de evitar la salida de los cuerpos en ignición. Tendrán igualmente un dispositivo para que las partículas detenidas bajen por conductos cerrados a cajas colectoras. Cuando se construyan edificios más altos con posterioridad, se levantarán proporcionalmente la altura de la chimenea.

Artículo 20°- Los establecimientos incómodos por vapores usarán de procedimientos adecuados para condensarlos o evitarlos.

Artículo 21°- Para evitar malos olores, se mantendrá escrupulosa limpieza en los establecimientos; se usarán procedimientos que eviten las fermentaciones pútreas y en casos necesarios, se usarán deodorizantes, campanas y chimeneas.

Los materiales mal olientes, serán almacenados en recintos herméticamente cerrados.

Artículo 22°- El Departamento de Ingeniería Sanitaria velará por que se tomen las medidas especificadas, para evitar molestias a los vecinos o al público. Cuando el propietario rehuse ponerlas en práctica o cuando a pesar de su empleo no desaparezca la molestia, el Departamento de Ingeniería Sanitaria recomendará a la autoridad competente la clausura del establecimiento que la produzca.

Artículo 23°- Se entienden por insalubres los establecimientos industriales que puedan originar, por la naturaleza de los trabajos que allí se desarrollen, condiciones capaces de amenazar o dañar la salud de los trabajadores o del vecindario, debido a los materiales empleados, elaborados, desprendidos o de desecho. Estos establecimientos se situarán fuera de los lugares poblados y en los sitios que determine el Departamento de Ingeniería Sanitaria.

Artículo 24°- Cuando las sustancias desprendidas en forma de polvo o gases, puedan dañar la salud de los trabajadores o de los vecinos, será requisito indispensable tratar en forma adecuada dichas sustancias, antes de lanzarlas al exterior.

Artículo 25°- Se prohibe dar curso libre a las aguas residuales de desecho industrial cuando sean perjudiciales a la salud del hombre o de los animales, o cuando, por su composición química o por su temperatura, ataquen el sistema de atarjeas establecido o cuando perjudiquen las tierras destinadas a la agricultura o la ganadería.

Los demás desechos industriales deberán ser alejados de tal manera que no perjudiquen la salud o los intereses de terceras personas.

Artículo 26°- En las zonas señaladas para industrias insalubres, no se permitirán habitaciones vecinas en un radio de doscientos metros.

Artículo 27 - Se tendrán como peligrosos los establecimientos industriales que dañen o puedan dañar de modo inmediato y grave la vida de los trabajadores, que en ellos laboren, o del vecindario, ya sea por la naturaleza de lo trabajos allí desarrollados, o de los materiales empleados, elaborados, desprendidos o de desecho, o de cualquier otra naturaleza; o por el almacenamiento d sustancias tóxicas, corrosivas, inflamantes o explosivas.

Estos establecimientos, cuando constituyan un peligro para el vecindari se situarán por lo menos a un kilómetro de los sitios poblados o a la distanc: que señale el Departamento de Ingeniería Sanitaria, de acuerdo con la magnitud del peligro que considere existente.

Artículo 28°- El Departamento de Ingeniería Sanitaria hará, de acuerdo co los artículos anteriores, la clasificación de todos los establecimientos indust: les.

Artículo 29°- De acuerdo con lo dispuesto en el artículo 296 del Código Sanitario, en lo sucesivo no se concederá permiso para instalar ni trasladar- en los lugares poblados-aserraderos; carrocerías, herrerías, talleres de mecánica, de fundición, de vulcanización u otros similares; ni las demás industrias que puedan estimarse comprendidas en dicho texto, a menos que supriman los inconvenientes o molestias que originan.

Artículo 30°- Sin perjuicio de los preceptuado en el artículo anterior, para instalar establecimientos industriales o trasladar los existentes, deberá presentarse la solicitud respectiva ante el Departamento de Ingeniería

A la solicitud deberá acompañarse:

a) Certificación de la autoridad sanitaria correspondiente, de que en el lugar señalado para la instalación, existen servicios de agua potable; y

b) Dos ejemplares del plano del establecimiento, los cuales deberán contener:

1- La planta de los distintos pisos del edificio con especificación clara del destino de cada pieza, señalando los espacios descubiertos, así como las instalaciones sanitarias, tuberías de agua potable, llaves de servicio, cajas de registro, tanques lavadores, excusados, mingitorios, baños, lavabos, y en general todos aquellos detalles que puedan contribuir a la mejor apreciación de las condiciones sanitarias y de trabajo del establecimiento.

2- Los linderos del predio, con indicación de los nombres de los propietarios de las fincas vecinas y los demás datos que permitan precisar la situación del lugar elegido.

3- Clase de industria que se va a establecer.

4- Departamentos que va a contener el edificio, con sus denominaciones

5- Cuando sea necesario la iluminación artificial, se indicará la naturaleza, situación e intensidad de los focos luminosos.

6- Sitios que ocuperán las máquinas, motores, generadores y calderas, especificando detalladamente la cantidad o número de ellas y las características de trabajo de cada una.

Artículo 31° - Todo establecimiento industrial debe llenar los siguientes requisitos:

a) Los pisos de las salas de trabajo y de los patios, deben ser en general de material impermeable, con la inclinación y canalización suficientes para facilitar el escurrimiento de los líquidos. Cuando por, la extensión de los patios no sea posible su impermeabilidad total, se cubrirán parcialmente con césped u otro medio higiénico a juicio del Departamento de Ingeniería Sanitaria;

b) La superficie del piso de las salas de trabajo, nunca será inferior a dos metros cuadrados libres para cada trabajador;

c) La altura del local que ocupen los trabajadores, no será inferior a dos metros cincuenta centímetros pudiendo, en casos especiales admitirse una altura de dos metros como mínimo, siempre que a juicio del Departamento de Ingeniería Sanitaria, quede compensada la falta de altura por medios artificiales de ventilación e iluminación.

d) Los muros deberán tener superficie lisa e impermeable hasta una altura de dos metros, en los locales de los establecimientos industriales que haya humedad, y en los que, a juicio del Departamento de Ingeniería Sanitaria deban impermeabilizarse;

e) Los techos serán impermeables y malos conductores del calor cuando no llenen este requisito, queda a juicio del Departamento de Ingeniería Sanitaria, exigir algún medio que evite los cambios bruscos de temperatura del ambiente del establecimiento; y

f) Los muros, paredes y techos de salas de trabajo deberán ser pintados regularmente en tonos claros y mates.

Artículo 32 °- Cualquier cambio posterior a las condiciones de trabajo o de sanidad del establecimiento, o en la instalación o naturaleza del trabajo de las máquinás, o del número de unidades, deberá hacerse previa autorización del Departamento de Ingeniería Sanitaria. La infracción de esta disposición será sancionada con la clausura inmediata del establecimiento en referencia, previa información suma ria que levantará la autoridad competente. No se podrán instalar o acondicionar establecimientos industriales en los cuales no se hayan adoptado las medidas sanitarias pertinentes para prevenir o atenuar los inconvenientes o los peligros que éstos puedan ocasionar a los trabajadores o a los vecinos.

Artículo 33 ° - Una vez aprobados los planos y hecha la clasificación por el Departamento de Ingeniería Sabitaria, el interesado recibirá una autorización para instalar su establecimiento industrial, la cual deberá presentar a la Municipalidad del cantón correspondiente a efecto de obtener la patente respectiva.

Artículo 34°- La clasificación y circunstancias referidas serán válidas por un año. Anualmente, cada dueño o administrador del establecimiento industrial debe hacer una solicitud de revisión al Departamento de Ingeniería Sanitaria, con el objeto de obtener el visto bueno correspondiente.

Artículo 35°- Los servicios de agua de todo establecimiento industrial deberán ser permanentes, de modo que en cualquier momento se obtenga la cantidad suficiente de agua a presión de todas las llaves para las necesidades de su personal.

Artículo 36 °- La provisión de agua para uso industrial debe ser potable, cuando la naturaleza de la industria así lo requiera. Cuando el agua para el uso industrial no sea potable, deberá distribuirse por un sistema de tuberías totalmente independiente de la cañería potable, marcado con colores distintos cada sistema de distribución.

Artículo 37 °- Los locales destinados a excusados, mingitorios o baños, deben tener piso de mosaico o de cualquier otro material impermeable. Los muros o tabiques serán también de revestimiento impermeable, hasta una altura de dos metros; y su altura total mínima libre, será de dos metros cincuenta centímetros.

Artículo 38 °- En aquellas localidades donde esté instalado el servicio de cloacas, todos los establecimientos industriales deberán tener sus servicios sanitarios conectados al ramal general de cloacas y provistos de suficiente papel higiénico para el servicio.

Artículo 39°- Los locales donde queden instalados los servicios sanitarios, tendrán ventanas a la calle o a los patios de los edificios; o estarán provistos de un sistema artificial de ventilación que renueve el aire suficientemente. Esta centilación será independiente de los sistemas que sirven para el resto del establecimiento.

Artículo 40 °- Los excusados deberán estar en proporción de uno por cada veinte trabajadores en turno o fracción, y mingitorios en la proporción de uno por cada veinte trabajadores en turno o fracción.

Artículo 41°- Cuando en un establecimiento industrial trabajen simultáneamente hombres y mujeres, habrá servicios sanitarios separados para cada sexo, siempre que el personal exceda de diez individuos.

Artículo 42°- Todo establecimiento industrial deberá tener lavabos con servicio de agua corriente, a razón de uno por cada veinticinco trabajadores en turno; jabón suficiente y toallas de papel o secadores de aire caliente.

Artículo 43°- El Departamento de Ingeniería Sanitaria indicará los casos en que deban instalarse baños de regadera, en número suficiente para el servicio de los trabajadores.

Artículo 44 °- Toda sala de trabajo deberá tener una cubicación mínima interior de seis metros cúbicos libres, para cada trabajador.

Cuando está provista de ventilación mecánica activa, dicha cubicación podrá reducirse a juicio del Departamento de Ingeniería Sanitaria, pero no podrá ser menor de cuatro metros cúbicos por persona.

Artículo 45°- Los locales de trabajo deben reunir las condiciones necesarias para mantener en el interior, durante las horas de labor, por medio de sistemas adecuados, una temperatura que no sea perjucicial para la salud de los trabajadores.

Artículo 46°- En los locales en que, por razones de la producción y la técnica empleada, fuere necesario mantener cerradas las puertas y ventanas - durante el trabajo, se instalará un sistema de ventilación artificial que asegure la renovación del aire.

Artículo 47 °- Cuando se emplee chimenea en los dispositivos para lograr la renovación del aire, la extremidad superior deberá alcanzar una altura suficiente para asegurar su tiro; no podrá ser menor de tres metros en un radio de diez, sobre las azoteas o techos vecinos.

Artículo 48°- Para la iluminación diurna de los talleres y salas de trabajo, se dará preferencia a la luz difusa, la que penetrará por tragaluces o ventanas, cuya superficie total será lo suficiente para obtener la iluminación necesaria.

Artículo 49°- Cuando no sea posible iluminar total y suficientemente las salas con luz natural, se empleará la artificial eléctrica, hasta obtener la intensidad indispensable para el trabajo que se ejecute; se exigirá la autorización del Departamento de Ingeniería Sanitaria, para usar otro procedimiento de iluminación.

Artículo 50°- La limpieza de los locales de trabajo debe hacerse diariamente, de preferencia fuera de las horas de labor. Cuando no existan períodos de descanso por sucesión inmediata de turnos, se permitirá el aseo de los talleres en horas de trabajo, siempre que para hacerlo se empleen equipos que no permitan el levantamiento de polvo hacia la atmósfera respirable.

Artículo 51 °- Las basuras y desperdicios de los establecimientos industriales serán incinerados o evacuados diariamente, y mientras tanto, sólo podrán permanecer en recipientes metálicos de cierre hermético. Cuando sean aprovechables para usos industriales, podrán permanecer más tiempo en el establecimiento, en los recipientes referidos o en aposentos que cierren herméticamente.

Artículo 52 °- Los locales donde se trabaje a altas temperaturas, están provistos de sistemas adecuados de ventilación, a fin de renovar suficientemente el aire para bajar la temperatura hasta un límite que no perjudique la salud de los trabajadores.

Artículo 53 °- Los locales de trabajo que tengan pisos fríos o húmedos, deberán tener rejillas de madera fácilmente movilizables, o cualquier otro medio adecuado para la protección de los trabajadores.

Artículo 54 ° En las industrias en que, por la iluminación muy intensa o que por cualquier otra causa haya amenaza de daño para la vista de los trabajadores, se proveerá a éstos de medios adecuados para evitarlo.

Artículo 55 °- En las industrias que se produzcan ruidos muy intensos, se tomarán las medidas que el Departamento de Ingeniería Sanitaria determine para la protección de los trabajadores.

Artículo 56°- En las industrias en que se manejen sustancias cáusticas, tóxicas, irritantes o infectantes, se tomarán las medidas que el Departamento de Ingeniería Sanitaria juzque necesario para evitar los perjucios que puedan ocasionar.

Artículo 57 °- Es prohibida la entrada a los establecimientos industriales de los trabajadores en estado de embriaguez, o bajo la acción de drogas enervantes. En caso de existir duda sobre el estado del trabajador, se consultará al Médico Oficial o a cualquier otro facultativo en caso de urgencia, debiendo extender el certificado correspondiente.

Artículo 58°- Se prohibe terminantemente la introducción y uso de bebidas embriagantes en los lugares de trabajo.

Artículo 59 °- Es prohibido comer en los talleres; cuando las necesidades de la industria obliguen a los trabajadoras a tomar alimentos dentro del establecimiento, lo harán en sitios especiales, acondicionados al efecto.

Artículo 60 °- No se permitirá que los trabajadores a los particulares duerman en los establecimientos industriales, salvo cuando el Departamento de Ingeniería Sa nitaria lo autorice expresamente por estimar que no hay perjuicio para la salud de las personas.

Artículo 61 °- Los aparatos de combustión tendrán chimeneas construidas hasta una altura de cinco metros cuando menos, por encima del edificio vecino de mayor altura que se encuentre en un radio de seis metros, y terminarán por un tubo de hierro que tenga en su extremidad una rejilla de alambre, con el fin de evitar la salida de cuerpos en ignición.

Artículo 62 °- Los polvos, gases, vapores humos irritantes, tóxicos, así como los olores molestos, no deberán ser expulsados al exterior, sino después de haber sido tratados en forma adecuada, de acuerdo con las indicaciones que al respecto fije el Departamento de Ingeniería Sanitaria.

Artículo 63 °- En toda industria cuyas maquinarias, motores, aparatos o instrumentos den lugar a ruidos o a trepidaciones molestas para los vecinos de emplearán los aisladores necesarios a fin de suprimirlos o amortiguarlos notoriamente.

Artículo 64° - Es prohibido en los establecimientos industriales, el trabajo después de las dieciocho horas y antes de las seis horas, cuando produzcan ruidos molestos para el vecindario.

Artículo 65° - Es obligatorio en todos los establecimientos industriales, poner en lugar visible de las salas de trabajo leyendas certelones, cuyos asuntos se refieran a la prevención de enfermedades especialmente de las venéreas, previamente aprobados por la Secretaría de Salubridad Pública y Protección Social. Asimismo están obligados a fijar y cuidar de la conservación de un ejemplar de este Reglamento.

Artículo 66°- La Secretaría de Salubridad Pública y Protección Social, indicará los casos en que las industrias deben instalar Salas de Maternidad o Salas-Cuna, para que las trabajadoras amamanten a sus hijos.

Artículo 67°- El Departamento de Ingeniería Sanitaria puede ordenar, en cualquier tiempo que se ejecute o adopte cualquier medida sanitaria en los establecimientos industriales, para prevenir o atenuar los inconvenientes o peligros a que éstos puedan dar lugar en perjuicio de los trabajadores o de los vecinos, y los dueños, administradores o encargados, tienen la obligación de acatar dicha orden dentro de los términos que al efecto se diga.

Artículo 68° - En cuanto a las horas de labor personal y a las condiciones de higiene y de seguridad en el trabajo, se estará, a falta de previsión concreta en este Reglamento, a lo dispuesto sobre el particular por el Código de Trabajo, que también regirá en lo concerniente a la edad y sexo de los trabajadores.

Artículo 69 °- No se permitirá en un radio de doscientos metros a la redonda de una industria establecida fuera de poblado, ya sea por haber sido ésta clasificada por incómoda, insalubre o peligrosa, la construcción de ninguna vivienda.

Artículo 70° - Toda infracción a las disposiciones de este Reglamento, será sancionado de acuerdo con el artículo 462 del Código Sanitario, con multa de dos a trescientos sesenta colones o arresto de uno a ciento ochenta días, o ambas penas, sin perjuicio de que las autoridades competentes ordenen la suspensión del trabajo o la clausura inmediata de los establecimientos industriales, cuando así lo exijan los interesados de la salubridad pública, o no se observen en ellos las disposiciones de este Reglamento, previo informe del Departamento de Ingeniería Sanitaria.

Artículo 71 °- Los establecimientos industriales que sean clausurados por incurrir en una o más de las causales que señala este Reglamento, podrán reanudar su actividad, si corrigen al o los motivos que originaron su cierre, previa comprobación de los correctivos y su resultado practicada por el Departamento de Ingeniería Sanitaria.

Dado en la Casa Presidencial-San José, a los dieciocho días del mes de mayo de mil novecientos cuarenta y cinco

TEODORO PICADO

El Secretario de Estado en el Despacho
de Salubridad Pública y Protección Social
Solón Núñez

ANEXO 1

EVALUACION DE RUIDOS POR EL ESCAPE DE LOS VEHICULOS AUTOMOTORES

1.—Propósito:

El presente método define el procedimiento para verificar que cualquier vehículo automotor no emita con su escape, ruidos por encima de los niveles admisibles.

2.—Alcance:

El método propuesto será aplicado a todos los vehículos automotores, debiendo cumplir los valores indicados en este anexo, según modelo y tipo correspondiente.

3.1 Condiciones de prueba:

3.—Método de pruebas:

3.1—Condiciones de prueba:

La prueba se realiza en un ambiente acústico según se indica en el párrafo 3.1.1 con el vehículo detenido y el motor en marcha, según 3.1.2.

3.1.1. Ambiente acústico:

El nivel de ruido, incluyendo vientos, debe ser tal que la lectura en el medidor sea como mínimo 10 dB (A) menor que la producida por el escape del vehículo en prueba. El lugar de prueba debe ser a cielo abierto y libre de obstáculos en un radio mínimo de 2 metros alrededor del punto de medición con suelo pavimentado de hormigón, asfalto o material de alto poder reflectante.

El vehículo debe ubicarse a no menos de 1 metro del cordón de la acera, si la hubiera.

3.1.2. Condiciones del vehículo:

El vehículo debe estar detenido y su motor en marcha a la temperatura estabilizada de funcionamiento. Si el vehículo está equipado con cualquier dispositivo o aparato especial como: acondicionador de aire, mezclador de cemento, compresor, bomba, etc., éstos no deberán hallarse en funcionamiento durante la prueba.

3.2 Método de medición:

a) Vehículos equipados con motor de ignición, por chispa o que funcione con gasolina.

El motor se acelera en vacío a un régimen igual a las 3/4 partes número de revoluciones por minuto a las que desarrolla su potencia máxima. (Dato del fabricante).

Este régimen debe mantenerse constante midiendo con un instrumento cuya tolerancia sea inferior al 3% y tan pronto como sea posible se suelta el acelerador.

La medición se efectúa en el período comprendido entre el instante en que se alcanza el número de revoluciones anteriormente especi-

Table A.11: Costa Rica Noise Regulations

Source: Ministerio de Obras Publicas y Transportas, Noise Regulations, San Jose, Costa Rica, 1982 ficadas y el correspondiente al ralenti.

Se toma el mayor valor obtenido durante dicho período.

Para vehículos de los cuales no se dispone el dato del número de revoluciones de máxima potencia, por ser de fabricación descontinuada, de poca importancia, etc., se adopta el número de revoluciones por minuto según la siguiente tabla:

8 cilindros	3000 rpm ± 100 rpm
6 cilindros	3200 rpm ± 100 rpm
4 cilindros	3400 rpm ± 100 rpm
3 cilindros	3500 rpm ± 100 rpm
2 y 1 cilindros	3800 rpm ± 100 rpm

b) Vehículos equipados con motor diesel:

El motor se acelera en vacío hasta el número de revoluciones por minuto que indica la tabla siguiente:

n = 1/2 S	si S >	5000 rpm
n = 3/4	si S <	5000 rpm

Siendo S el número de revoluciones a lo cual el motor entrega su máxima potencia.

3.2.1. Posición de la medición:

3.2.1.1. El micrófono del medidor se ubica en el plano horizontal que pasa por la salida del escape, con un ángulo de 45° ± 10° a partir de la proyección horizontal del último tramo del mismo hacia el lateral más próximo, salvo el caso en que la posición simétrica evite interferencias o reflexiones y a una distancia de 1,00 m ± 0,05m. Si el medidor es del tipo de micrófono integrado, éste debe disponer de un soporte adecuado para su correcta localización.

3.2.1.2. En caso de que la salida del escape fuera vertical hacia arriba, la medición se efectúa a la distancia de 1,00 m ± 0,05 m en el plano horizontal que pasa por la boca de salida.

3.2.1.3. Si elementos del vehículo impiden la ubicación del micrófono de acuerdo a los párrafos anteriores, debe colocárselo en la posición más próxima posible a la indicada.

3.2.1.4. En caso de escape con dos salidas distantes a menos de 0,30 m entre ellas, ambas partiendo de un mismo silenciador, se efectuará una sola medición y desde el lateral más próximo.

En el caso de dos o más salidas dispuestas a una distancia mayor de 0,30 m, se efectúa la medición en cada una de ellas y se registra la que emite el nivel más alto.

3.2.2. Número de mediciones:

Se efectúan 3 mediciones a intervalos no menores de 10 segundos. La diferencia entre las lecturas no debe exceder los 2 dB (a), en caso contrario, se repiten las mediciones hasta obtener tres valores consecutivos que tengan una dispersión menos de 2 dB (A).

3.3. Instrumental de medición sonora:

El medidor de nivel sonoro debe cumplir con normas aceptadas internacionalmente. Se emplea en la curva de ponderación "A" y en respuesta "Rápida".

Si el medidor de nivel sonoro tiene retención de nivel máximo, el modo de respuesta en ese caso debe ser tal que, el valor máximo corresponda con el obtenido con la aplicación descrita en el primer párrafo.

El medidor debe calibrarse antes de cada período de medición.

3.4. **Registro de los resultados:**
El nivel de ruido considerado es el valor más alto de las 3 lecturas válidas según 3.2.2.

II.—Uso de dispositivos de señal sonora:

Todo vehículo debe estar provisto de un equipo de señal sonora, tipo claxon o bocina, cuyo sonido puede producirse en no más de dos tonos, de acción simultánea, que no resulte estridente ni prolongado y pueda ser escuchado en condiciones climáticas normales, a campo libre, de acuerdo a los siguientes niveles máximos de sonoridad tolerables:

a) En vehículos particulares, de carga y/o de transporte remunerado de personas, el nivel debe hallarse entre 105 dB (A) y 118 dB (A), con el sonómetro ubicado a dos metros del vehículo;

b) En las motocicletas de cualquier tipo, el nivel debe hallarse entre 90 dB (A) y 105 dB (A), según las mismas condiciones de medidas anterior; y

c) En las ambulancias, vehículos de policía o de seguridad, bomberos y/o servicios públicos debidamente autorizados, el nivel de ruido no debe superar los 120 dB (A) con el sonómetro ubicado a los 7,50 m del vehículo en la prolongación del plano vertical medio de dicho vehículo detenido:

VEHICULOS	Ruido—Niveles máximos admisibles		Pruebas previas	Pruebas en servicio
2 y 3 ruedas	—hasta 125 cm³		90	96
	—más de 125 cm³ y hasta 500 cm³		92	96
	—más de 500 cm³		94	98
4 o más ruedas	Vehículos de transporte de personas de 9 plazas y menos (¹) (Taxis—particulares)	diesel	92	96
		otros	90	94
	Vehículos de transporte colectivo de personas	—más de 9 plazas y hasta 21 plazas (¹)	94	98
		—más de 21 plazas (¹)	96	100
	Vehículo de transporte de carga	hasta 3,5 ton.	92	96
		más de 3,5 ton. y hasta 8,0 ton.	94	98
		más de 8 ton.	96	100

(¹) Incluyendo al conductor.

ANEXO 2

EVALUACION DE HUMOS EMITIDOS POR VEHICULOS CON MOTORES DIESEL

Métodos de ensayo para automotores en servicio:

1.—Propósito:

El presente método de prueba define el procedimiento para verificar que los vehículos automotores equipados con motores diesel no emitan humos por encima de los niveles admisibles.

2.—Alcance:

El método propuesto será usado para la evaluación de los humos emitidos por vehículos equipados con motores diesel.

La prueba puede efectuarse al costado del camino o en talleres o terminales de líneas o centro de revisión pública.

Los vehículos deben cumplir los valores indicados en la tabla II de este anexo.

3.—Equipo de prueba:

Se utiliza un equipo medidor de humos del tipo opacímetro por extinción luminosa, aprobado por las autoridades competentes con la escala graduada de cero a cien (0 a 100) correspondiendo el valor cero (0) a la transferencia de aire, ambiente y el valor cien (100) a la opacidad total.

4.—Condiciones previas a la prueba:

4.1 Durante la prueba el motor debe encontrarse en condiciones normales de funcionamiento. Si la prueba se efectúa sobre un vehículo estacionado el motor debe ser llevado previamente a las condiciones normales de funcionamiento mediante un recorrido en ruta o un período de calentamiento adecuado. La cámara de combustión no debe ser enfriada o ensuciada por un prolongado período de funcionamiento en ralenti precedente a la prueba.

4.2 Se verifica que no se haya hecho modificación alguna que pudiera falsear la real opacidad de los humos emitidos en especial el sistema de escape no debe presentar orificio alguno que pudiera permitir la dilución de los gases emitidos.

4.3 El combustible con que se realice la prueba es el que se encuentre utilizando el vehículo en el momento de la medición.

5.—Procedimiento de la prueba:

5.1 Durante la prueba la palanca de la caja de velocidades se mantiene en posición de punto muerto y con el embrague del motor acoplado

5.2 Con el motor funcionando en ralenti se procede a oprimir el acelerador rápidamente, en forma continua y sin brusquedades, de modo de obtener el máximo abastecimiento con la bomba de inyección, hasta que el motor gire a su máxima velocidad en vacío.

Cuando se alcance dicha velocidad se suelta el pedal del acelerador hasta que el motor retorne a la velocidad de ralenti.

5.3 La operación descrita en el párrafo 5.2 debe ser repetida por lo menos tres veces para limpiar el sistema de escape y permitir un eventual ajuste del aparato de medición.

5.4 A partir de la cuarta aceleración, se registra o anota los máximos señalados por el instrumento de medición, hasta que dos valores sucesivos no difieran en más de 5 unidades del instrumento definido en el artículo 3º.

5.5 El valor de la opacidad del humo será el promedio de las dos (2) primeras lecturas que no difieran de lo que señala el artículo 5.4.

6.—Para los motores con sobrealimentador, con posibilidad opcional de servicio, se procede a realizar dos ciclos completos de medición con y sin sobrealimentador. El valor que se toma en cuenta es el mayor de los obtenidos en cada uno de los ciclos.

Humo · Niveles máximos admisibles
Unidades Hartridge (H)
Unidades Bosch (B)

VEHICULOS	Pruebas previas o de primera visita. Unidades de opacidad		Pruebas de verificación en servicio y/o de revisión periódica Unidades de opacidad	
	H	B	H	B
–vehículos de transporte de personas de más de 21 plazas. –vehículos de transporte de carga de más de 3,5 toneladas.	50	30	60	35
–vehículos de transporte de personas hasta 21 plazas (microbuses, automóviles, taxis...). –vehículos de transporte de carga de menos de 3,5 toneladas.	45	30	50	35

H Medidor del tipo opacímetro por extinción luminosa directa.
B Medidor del tipo opacímetro por extinción luminosa indirecta.

EVALUACION DE LOS GASES DEL ESCAPE EMITIDOS POR LOS VEHICULOS AUTOMOTORES CON MOTORES DE IGNICION POR CHISPA O DE GASOLINA

1.—Propósito:

El presente anexo define las reglas técnicas y el procedimiento para verificar que los vehículos automotores equipados con motores de combustión interna con ignición por chispa, no emitan contaminantes gaseosos por encima de los niveles admisibles que a continuación se especifican.

2.—Alcance:

El método de evaluación propuesto es empleado para la determinación del contenido de Monóxido de Carbono en los gases del escape de los vehículos citados y solamente en aquellos que tienen un peso máximo autorizado superior a 400 Kg y capaces de alcanzar una velocidad máxima igual o superior a los 30 kph por construcción, a excepción de los equipos especiales.

3.—Requerimientos:

Los vehículos sometidos a la prueba de verificación, serán los que hayan recorrido una distancia igual o superior a los 3 000 Km, los que no deben emitir por el escape un contenido de monóxido de carbono que exceda al 4,5% del volumen total de los gases emitidos, con el motor en funcionamiento (en ralenti) y el vehículo detenido.

La prueba se efectúa en los centros de revisión técnica que se establezcan, o en la vía pública.

4.—Equipo de prueba:

Se utiliza para la medición de monóxido de carbono cualquier equipo que cumpla con las normas internacionales, sea aprobado por las autoridades competentes.

5.—Condiciones previas a la prueba:

El combustible con que se realiza la prueba es el que utiliza normalmente el vehículo. La medida de monóxido de carbono en ralenti debe efectuarse a la temperatura del motor en funcionamiento normal.

6.—Procedimiento de prueba:

Durante la prueba se mantiene la palanca de la caja de velocidades manual en posición de punto muerto y con el embrague del motor acoplado.

En los casos de vehículos con transmisión automática, la prueba es efectuada con la caja de velocidades en posición cero (0) o estacionamiento.

Se puede realizar la medida en 3 condiciones de afinamiento de los diversos elementos del motor. La sonda de extracción se ubica en el caño de escape y unida al aparato de prueba.

Para tomar en cuenta las eventualidades diluciones de los gases del escape con el aire se puede hacer la medida en volumen de monóxido de carbono (T 1) y dióxido de carbono (T 2); el valor del volumen T a comparar con el límite prescrito se calcula en la forma:

$$T = T1 \quad 0.15/.\, T1)(T2$$

DR. CARMELO CALVOSA CHACON
Ministro de Salud

DR. JORGE ARIAS SOBRADO
Viceministro de Salud

DR. LEORNARDO MARRANGHELLO
Director General de Salud

ING. EDISON RIVERA C.
Director de la División de
Saneamiento Ambiental

Table A.12: Studies done in Costa Rica Related to Environmental Aspects

Source: Ministerio de Salud, Reporta I y II sobre Contaminacion del Aire, San Jose, Costa Rica, 1979-1980

MINISTERIO DE SALUD

DIVISION DE SANEAMIENTO AMBIENTAL

SAN JOSE, COSTA RICA

PROGRAMA NACIONAL DE SANEAMIENTO AMBIENTAL

INFORME SOBRE LA PREPARACION DEL PROGRAMA PARA CONTROL DE LA CONTAMINACION DEL AIRE

PRIMERA FASE

1ª AL 31 DE MARZO DE 1980

ORGANIZACION PANAMERICANA DE LA SALUD

OFICINA SANITARIA PANAMERICANA, OFICINA REGIONAL DE LA

ORGANIZACION MUNDIAL DE LA SALUD

PROYECTO DE COOPERACION TECNICA
COR - 2001
PARA EL DESARROLLO DEL
PROGRAMA NACIONAL DE SANEAMIENTO AMBIENTAL

LIC. RODRIGO MENESES CASTRO
Director a.i.
Unidad Sectorial de Planificación
Representante, Ministerio de Salud

ING. EDISON RIVERA CASTAING
Director
División de Saneamiento Ambiental
Director del Proyecto

ING. ALEJANDRO CASTRO
Consultor OPS/OMS
Administrador del Proyecto

ESTUDIO ELABORADO POR:

Ing. Germán Gómez	Consultor a corto plazo OPS/OMS

COORDINADOR GENERAL:

Ing. Alejandro Castro	Ingeniero de Proyecto COR-2000 OPS/OMS

CONTRAPARTE NACIONAL:

Ing. Orlando Rodríguez	Director, Programa de Higiene y Seguridad del Trabajo Ministerio de Salud

GRUPO DE TRABAJO

Sr. Gerson Hernández	Auxiliar de Saneamiento Ministerio de Salud
Sr. Luis Diego Espinach	Auxiliar de Saneamiento Ministerio de Salud

CONTENIDO

MINISTERIO DE SALUD

DIVISION DE SANEAMIENTO AMBIENTAL

SAN JOSE, COSTA RICA

PROGRAMA NACIONAL DE SANEAMIENTO AMBIENTAL

INFORME SOBRE LA PREPARACION DEL PROGRAMA PARA CONTROL DE LA CONTAMINACION DEL AIRE

SEGUNDA FASE

DEL 5 DE ENERO AL 3 DE FEBRERO DE 1981

ORGANIZACION PANAMERICANA DE LA SALUD

OFICINA SANITARIA PANAMERICANA, OFICINA REGIONAL DE LA

ORGANIZACION MUNDIAL DE LA SALUD

CONTENIDO

1.0 RESUMEN DE CONCLUSIONES Y RECOMENDACIONES

a. Conclusiones

1. El problema de la contaminación atmosférica en Costa Rica está ubicado principalmente en el área metropolitana de San José, donde circula el 41% del parque automotor del país, están ubicados el 51% de los establecimientos industriales y vive el 27% de la población. La emisión estimada de contaminantes de origen automotor es del orden de 67.860 toneladas anuales, lo que produce concentraciones de monóxido de carbono cercanas al 40% de los límites permisibles, y de anhidrído sulfuroso superiores al 85% de la norma.

2. La contaminación de origen automotor crece a un 7% anual, y de la origen industrial a un 8% anual. Esto implica que las emisiones se duplicarán cada 10 y 9 años respectivamente. Por lo tanto las concentraciones de contaminantes alcanzarán los límites permisibles en un lapso no mayor de 10 años.

3. No existe una red de muestreo del aire que indique los niveles reales ni su variación con el tiempo.

4. No existen normas de calidad del aire, ni normas de emisión, ni un programa sistemático de control de fuentes fijas y móviles.

5. En la ley general de salud existen las bases para definir normas de calidad del aire, normas de emisión y un programa sistemático de control.

6. Existe una infraestructura técnica en sus comienzos, que puede servir de base para desarrollar un programa de control.

b. Recomendaciones

1. Se recomienda instalar la red de muestreo normalizado del aire, de acuerdo a los diseños y especificaciones dadas en el Anexo 2.

2. Se recomienda reglamentar las emisiones de automores nuevos y usados, y adelantar en coordinación con el MOPT y RECOPE el estudio de las siguientes medidas de control:

   a. Retirar de circulación los vehículos de servicio público (buses, taxis y camiones) con más de 10 años de antiguedad.

   b. Imponer una revisión periódica a los vehículos de servicio público, para ajustarlos a óptimas condiciones de operación.

   c. Reglamentar la máxima carga por vehículo de acuerdo al volumen del motor.

   d. Suministrar diesel oil con un contenido de azufre inferior al 0.4%.

   e. Definir zonas peatonales en el centro de la ciudad y controlar rutas de buses en las vías centrales.

   f. Analizar la alternativa de buses a base de energía eléctrica.

3. Iniciar el inventario de emisiones de acuerdo a lo propuesto en el Anexo 3.

4. Definir zonas industriales en coordinación con el INVU, OFIPLAN, Instituto Geográfico Costarricense e Insitituto Metereológico Nacional.

5. Promulgar e implementar las normas de calidad del aire, las normas de emisión y los procedimientos de control, propuestos en el Anexo 6.

APPENDIX B

DESCRIPTION OF METHODS

1. Delphi and One of Its Modifications
2. Saaty
3. "KJ" Method

APPENDIX B

DESCRIPTION OF METHODS

1. DELPHI METHOD AND ONE OF ITS MODIFICATIONS

The dynamic nature of the market's tendency, the unexpected effects from political and economic events, the high rate of technological change, and the arrival of new products and production methods have contributed to the degree of uncertainty, so managers are obligated to find tools by which to foresee future events which will affect their goals.

Experts in planning point out that big benefits can be expected from a modest investment to extend validity of the planning process, which will in turn increase the ability of the managers to organize future activities and consequently improve the effectiveness of the company.

The Delphi technique derives its name from the ancient Greeks who met at the site of Delphi to receive the oracles from Apollo through his intermediary, the seer. Today the place of Apollo and the seers is usurped by a group of experts. In the 1950s the United States Army commissioned the RAND Corporation to develop the Delphi Project.[8] The purpose of this project was to compile information needed by Armed Forces from a group of experts in various fields. Subsequently, the method has been adopted widely by business, industry, politics, education, and virtually all areas of planning.

The purpose of the Delphi method is to obtain the most reliable consensus from a group of experts through a series of intensive questionnaires. At each step of the series, each participant receives anonymous feedback of the information from all other participants, re-evaluating his own information in light of the new information, and so on until a consensus is approached.

The proponents of the Delphi method advocate the use of questionnaires answered by individuals privately without knowledge of other participants, thus keeping to a minimum influence exerted by one over another. By this method the negative factors of group interaction can be eliminated. For example, the method tries to avoid the "aggressive expert" who feels obligated to defend his publicly announced opinions, the top executive whose subordinates defer to his opinion, or the "super salesman" who can sell the proverbial refrigerators to the eskimos.

Excessive direct confrontation often results in a hasty formulation of preconceived notions, an inclination to close the mind to new ideas, a tendency to defend the taken position, or a predisposition to be convinced by the opinions declared by others. All of these factors constitute the basis of the Delphi method and their implications need to be totally understood when the method's validity and effectiveness are discussed.

The following is an example of the application of the Delphi method[12] to a company. The project was conducted to obtain from the participants a list of the probable events of significance to the company. Each participant was instructed to evaluate each previous event with respect to three principal factors: Desirability (considered from the consumer approach), which includes categories such as "essential," "desirable" or "possible" and "indispensable;" Feasibility, by "high feasibility," "probable feasibility" or "possible feasibility;" and, finally, Time, the year in which the event will occur, which is divided into three probabilities: 10% (reasonable opportunity); 50% (more probable opportunity, or 90% (near certain probability).

The second round of questionnaires began with a list of events obtained from the first round, so that each participant could establish his own evaluation of the probability of each event. Each participant was also asked to indicate if his familiarity with the subject of study was adequate, good, or excellent, even though it was not clear yet how this additional information could be used to evaluate the estimations already reached.

The results of those exercises show a wide range of opinions and the next stage is to reduce the divergences. This may be done in one of two ways: the compiler through a discussion may request a series of individual discussions with the expert who gave the most radical or divergent answers; or he may supply an additional questionnaire with additional information. In order to remain objective new information must not imply the trend toward the consensus, and the participant can modify his initial evaluation with the security of unanimity. In the majority of the Delphi projects the feedback in each round explicitly lists the total results of the previous rounds without revealing the identity of the participants. In this manner, each participant can express his opinion independently of the other participants' second answers. If the participant finds that his answer agrees closely with the rest of the group, he may not modify his answer drastically in the next round, but if he discovers that his answer is too different he may alter his thinking before answering another time.

It is not surprising that as the experiment continues the answers start to converge, which is the goal of the procedure, obtaining a consensus and eliminating the extreme points of view.

In summary, the Delphi process is an iterative method that combines the knowledge and abilities of a group of experts to quantified parameters that either can be intangible or have certain degrees of uncertainty; it is very well known because of its use in technological forecasting and estimations of military strategies.

The first use of the Delphi as reported by Rutherford [8] was in 1953 when Dalkey and Helmer used a version of it to ask for the opinions of seven experts in a hypothetical atomic war, as part of the defense scheme. The job was secret and unpublished until 1962. In 1959 Helmer and Rescher wrote the article, "On the Epistemology of the Inexact Sciences," also described by Rutherford, in which they tried to justify as scientific the use of the judgment of experts in areas where a theoretical infrastructure is not available. The experiment that probably generated more interest was one undertaken by Gordon and Helmer for the forecasting of technological events. That study represented the first utilization of the Delphi process on a big scale. In recent years the procedure has had many other applications in areas such as innovative education, industry, planning of social events at the community level, and evaluation of research projects. In the evaluation of goal formulation for socio-technical systems, Rutherford[8] applied a variation of the Delphi method in which direct interaction among participants was permitted. The final purpose of Rutherford's group was to find the goals for an experimental forest center (Morton Arboretum, in Lisle III). Accordingly, they developed an iterative process consisting of four main stages based on a modification of the Delphi method. In the first phase a list of objectives was established through informal discussion. Then, these goals were integrated into groups that were located inside a hierarchical structure. Finally, the iterative process was used again to define the relative priority between the elements in the structure.

In Figure B-1 the basic stages are shown. The experiment was done by two groups, one consisting of seven experts and

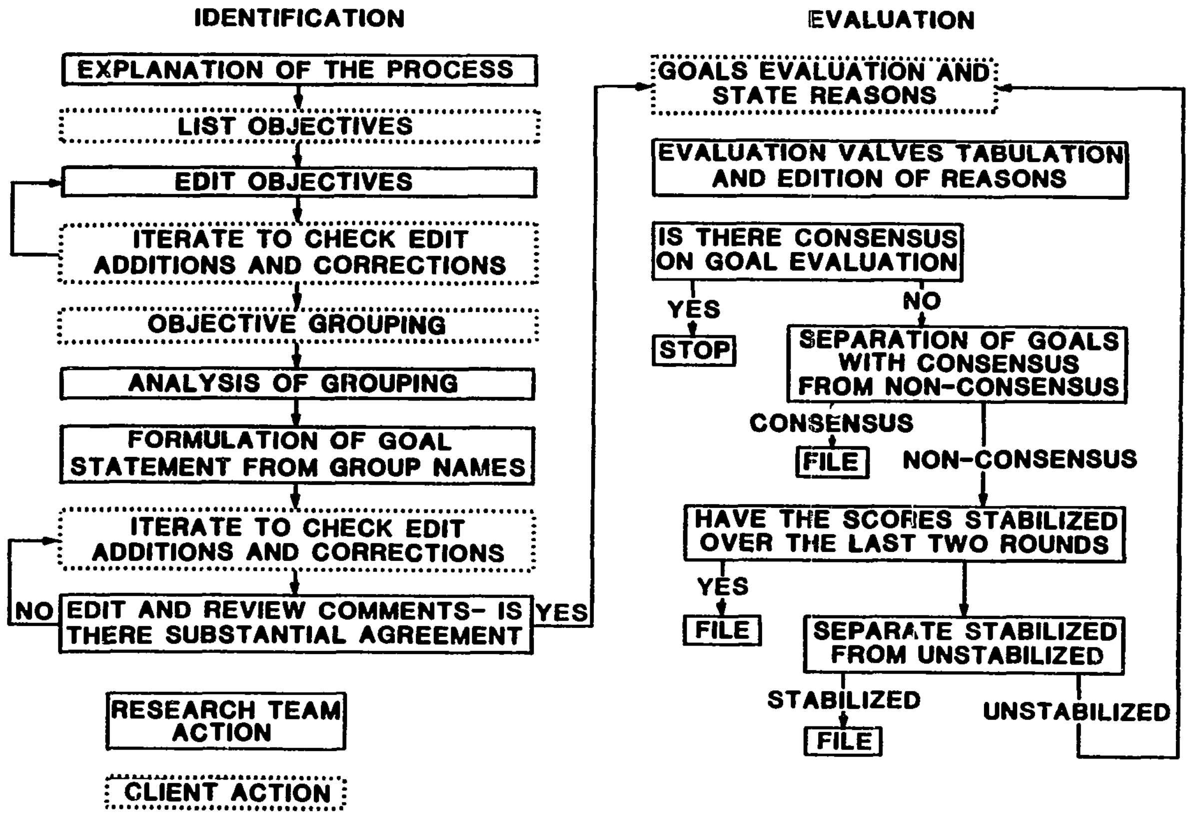


FIGURE B.1 IDENTIFICATION AND EVALUATION OF GOALS

Source: Rutherford G., et. all., Goal Formulation for Socio-Technical Systems, Journal of the Urban Planning and Development Division. September 1973, pp. 163.

the other consisting of researchers. Initially the two groups met to explain characteristics of the Delphi process. The next stage consisted in asking the experts to establish the objectives the institutitions would have. In order to do this, the meaning of the term "objectives" was clearly explained and defined. It was decided to ask first for the objectives instead of the goals because it is easier for people to discuss objectives on a more general level than to refer to higher levels of generalities which is characteristic of the goals. The list of suggested objectives was edited and fed back to be sure of accuracy and clarity, and at the same time to edit further and re-group the objectives.

The next stage consisted in asking the experts to group the obtained objectives according to similar functions, properties or goals. Each objective was written on a separate sheet and then grouped. After these categories were recorded, the sheets were reshuffled and passed to the research group which re-categorized the objectives and fed back their results to the expert group. Each member of this group then reconsidered and edited his first categorization in light of the research findings. This process is repeated until a consensus is near concerning grouping of the objectives. A name is assigned to each major category. Each participant identified from four to nine groups, each of which had from one to twelve objectives. This information was edited and matched into pairs and placed on a matrix as in Figure B-2. That matrix shows how many objectives

OBJECTIVES

OBJECTIVES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1		1		1	3				3	2	5		1	1	1		2	7	3			1	3	1	
2				1	3			1	2	2	2	5			2			1	2		1	1	3		2
3				1		1	1	2	1	1		1	2	2		7	1		1	2	2	1		1	
4					1		2	3	3	4	2		2	3	5	1	7	1	3	4	3	5	3		1
5							2		2	1	2	2			2		2	3	2				2		1
6							4						3	2		1	2			3		1		6	
7								2		1		1	2	2	1	1	3			5	2	3		4	
8										1		1	1	1	3	2	1			1	7	4			1
9										6	5	1	2	3	4		1	3	7			1	6		1
10											4	1	2	3	4	1		2	6		1	2	5		1
11												1	2	2	3		1	5	5			1	5		1
12															2	1					1	1	1		3
13														6	1	2	2	1	2	4	1	1	3	3	1
14															1	2	2	1	3	3	1	1	4	2	1
15																		1	3		2	5	3		2
16																	1		1	2	2	1		1	
17																		2	1	2	2	1	1	2	
18																			3			1	3	1	
19																						1	5		
20																					1	2		6	
21																						3			
22																							1	1	1
23																									1
24																									
25																									3

Figure B.2 Number of Participants Linking Particular Objective Pairs.

Source: Rutherford G., et. all., Goal Formulation For Socio-Technical Systems, Journal of the Urban Planning and Development Division. Sept. 1973, pp. 163.

each participant matched up. As can be observed, seven experts formed identical pairs of objectives; six experts paired the objectives differently. This information was used to form a graphic analysis of the connections, as shown in Figure B-3. The numbers inside the circles represent the objectives, and the numbers above the lines represent the number of people who connected this pair of objectives.

Then, the research group used the scheme of Figure B-3 to form sets of relatively independent objectives. Figure B-4 shows the results of this taxonomic process. To the groups formed in this way, the experts assigned names. Then, the research group summarized the different names assigned to the same group of objectives, determining in that way the most general goals of the institution.

The last stage of the process consisted in the establishment of priorities between the goals. It used a scale from 0 to 100 to evaluate the goals. The experts then graded the goals according to this scale. The results of this first iteration were edited by the research team and fed back to the experts. The iteration process continued until the value distribution assigned to each goal had a range of distribution equal to or less than 10. The scoring consists of the mean values resulting from the first round of the assignation process of priorities. During preparation of the second round the values obtained during the first were plotted like a

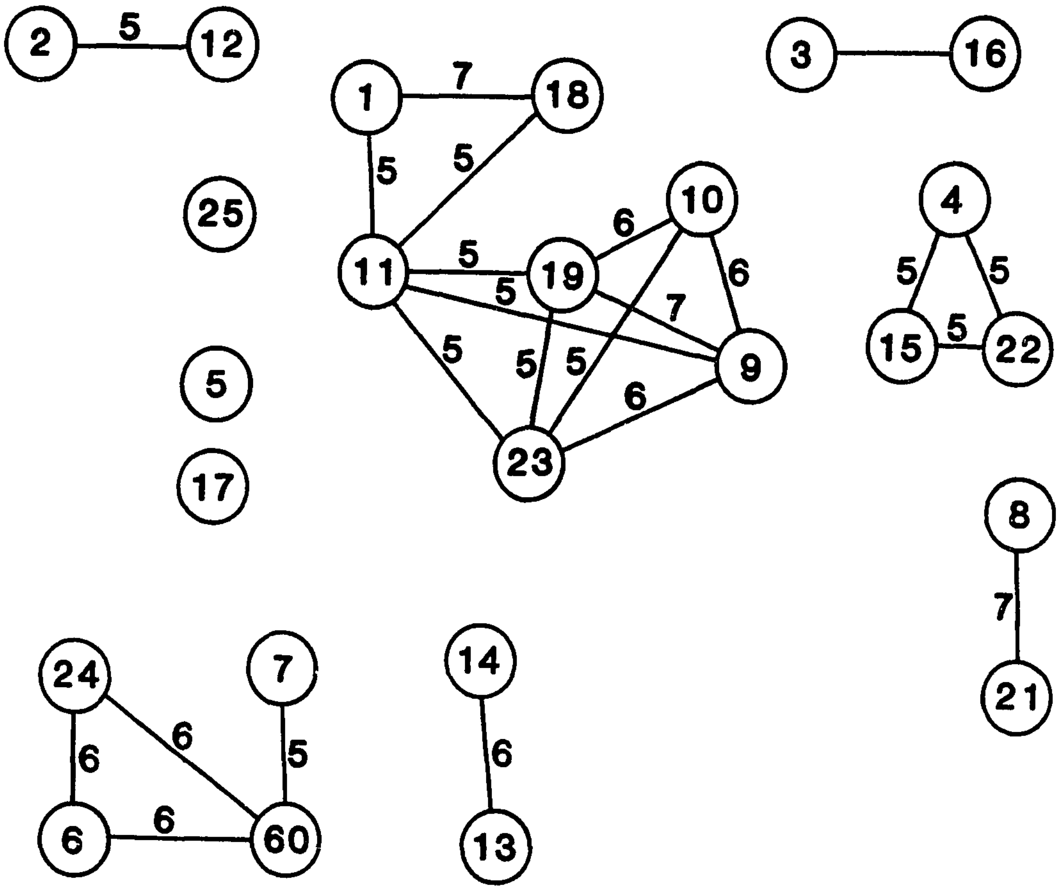


Figure B.3 Graphical Objective Group Linkage Analysis Based on Participant Responses.

Source: Rutherford G., et. all.

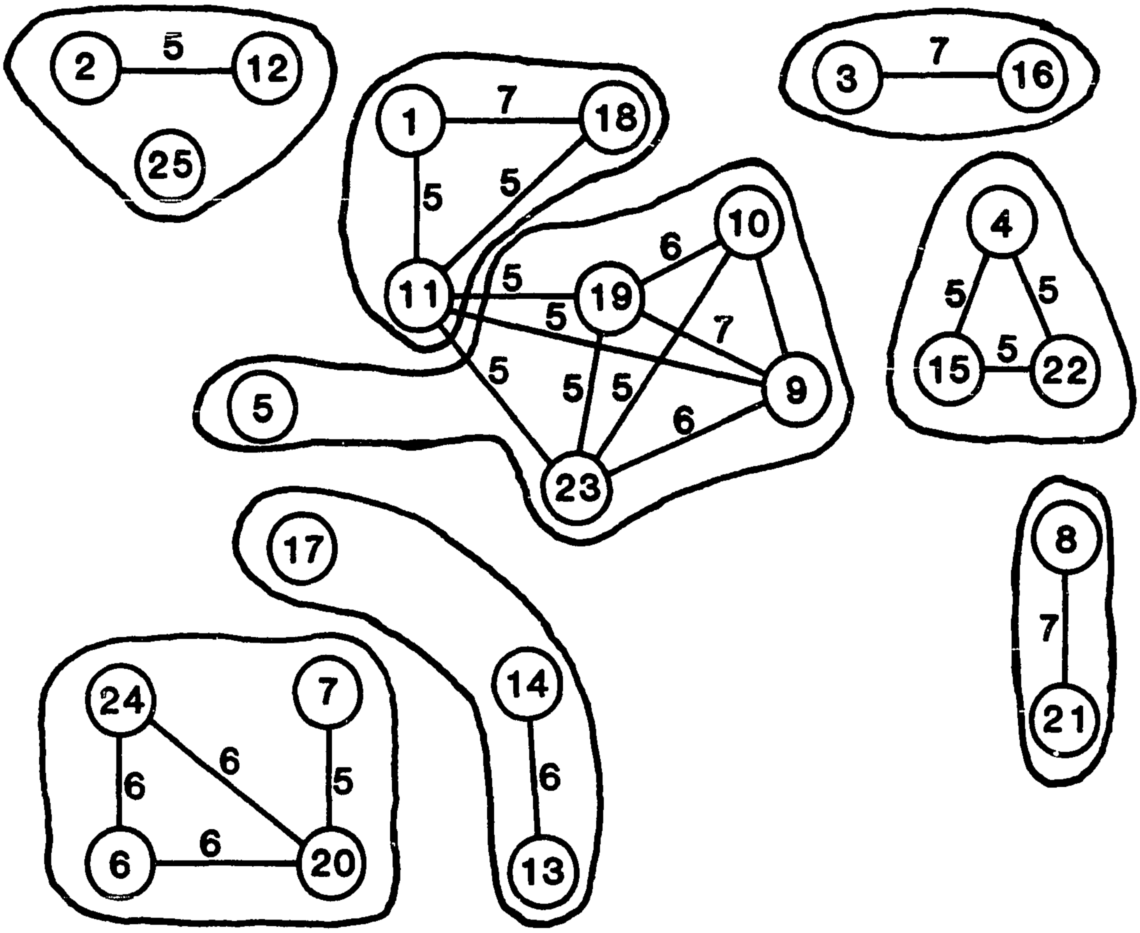


Figure B.4 Objective Group Graphical Linkage Analysis Based on Research Team Responses.

Source: Rutherford G., et. al.,

hystograph. This was done with the goals so that each expert could observe the position of his answer in relation to those of the rest of the group. The experts, consequently, had the opportunity to review their designation of the priorities, asking the people which values fall close to the edges of the distribution bell and to explain the reasons on which they based the results of their opinions. The results of the second round can be seen on Table B-1. Some of the priorities distributions are remarkably close while others contain their wide initial ranges.

To be accepted, a goal must fall within the range of one to ten. According to this criteria, five of the eight goals were accepted.

TABLE B-1

GOALS ACCEPTED

Number of the Goal	Score Mean	Range
II	12.50	7.5
III	8.40	6.0
IV	12.40	8.5
VII	7.88	6.0
VIII	14.20	10.0

Source: Rutherford, G.S.; Schofer, J. L.; Wasche, M., "Goal Formulation for Sociotechnical Systems," Journal of Urban Planning and Development Division. (September 1975) pp. 157-69

The goals on which a consensus was not reached were the I, V, and VI. Goal VI appears to be a special situation--if one vote is ignored consensus can be reached. Because of this situation and in order to respect the opinion of the majority and the relative values to the other goals, the mean of the distribution[11] is used.

Goals I and V received wide ranges after the second iteration, six and twenty-seven points respectively. Those, consequently, could be the focus of the subsequent iterations, for the goals at the edges of the distribution priorities, and could serve as a base for future negotiations through the Delphi process. In this experiment, however, the iterations were interrupted because a real consensus was not reached.

2. THE SAATY METHOD

The Saaty method has been utilized in planning to establish quantitatively the importance between the pairs of factors, of activities, or of objectives. That importance is evaluated subjectively by the experts who assign values which indicate the most important or influential of the two objectives in the pair.[6] Specifically, Saaty applies this method to establish the domination of one scenario over the other one, understanding as a scenario the future perspectives of systems that are submitted to such factors as environmental, social, political, technological, and economic. Also, it has been used in the energy distribution for energy shortage situations,[13] in planning the future of a corporation, in measuring the impact of environmental factors on their development, in selecting assignments, analyzing of diffuse sets,[6] in nominatory candidates for the Democratic Party of the United States,[14] and in evaluating articles to be published.

The Saaty method must be applied in a hierarchical structure. A hierarchy is a set H, not empty, that is divided into subsets, called the hierarchical levels. H is constituted of a chain of levels with a simple order, so that each element of each level is dominated by at least one element of the subsequent inferior level. Each level is divided into subsets, each one of which is composed of those elements dominated by each element of the immediately preceding level. In each of those sets there can be a total order (relating to the dominant element of the higher level) that is reflexive and antisymetric (but not necessarily transitive). A hierarchy is complete if each element of a given level is dominated by each element of the following superior level. The elements mentioned in the preceding paragraphs could be interpreted as activities that are executed to accomplish some functions, objectives, and so on. The group of experts is asked to judge the relative importance between two activities, and their perception of the intensity of the difference is quantified according to a scale.

To establish intensity values for grading the importance between two activities, Saaty used the following scale shown in Table B-2.

TABLE B-2

VALUES SCALE PROPOSED BY SAATY[15]

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal importance	Two activities contribute equally to the goals
3	Weak importance	The judgment favors one activity above the other one; but not conclusively
5	Strong importance	The judgment strongly favors one activity over the other one
7	Demonstrated importance	Conclusive judgment favors one activity over the other one
9	Absolute importance	The judgment favors one activity over the other one in the highest order possible

Source: Saaty, Thomas L. and Rogers, C., "Higher Education in The United States (1985-2000); Scenario Construction Using a Hierarchical Frame Work with Eigenvector Weighting." Socio Econ. Plan. Sci., (October 1976): 251-63.

The values 2, 4, 6, and 8 are intermediate between the preceding values, and their use is optional.

The scale in Table B-2 begins with a value of 1, which indicates equal importance between the two activities; succeeding values show the difference in the magnitude of importance of the pairs.

The reciprocal of these values is used in order to show the difference in importance between the pair of activities, and the value favoring one of the activities is written in the matrix's box that corresponds to the dominant activity; directly across from the box, using as a reference the diagonal, the reciprocal of the value is written. Because of this, small numbers are used in order to avoid reciprocals with numbers so small that they are insignificant.

These values calculate the relative importance a_{ij} for activities i and j. So when the expert quantifies his judgment by comparison of pairs it is the value of a_{ij} which is set in the matrix called "matrix of judgment." The values a_{ij} of the matrix are the quantification of the activities associated with rows and columns. In this way the method tries to estimate the absolute values W_i, ... W_n of the activities. The element a_{ij} can be considered as an approximation of the rate w_i/W_j. If the matrix of judgment accomplishes equality, in other words, $a_{ij}= W_i/W_j$, the values are estimated exactly.

Consistent means that $a_{ij} * a_{jk}$ from the matrix diagonal is $a_{ii}=1$ and the reciprocal relations $a_{ji}= 1/a_{ij}$ is accomplished. Some characteristics of consistency cannot be rigorously conserved. However, for any value a_{ij} which is used, its reciprocal is used to assign the value for the comparison of the activity j with i.

Some of the inconsistences are $a_{ij}(W_j/W_i)=1$, consequently a condition is found where the matrix is consistent: $a_{ij}(W_j/W_i) = n$, for i=1 until n. In this equation, the right side is the same constant n; in other words, the highest characteristic values are zeros because the range of the matrix of judgment is unitary and the sum of the characteristic values are equal to the trace $\sum_{i=1}^{n} a_{ij} = n$.

It is argued that generally the vector $(W_{i,}\ldots.,W_n)$ should satisfy the problem of the characteristic vectors AW = max.W, where max. is the highest characteristic value of A. This max characteristic value, according to the Perron-Forbenius theory, has only one unique and not negative solution W if A is not negative and is not reducible. The following shows how this formulation of characteristic values for the general problem is reached. First of all, for the case of consistency, if a typical row $a_{i1}, \ldots., a_{in}$ is multiplied by $W_j, \ldots., W_n$ from $i_2, \ldots., a_{in}$, the values are identical $W_i, \ldots., W_i$. Because of that, when the operation AW is performed the vector of nW is obtained; and consequently, as has been established, the problem AW=nW is solved. The vector W is obtained by normalization, which consists in dividing each of its elements by n/W_i. Multiplying the last row produces deviations around the accuracy value, not exactly W_i. In the theory of matrices, characteristic values of one matrix are continuous functions of the coefficients. If the coefficients of a consistent matrix are perturbated, the highest characteristic value will remain close to n and the others close to zero. Thus, the problem is to find W that satisfies AW= max. W, and the result will have validity as max. is close to n. This is a consistency index and its derivation can be used as an indicator.

The following example shows an application of the Saaty method.[15] The rate of the luminous energy emission from a source, evaluated in terms of its visual effects, is related to a light flow. The surface illumination is defined as the light flow quantity that is received per unit of area. An experiment was conducted to find a relation between the lighting received by four identical objectives, located at known distances from a light source. The comparison of the illumination intensity was accomplished visually and independently by two groups of people. The objects were located at 9, 15, 21, and 28 yards from the light source; in normalized form those distances are 0.123, 0.205, 0.288, and 0.384. The experts made evaluations for pairs of objects and, on a base of these evaluations, constructed two matrices of judgment to find the brilliance of the objects in crescent order according to their closeness to the source. Those matrices were:[15]

TABLE B-3

MATRIX OF JUDGMENT #1

	C_1	C_2	C_3	C_4	Characteristic Vector
C_1	1	5	6	7	.62
C_2	1/5	1	4	6	.23
C_3	1/6	1/4	1	4	.10
C_4	1/7	1/6	1/4	1	.05
					λmax.= 4.39

Source: Saaty, Thomas L. and Rogers, C., "Higher Education in the United States (1985-2000); Scenario Construction Using a Hierarchical Frame Word with Eigenvector Weighting." Socio Econ. Plan. Sci., (October 1976): 251-63.

TABLE B-4

MATRIX OF JUDGMENT #2

	C_1	C_2	C_3	C_4	Characteristic Vector
C_1	1	4	6	7	.63
C_2	1/4	1	3	4	.22
C_3	1/6	1/3	1	2	.09
C_4	1/7	1/4	1/2	1	.06
					λ max.= 4.1

Source: Ibid.

For example, the object C_1 appears definitely more brilliant than C_4 in each test. When the characteristic vector components are compared with the square reciprocals of the normalized distances, a good concordance was found.

TABLE B-5

MEAN VALUES OF THE CHARACTERISTIC VECTOR OF THE JUDGMENT MATRIX

CHARACTERISTIC VECTOR	MEAN VALUE
.625	$(1/.123)^2/108.731=.608$
.225	$(1/.204)^2/108.731=.219$
.095	$(1/.288)^2/108.731=.111$
.055	$(1/.384)^2/108.731=.062$

Source: Ibid.

3. THE KJ METHOD

The KJ method was developed by Dr. Jiro Kawakita[16] to integrate, in a logic and comprehensive manner, heterogeneous data and to organize it in a scheme of groups. It is widely used as a scientific approach for the planning and solution of problems in education, business, industry, and other fields.

The KJ method consists of a series of stages through which the problem's solution is found. In this research reference to only the first stage of the method is made because it is attempting to develop an adequate methodology for the evaluation and categorization of an environmental program with special reference to the Costa Rica case.

The first stage of the method consists basically of the following steps:

a. Gathering information

b. Elaboration of labels

c. Grouping of labels

d. Construction of Scheme KJ, type A

e. Explanation of the results in written and oral forms, KJ types B and B'

The first step in the method consists in defining the topic or problem to be researched. Then ideas and information that appear to be important for the problem are accumulated and summarized on the labels. The information, which is obtained through a field investigation, is current and direct rather than theoretical or indirectly obtained. All possible concepts that present themselves should be included, even if their appropriateness or importance is not immediately evident.

It is important that only one concept, concisely stated, appears on each label. There is no limit to the quantity; labels are accumulated until the information is exhausted regardless of the number of labels required. See Figure B-1.

The process of grouping the labels is subdivided in the following steps:

i) Spread the labels

ii) Categorize labels into groups

iii) Name each group

Feeling and not logic should guide the group formation. Two or a maximum of three labels should constitute a group. When the labels are unusually similar, four may constitute a group. See Figure B-6. In the grouping process, it is possible that some labels cannot be grouped during the first states; these "lone wolves" may be grouped in the subsequent stages.

After the first label groups are formed, they are then titled. The title is usually a concise statement of the scene of the content of the group. This process is known as Hyosatsu.[16] The lone wolves do not participate in this stage but are separated for later use. Hyosatsu process is continued until all groups are exhausted. See Figures B-7 and B-8. After this condition, the KJ scheme type A is elaborated. There should be no more than ten groups in the final arrangement which should show clearly the relationship between the groups. Once the arrangement is determined, the labels are transferred to a paper sufficiently large to display all of them. See Figure B-9.

The labels from the groups constituted in the first step and their titles are attached to a large paper according to the relations they have to each other. Each group should be limited by a line, in the way that begins the scheme that will be done by hand. The rest of the signs should not be attached, but should be substituted by posters written by hand above the line that marks each group. It is important to draw the lines in a way so that the different groups that belong to

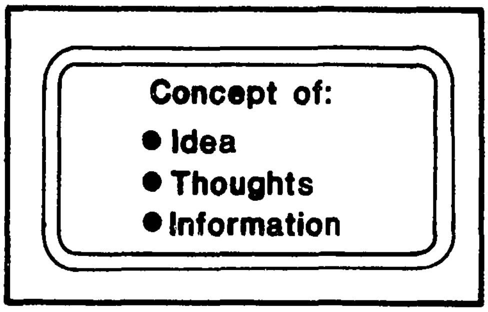


Figure B. 5 Labels where the problem concept to be solved is written.

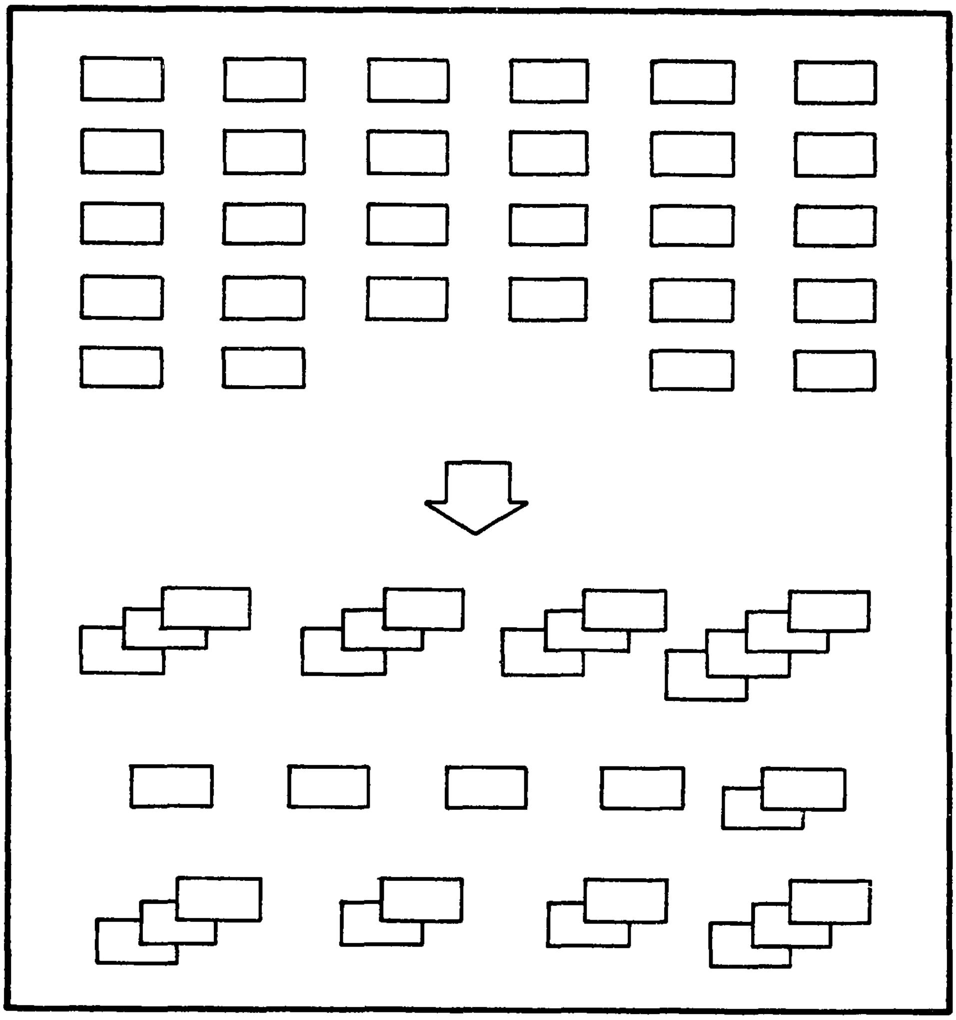


Figure B.6 Label grouping process.

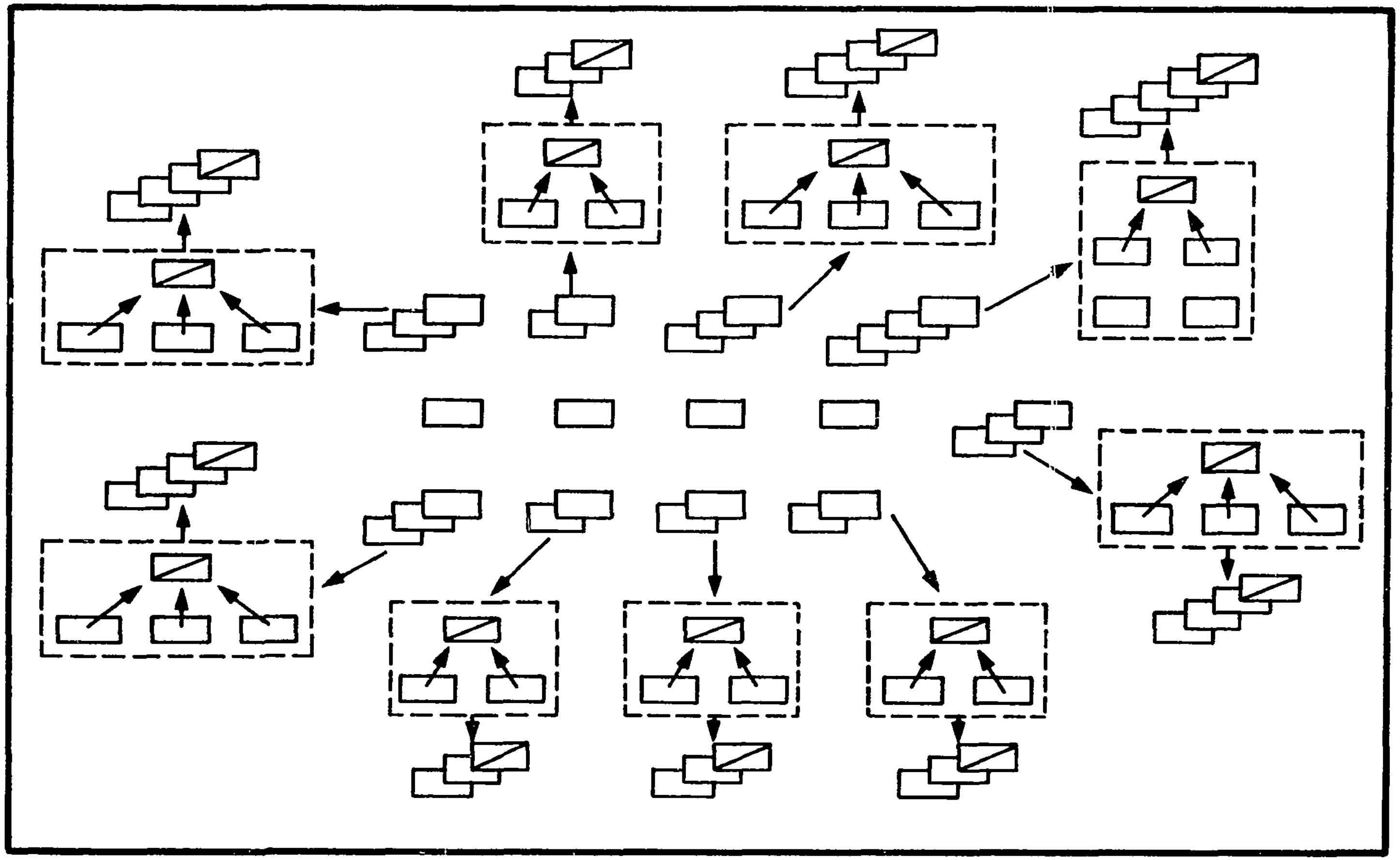


Figure B.7 Hyosatsu process to identify groups.

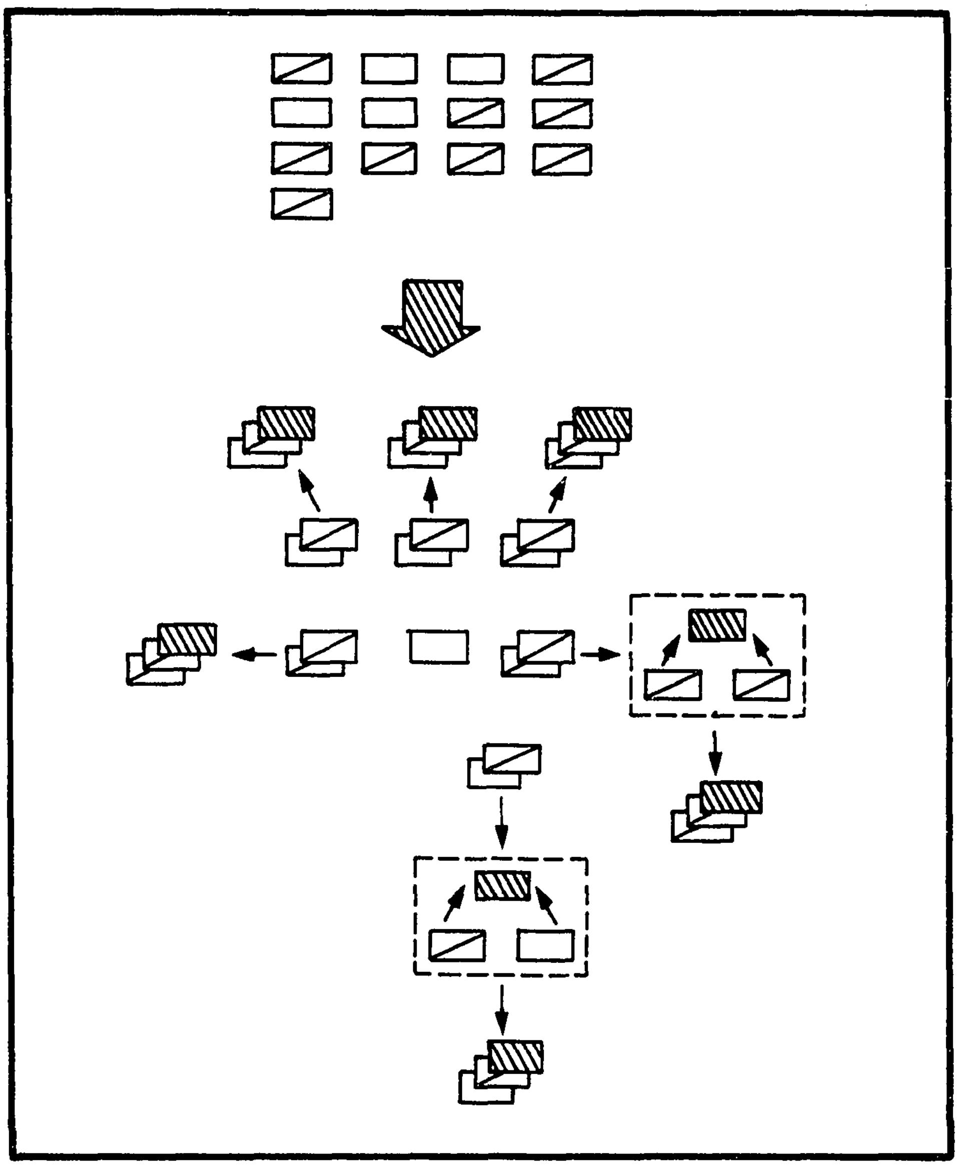


Figure B.8 Hyosatsu serial group.

the scheme can be distinguished. See Figure B-4.

After constructing the scheme, the written explanation of KJ type B is made on the base of the scheme. In the event that any new ideas emerge while the writing is being done, they are also included. It is convenient to attach schemes, maps and statistics, and so on.

Finally, the oral explanation of the KJ type B' is undertaken. For that the scheme is displayed on a wall before the people who will make the explanation. The scenario of the problem should be constructed and explained clearly and concisely,[16] in words not repetitive of the written explanation.

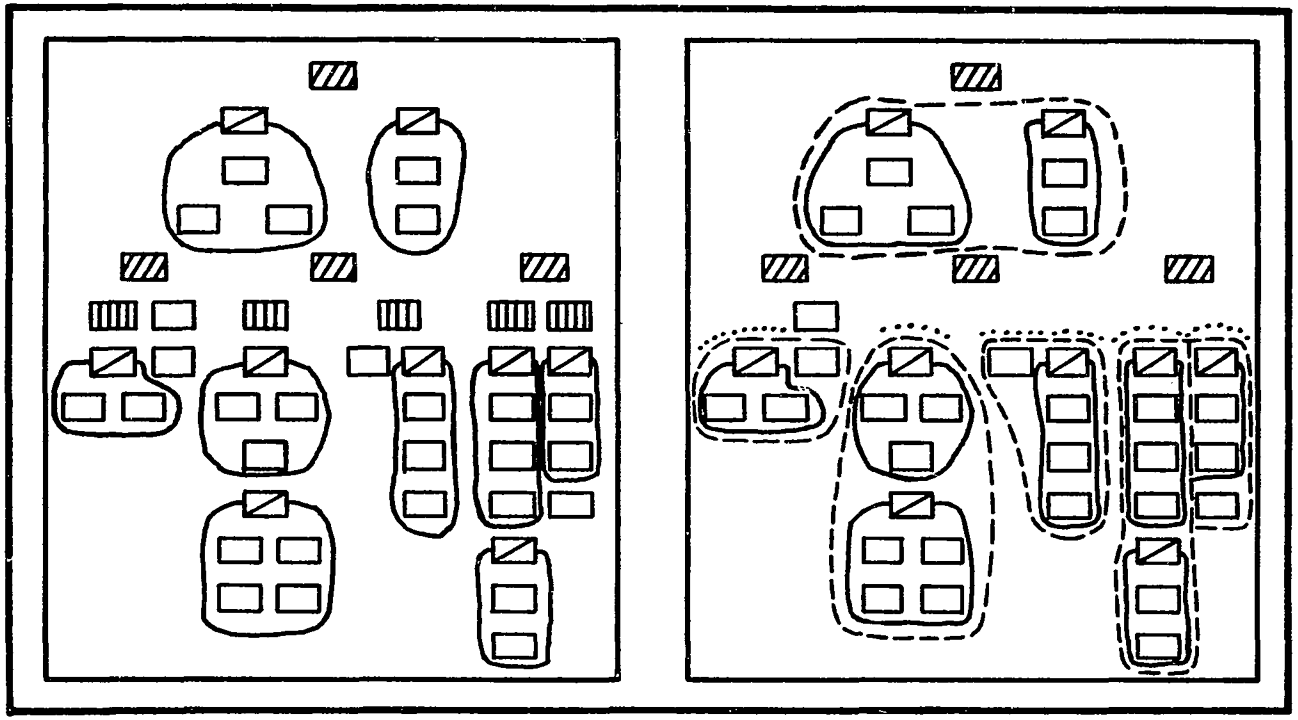


Figure B.9 OBTAINING SCHEME GROUPS

APPENDIX C

GRAPHIC PRESENTATION OF THE TREE

1. Introduction
2. Construction of the Tree by the Systemic Approach Method. Questionnaire
3. Graphic Representation of the Tree
4. Hierarchical Relations Nomenclature

APPENDIX C

GRAPHIC REPRESENTATION OF THE TREE

1. Introduction

In this section a sketch of the tree which was obtained after applying the systemic approach is shown. The principal goal that was considered by the group of experts was the country's development, followed by six goals which were the institution's related to the environmental program. Associated with the goals of the institutions were the following five activities: administration and inspection; research; designing, standardizing, monitoring and sampling; dissemination, collection of information, and teaching; and assistance. After the activities were found, the functions which should be performed by the institution's personnel were found. The tree shown in Figure C.1 served as the framework for the Saaty method.

Thus the absolute values of the activities of the institution's personnel related to environmental problems were obtained. In the last section the nomenclature of the components of the tree is shown.

2. Construction of the Tree by the Systemic Approach Method

QUESTIONNAIRE

CONSTRUCTION OF THE TREE

November 1, 1981

Dear _____:

I am a native of Costa Rica currently enrolled in a doctoral program at The University of Oklahoma. My research topic is "Design of a General Methodology for the Evaluation and Categorization of an Environmental Program with Special Reference to Costa Rica." Having learned of your interest in environmental matters, I am writing to seek your assistance in my work. Specifically, this letter is meant to explain the attached questionnaire, which I hope you can find the time to complete and return.

The purpose of the questionnaire is to determine the status of the environmental aspects in developing countries (in the test case, Costa Rica), to investigate the environmental concerns of persons like yourself, and to develop a hierarchical tree related to needs of an environmental program. In countries like Costa Rica there are institutions and laws related directly to environmental aspects, but they have not worked as the government expected during recent years. In general, the problems worsened because of the lack of coordination between institutions. Often duplication of efforts causes loss of money, waste of time, and inadequate use of technology.

The government of Costa Rica has stated the need for a formal procedure for the evaluation and categorization of an environmental program that will provide a better understanding of the environmental, legal, technical, and economic complexities of dealing with resources. This explanation shows the need to have an explicit and formal procedure that will identify the categories of activities which most need to be considered. It also will determine the values of each category and will allocate them throughout the infrastructure by using an adequate and effective methodology to categorize and evaluate any environmental program. This procedure which will be tested in Costa Rica can then be applied to countries and institutions with similar needs.

The systemic approach is the most adequate method for the construction of the tree's factors since it does not involve too many successive questionnaires in order to arrive at a consensus. The questionnaire is divided into three parts. Part one is a personal profile; part two contains specific questions addressed to the institutions related to environmental aspects, their activities and functions which are designed to further develop the country. Part three is a miscellaneous section where any concerns which were not specifically addressed earlier may be included. Although space is provided for the expert's name and address, this information is optional. A desire for anonymity will be respected. But whether or not the name is given we are interested in hearing your views.

Part one is included to gain a little information about yourself. This data will be used to compare responses by people from different institutions within the country and by people from international organizations. The remaining questions are subjective in nature. They all relate to your perception of environmental affairs in developing countries, specifically Costa Rica.

Your cooperation in completing and returning the questionnaire will be greatly appreciated. My work depends quite heavily on your assistance. I thank you in advance and look forward to your reply.

Yours sincerely,

Harry Castillo
Doctoral Candidate

Carson Engineering Building
The University of Oklahoma at Norman
Norman, Oklahoma 73019

HCV/hcv

Attachments

QUESTIONNAIRE

TREE CONSTRUCTION

DESIGN OF A GENERAL METHODOLOGY FOR THE
EVALUATION AND CATEGORIZATION OF AN
ENVIRONMENTAL PROGRAM WITH SPECIAL
REFERENCE TO COSTA RICA

Name:________________________ Postal Address________________

____

____

Telephone Number:___________________

PART 1: PERSONAL (Optional)

(1) Please name your institution and country:______________

____

(2) In what sector are you employed?

( ) Government Service ( ) Education ( ) Industry

( ) Private

(3) What is your highest level of formal education?

( ) Pre-University ( ) Vocational Training

( ) Bachelor's Degree ( ) Master's Degree

( ) Doctoral Degree ( ) Post Doctoral

(4) Do you have specialized training in environmental sciences?

( ) YES ( ) NO

PART 2: DEVELOPMENT OF THE COUNTRY

(1) Which are the principal environmental fields in development countries that should be considered by the institutions in order to accomplish the development of the country?

(2) Which are the basic common activities necessary for each institution to accomplish its goals?

(3) Which are the basic functions necessary to accomplish the corresponding activities?

PART 3: MISCELLANEOUS:

Are there any other comments that you wish to make? Please include additional sheets as needed.

Please return completed questionnaire to:

Harry Castillo
1118-A McGee Drive
Norman, Oklahoma 73069/U.S.A.
Phone: 405-321-3254

From the experts' answers to the preceding questionnaire, in which thirteen experts participated, five outside the country and eight inside, answers for each item were studied and analyzed. Then the resulted information was set up in the tree shown as Figure C.1.

3. Graphic Representation of the Tree

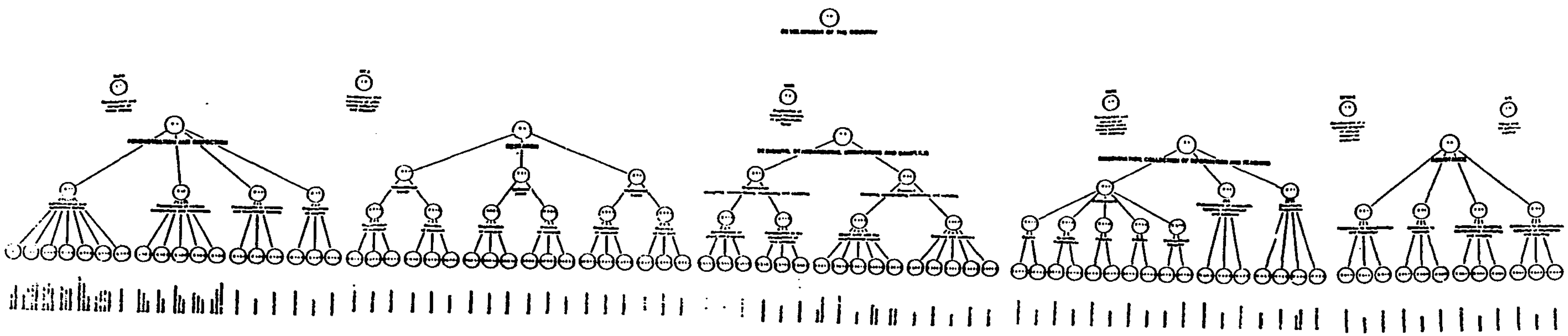


Figure C.1 TREE WITH THE HIERARCHICAL RELATIONS BETWEEN OBJECTIVES, ACTIVITIES AND FUNCTIONS OF AN ENVIRONMENTAL PROGRAM WITH SPECIAL REFERENCE TO COSTA RICA, RESULTING FROM THE EXPERTS' ANSWERS TO THE QUESTIONNAIRE.

4. Hierarchical Relations Nomenclature

LEVEL 0 : Country Development

LEVEL I : Goals of the institutions related to environmental programs contributing to the development of the country

- I-1 Development and services of water supply (INAA)
- I-2 Development and services of solid waste collection and disposal (MSJ)
- I-3 Preparation of human resources at post-graduate level (UCR)
- I-4 Development and services of industrial solid waste treatment and disposal (MEIC)
- I-5 Development of a national program of natural resources protection (SENAS)
- I-6 Noise and air pollution control (MS)

All of these participate in and contribute to the solution not only of practical problems, but also of planning and administration in the different sectors of the country.

LEVEL II : Basic activities of the institutions

I-1 Development and services of water supply (INAA)

- II-1 Administration and inspection
- II-2 Research
- II-3 Designing, standardizing, monitoring and sampling
- II-4 Dissemination, collection of information, and teaching
- II-5 Assistance

I-2 Development and services of solid waste collection and disposal (MSJ)

- II-1 Administration and inspection
- II-2 Research
- II-3 Designing, standardizing, monitoring and sampling
- II-4 Dissemination, collection of information, and teaching
- II-5 Teaching

I-3 Preparation of human resources at postgraduate level (UCR)

- II-1 Administration and inspection
- II-2 Research
- II-3 Designing, standardizing, monitoring and sampling
- II-4 Dissemination, collection of information, and teaching

II-5 Assistance

I-6 Noise and air pollution control (MS)

II-1 Administration and inspection

II-2 Research

II-3 Designing, standardizing, monitoring and sampling

II-4 Dissemination, collection of information, and teaching

II-5 Assistance

Division of functions that contribute to the activities.

II-1 Administration and inspection

II-1.1 Administrative and inspective duties

II-1.1.1 General management

II-1.1.2 General Director of Administration and Inspection

II-1.1.3 Chairman of Administrative Department

II-1.1.4 Chairman of Inspection Department

II-1.1.5 Vice-Chairman of Administrative Section

II-1.1.6 Chief of Laboratory Section for Inspection

II-1.1.7 Coordinator

II-1.2 Participation on various commissions and committees

- II-1.2.1 Government Executive Board
- II-1.2.2 Institutional council
- II-1.2.3 Administrative technical council
- II-1.2.4 Inspectory technical council
- II-1.2.5 Special commissions and committees

II-1.3 Participation of the institution in scientific and technological societies

- II-1.3.1 International
- II-1.3.2 National
- II-1.3.3 Institutional

II-1.4 Organization for events

- II-1.4.1 International
- II-1.4.2 National
- II-1.4.3 Institutional

II-2 Research

- II-2.1 International level
  - II-2.1.1 Organization of Research
    - II-2.1.1.1 Coordinator
    - II-2.1.1.2 Supervisor
    - II-2.1.1.3 Researcher
  - II-2.1.2 Practice of Research
    - II-2.1.2.1 Supervisor
    - II-2.1.2.2 Researcher
    - II-2.1.2.3 Assistant

II-2.2 National level

II-2.2.1 Organization of Research

II-2.2.1.1 Coordinator

II-2.2.1.2 Supervisor

II-2.2.1.3 Researcher

II-2.2.2 Practice of Research

II-2.2.2.1 Supervisor

II-2.2.2.2 Researcher

II-2.2.2.3 Assistant

II-3 Designing, standardizing, monitoring and sampling

II-3.1 Organization of designing, standardizing, monitoring and sampling

II-3.1.1 Development of plans and programs for designing, standardizing, monitoring and sampling by studying, improving and implementing the programs

II-3.1.1.1 International

II-3.1.1.2 National

II-3.1.1.3 Institutional

II-3.1.2 Participation in the development of methods for designing, standardizing, monitoring and sampling

II-3.1.2.1 International

II-3.1.2.2 National

II-3.1.2.3 Institutional

II-3.2 Practice of designing, standardizing, monitoring and sampling

- II-3.2.1 Direct work with the environmental aspect
  - II-3.2.1.1 Design requirements
  - II-3.2.1.2 Standards law
  - II-3.2.1.3 Norms
  - II-3.2.1.4 Monitoring methods
  - II-3.2.1.5 Sampling methods
- II-3.2.2 Courses and seminars
  - II-3.2.2.1 Design
  - II-3.2.2.2 Standards
  - II-3.2.2.3 Norms
  - II-3.2.2.4 Monitoring
  - II-3.2.2.5 Sampling

II-4 Dissemination, collection of information, and teaching

- II-4.1 Publications
  - II-4.1.1 Books
    - II-4.1.1 International
    - II-4.1.2 National
  - II-4.1.2 Scientific Publications
    - II-4.1.2.1 International
    - II-4.1.2.2 National

II-4.1.3 Patents

II-4.1.3.1 International

II-4.1.3.2 National

II-4.1.4 Articles

II-4.1.4.1 International

II-4.1.4.2 National

II-4.1.5 Instructional Material

II-4.1.5.1 National

II-4.1.5.2 International

II-4.2 Presentations of proposals, lectures, conferences and seminars

II-4.2.1 International

II-4.2.2 National

II-4.2.3 Institutional

II-4.3 Documents preparation

II-4.3.1 Reports

II-4.3.2 Proposals

II-4.3.3 Outline of proposals

II-4.3.4 Summaries

II-5 Assistance

II-5.1 Assistance to administration and inspection

II-5.1.1 International

II-5.1.2 National

II-5.1.3 Institutional

II-5.2 Assistance to research

II-5.2.1 International

II-5.2.2 National

II-5.2.3 Institutional

II-5.3 Assistance to designing, standardizing, monitoring and sampling

II-5.3.1 International

II-5.3.2 National

II-5.3.3 Institutional

II-5.4 Assistance to dissemination, collection of information, and teaching

II-5.4.1 International

II-5.4.2 National

II-5.4.3 Institutional

APPENDIX D

COMPUTATION OF THE WEIGHTS OF THE TREE NODES

1. Introduction
2. Description of Computer Program
3. Weights of Tree Nodes by Saaty Method Questionnaires
4. Judgment Matrices from the Experts' Answers to Questionnaires. Characteristic Vectors
5. Tree in Detail with the Absolute Values from the Experts' Answers

APPENDIX D

COMPUTATION OF THE WEIGHTS OF TREE NODES

1. Introduction

Chapter IV, Section B demonstrated the importance of having a computer program to calculate the characteristic values and vectors of the judgment matrices and absolute values of the factors' importance. Thus, in this Appendix, Section 2 describes the program used to obtain the characteristic values and vectors of the matrices, which results are shown in Section 3 of this Appendix. By applying the Saaty method (see Appendix B, Section 2) to the answers of the questionnaires the matrices were obtained.

In the last section of this Appendix, the tree with the weight of each factor is shown.

2. Description of the Computer Program

The value obtained from the questionnaires were relative values of the importance between pairs of factors. From these relative values the absolute values of each basic function or activity were calculated by determining the vector of the real highest characteristic value. The calculation of this characteristic vector is time consuming if done manually; for this reason a computer program facilitates the calculations.

In the Computer Center of The University of Oklahoma at Norman, a computer program that calculates characteristic vectors and values of non-symetric matrices was found; in the package of statistics and mathematics of the system IMSL, the routine EIGRF.[17] A program in Fortran language was prepared to call such routine and also to accomplish the following conditions:

a. Feeding the judge matrix in two ways: with the average of the experts' opinions or without the average, in which case the computer will calculate them.
b. Obtaining only the lambda maximum (λ_{max}) and its corresponding results in the computer feed out.
c. Printing out of feeding data for their verification.
d. Normalization to one of each characteristic vector.[18]

The following chart in Figure D.1 shows the computer program process. Next an example of how the data is fed into the IBM computer and a list program in Fortran IV are shown.

The judgment matrix related to development of the country such as development and services of water supply, development and services of solid waste collection and disposal, preparation of human resources at graduate level, development and services of industrial solid waste treatment and disposal, development of a national program of natural resources protection, and noise and air pollution control, containing the results of the experts' opinions is shown as an example of how to calculate the highest characteristic vector through the computer program.

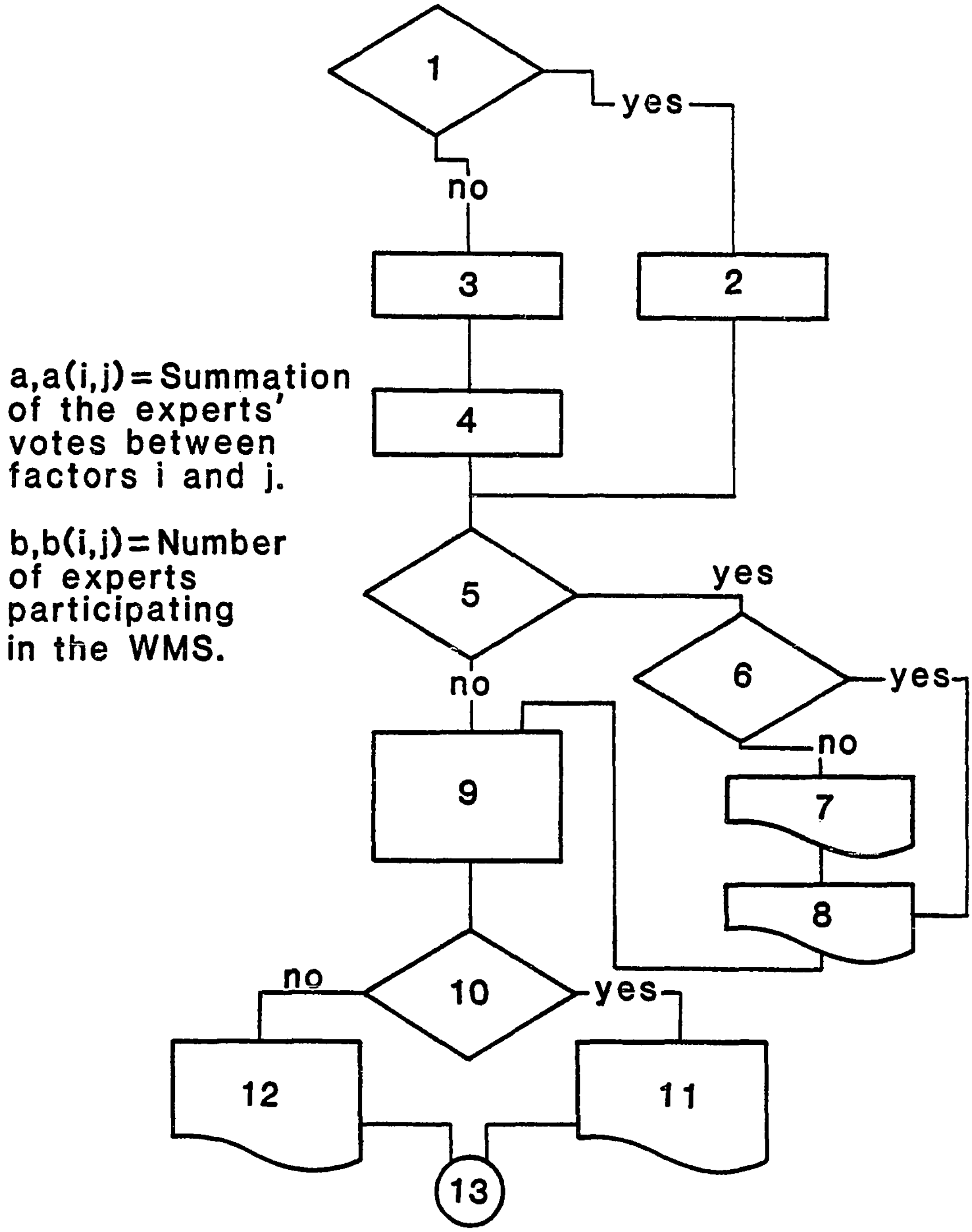


Figure D.1 FLOW CHART of the COMPUTER PROGRAM to CALCULATE the CHARACTERISTIC VALUES and VECTORS of the JUDGMENT MATRIXES.

1 Data from judge matrixes are fed as averages

2 Accept data average a(i,j)

3 Accept data aa(i,j), bb(i,j)

4 Calculate average $a(i,j) = \frac{\sum aa\ (i,j)}{\sum bb\ (i,j)}$

5 Print matrix of judgment data a(i,j)

6 Direct entry of average

7 a,a(i,j) b,b(i,j)

8 a(i,j)

9 Calculate the characteristic vectors and values ZR(i) and Z(4,i) corresponding to the judgment matrix a(i,j) respectively

10 Feed out any real characteristic vector

11 Print the vector of the highest characteristic value

12 All lambdas(λ) are complex

13 end

DESCRIPTIONS FOR Figure D.1

With the matrix data an information file was constructed in the computer. This information is shown on Table D.1 where number 2=NO indicates that the data from the judgment matrix fed to the computer was not the average of the experts' votes. There is a pair of data in which the first number represents the total sum of the votes given by the experts, and the second number represents the total number of experts that participated in the questionnaire answers. Also the number 1=YES indicates that, if the data needs to be verified, the computer will print out. Then there is another line where the computer asks for the size of the matrix and then located the pair values already explained. The sheet used to pick up the questionnaire answers from the experts' votes in this case related to the development of the country is attached. Also, the computer program in Fortram IV is listed.

DATE: Dec., 1981

LEVEL I-0: COUNTRY DEVELOPMENT

	C_1	C_2	C_3	C_4	C_5	C_6	CV*
C_1	1	65/13	55/13	65/13	63/13	65/13	0.437
C_2	13/65	1	24/13	55/13	263/13	65/13	0.263
C_3	13/55	13/24	1	60/13	81/13	50/13	0.263
C_4	13/65	13/55	13/60	1	43/13	55/13	0.0736
C_5	13/63	13/263	13/81	13/43	1	31/13	0.0377
C_6	13/65	13/65	13/50	13/55	13/31	1	0.0346

*CV refers to characteristic vectors

λmax= 7.1665

Figure D.2: Matrix of Judgment Used as Example in Application of the Computer Program

CONTRIBUTORY FACTORS:

C_1: I.1 Development and services of water supply (INAA)

C_2: I.2 Development and services of solid waste collection and disposal (MST)

C_3: I.3 Preparation of human resources at postgraduate level (UCR)

C_4: I.4 Development and services of industrial solid waste treatment and disposal (MEIC)

C_5: I.5 Development of a national program of natural resources protection (SENAS)

C_6: I.6 Noise and air pollution control (MS)

```
loadgo xxx fortlib lib('sys4.imsl.d.modules')
CHARACTERISTIC VALUES AND VECTORS
DIRECT INLET OF THE MATRIX A?
1 = YES 2 = NO
?
2
EXIT ONLY MAXIMUM LAMBDA VALUE?1 = YES 2 = NO
?
1
GIVE ME MATRIX SIZE
?
6

GIVE ME PAIRS
?
1,1,65,13,55,13,65,13,63,13,65,13

GIVE ME PAIRS
?
13,65,1,1,24,13,55,13,263,13,65,13

GIVE ME PAIRS
?
13,55,13,24,1,1,60,13,81,13,50,13
GIVE ME PAIRS
?
13,65,13,55,13,60,1,1,43,13,55,13

GIVE ME PAIRS
?
13,63,13,263,13,81,13,43,1,1,31,13


GIVE ME PAIRS
?
13,65,13,65,13,50,13,55,13,31,1,1

IF YOU WANT TO RECTIFY THE MATRIX DATA
PUSH 1 FOR YES OR 2 FOR NO
?
1
    1.000       1.000       65.00       13.00       55.00       13.
00       65.00       13.00       63.00       13.00
    65.00       13.00
    13.00       65.00       1.000       1.000       24.00       13.
```

Table D.1: Example of Data Fed to the Computer Program and Results.

```
          55.00          13.00          263.0          13.00
     65.00          13.00
     13.00          55.00          13.00          24.00          1.000          1.0
00          60.00          13.00          81.00          13.00
     50.00          13.00
     13.00          65.00          13.00          55.00          13.00          60.
00          1.000          1.000          43.00          13.00
     55.00          13.00
     13.00          63.00          13.00          263.0          13.00          81.
00          13.00          43.00          1.000          1.000
     31.00          13.00
     13.00          65.00          13.00          65.00          13.00          50.
00          13.00          55.00          13.00          31.00
     1.000          1.000
   1.000          5.000          4.231          5.000          4.846          5.00
0
   .2000          1.000          1.846          4.231          20.23          5.00
0
   .2364          .5417          1.000          4.615          6.231          3.84
6
   .2000          .2364          .2167          1.000          3.308          4.23
1
   .2063          .4943D-01      .1605          .3023          1.000          2.38
5
   .2000          .2000          .2600          .2364          .4194          1.00
0
IMSL ROUTINE ROUTINES IER =    0
(7.16645545648228044,.0)
(-.277229987021609281,2.74200730376339097)
(-.277229987021609281,-2.74200730376339097)
(-.465560278554652304,.0)
(-.732176019422198787E-01,.592476430250880703)
(-.732176019422198787E-01,-.592476430250880703)
(1.00000000000000000,.0) (1.00000000000000000,.0) (1.00000000000000000,.
0) (1.00000000000000000,.0)
(1.00000000000000000,.0) (1.00000000000000000,.0)
(.601945225473967171,.0) (-.135439365640915271,.486764367213642565) (-.1
35439365640915271,-.486764367213642565)
(.135805517954095834E-01,.0) (.541561605438447544,1.19510022307139097) (
.541561605438447544,-1.19510022307139097)
(.354181624145956109,.0) (.292790491834642679E-02,.185184891740372740) (
.292790491834642679E-02,-.185184891740372740)
(-.434899063389464366,.0) (-1.29523421309524256,-1.20621640150463838) (-
1.29523421309524256,1.20621640150463838)
(.168665097988663693,.0) (-.901637696252152454E-01,.14882213586973905E-
01) (-.901637696252152454E-01,-.14882213586973905E-01)
```

```
(.126235925486508041,.0) (.444871519125393702,-.174785165415073870) (.44
4871519125393702,.174785165415073870)
(.864154475580286158E-01,.0) (-.535642829037778464E-01,-.551348615670123
991E-01)
(-.535642829037778464E-01,.551348615670123991E-01) (.242838362658258835E
-01,.0)
(-.295544016740026142E-01,.916806969602003419E-01) (-.295544016740026142
E-01,-.916806969602003419E-01)
(.792321136156244332E-01,.0) (.195958309760997252E-01,-.5650163192732862
37E-01)
(.195958309760997252E-01,.565016319273286237E-01) (-.884736591209497186E
-01,.0)
(-.764641984030498129E-01,.299651233825133576E-01) (-.764641984030498129
E-01,-.299651233825133576E-01)
IER =    0
EXIT OF Z
         1 (7.16645545648228044,.0)           2 (-.277229987021609281,2
.74200730376339097)          3
(-.277229987021609281,-2.74200730376339097)          4 (-.465560278554
652304,.0)          5
(-.732176019422198787E-01,.592476430250880703)          6 (-.7321760194
22198787E-01,-.592476430250880703)
EXIT OF Z
  1.00      .0        1.00      .0        1.00      .0        1.00
  .0        1.00      .0        1.00      .0
*****************************
  .602      .0        -.135     .487      -.135     -.487     .136D-01
  .0        .542      1.20      .542      -1.20
*****************************
  .354      .0        .293D-02  .185      .293D-02 -.185      -.435
  .0        -1.30     -1.21     -1.30     1.21
*****************************
  .169      .0        -.902D-01  .149D-01 -.902D-01 -.149D-01  .126
  .0        .445      -.175     .445      .175
*****************************
  .864D-01  .0        -.536D-01 -.551D-01 -.536D-01  .551D-01  .243D-01
  .0        -.296D-01  .917D-01 -.296D-01 -.917D-01
*****************************
  .792D-01  .0        .196D-01 -.565D-01  .196D-01  .565D-01 -.885D-01
  .0        -.765D-01  .300D-01 -.765D-01 -.300D-01
*****************************
MAXIMUM LAMBDA
    1    7.1665
MAXIMUM LAMBDA
    0
CHARACTERISTIC VECTOR
  .437      .263      .155      .736D-01  .377D-01  .346D-01
```

```
C$JOB  NOLIST
          DIMENSION A(20,20),W(20),Z(20,20),WK(1000),RW(50),
     $     RZ(1000)
C    *    DIMENSION A(4,4),W(4),Z(4,4),WK(24),RW(8),RZ(32)
          DIMENSION ZR(20),AA(20,20),BB(20,20)
          COMPLEX Z,W,ZN
          EQUIVALENCE (W(1),RW(1)),(Z(1,1),RZ(1))
          LOGICAL LAMAX,DIRECT
          INTEGER AMEN
          IJOB=2
          IA=20
          IZ=20
 9005     FORMAT(1X,'CHARACTERISTIC VALUES AND VECTORS')
          WRITE(6,9005)
 9006     FORMAT(1X,'DIRECT INLET OF THE MATRIX A?'/1X,'1 = YES',
     $' 2 = NO')
          WRITE(6,9006)
          READ(5,*)AMEN
          DIRECT=.FALSE.
           IF(AMEN.EQ.1)
     $     DIRECT=.TRUE.
 9007      FORMAT(1X,'EXIT ONLY MAXIMUM LAMBDA VALUE?','1 = YES',
     $' 2 = NO')
            WRITE(6,9007)
            READ(5,*)AMEN
            LAMAX=.FALSE.
            IF(AMEN.EQ.1)
     $       LAMAX=.TRUE.
  9008     FORMAT(1X,'GIVE ME MATRIX SIZE')
     5     WRITE(6,9008)
            READ(5,*)N
              IF(DIRECT)GOTO 6
                DO 78 I=1,N
 9009            FORMAT(1X,'GIVE ME PAIRS')
        .     WRITE(6,9009)
            READ(5,*)(AA(I,J),BB(I,J),J=1,N)
C 230   FORMAT(10F7.3)
              DO 77 J=1,N
    77   A(I,J)=AA(I,J)/BB(I,J)
    78          CONTINUE
              GO TO 4
  9010    FORMAT(1X,'GIVE ME DATA OF THE MATRIX ELEMENTS')
    6      WRITE(6,9010)
              DO 1 I=1.N
```

Table D.2: List of the main Computer Program.

```
9011      FORMAT(1X,'GIVE ME THE ROW ELEMENTS OF THE MATRIX')
            WRITE(6,9011)
            READ(5,*)(A(I,J),J=1,N)
  1        CONTINUE
  4       WRITE(6,200)
 200      FORMAT(' IF YOU WANT TO RECTIFY THE MATRIX DATA',/
     $      ,' PUSH 1 FOR YES OR 2 FOR NO')
            READ(5,*)AMEN
            IF(AMEN.EQ.2)GOTO 2
            IF(AMEN.EQ.1)GOTO 3
9012        FORMAT(1X,'WAS NOT UNDERSTAND')
            WRITE(6,9012)
            GOTO 4
   3        IF(DIRECT)GOTO 8
                DO 9 I=1,N
   9        WRITE(6,225)(AA(I,J),BB(I,J),J=1,N)
 225        FORMAT(1X,10F10.3)
   8            DO 10 I=1,N
                WRITE(6,220)(A(I,J),J=1,N)
 220        FORMAT(10F7.4)
  10        CONTINUE
   2          CALL EIGRF(A,N,IA,IJOB,RW,Z,IZ,WK,IER)
              WRITE(6,9876) IER
9876          FORMAT(' IMSL ROUTINE ROUTINES IER = ',I4)
              DO 9879 II = 1, N
9879               WRITE(6,*) W(II)
                DO 12 J=1,N
                ZN=Z(1,J)
                DO 12 I=1,N
                Z(I,J)=Z(I,J)/ZN
  12            CONTINUE
              DO 9880 II=1,N
9880               WRITE(6,*) (Z(II, JJ), JJ=1,N)
                WRITE(6,9003)IER
9003            FORMAT(1X,'IER =',I5)
9013            FORMAT(1X,'EXIT OF Z')
                WRITE(6,9013)
                WRITE(6,*)(I,W(I),I=1,N)
9020            FORMAT(1X,'EXIT OF Z')
                WRITE(6,9020)
                DO 11 I=1,N
                WRITE(6,290)(Z(I,J),J=1,N)
 290            FORMAT(1X,7F10.3)
9014                FORMAT(1X,'**********************************')
                WRITE(6,9014)
  11            CONTINUE
C**************************************************************
                K=0
                DO 40 I=1,N
                IF(ABS(AIMAG(W(I))) .GT. 0.001) GOTO 40
                K=I
```

```
            AMAX=REAL(W(I))
   40       CONTINUE
            IF(K.EQ.0)WRITE(6,9004)
 9004       FORMAT(1X,'ALL LAMBDAS COMPLEX')
            IF(K.EQ.0)GOTO 5
            WRITE(6,9001)K,W(K)
 9001       FORMAT(1X,'MAXIMUM LAMBDA',/,1X,I5,F15.5)
            SU=0
            DO 41 J=1,N
            ZR(J)=REAL(Z(J,K))
   41        SU=SU+ZR(J)
            DO 42 J=1,N
   42        ZR(J)=ZR(J)/SU
 9015       FORMAT(1X,'CHARACTERISTIC VECTOR')
            WRITE(6,9015)
            WRITE(6,290)(ZR(J),J=1,N)
            GOTO 5
      DEBUG SUBCHK
            END
END OF DATA
```

IMSL ROUTINE: EIGRF

```
PURPOSE             - EIGENVALUES AND (OPTIONALLY) EIGENVECTORS OF
                      A REAL GENERAL MATRIX IN FULL STORAGE MODE

USAGE               - CALL EIGRF (A,N,IA,IJOB,W,Z,IZ,WK,IER)

ARGUMENTS   A       - THE INPUT REAL GENERAL MATRIX OF ORDER N
                      WHOSE EIGENVALUES AND EIGENVECTORS ARE TO BE
                      COMPUTED.  INPUT A IS DESTROYED IF IJOB IS
                      EQUAL TO 0 OR 1.
            N       - THE INPUT ORDER OF THE MATRIX A.
            IA      - THE INPUT ROW DIMENSION OF MATRIX A EXACTLY AS
                      SPECIFIED IN THE DIMENSION STATEMENT IN THE
                      CALLING PROGRAM.
            IJOB    - THE INPUT OPTION PARAMETER.  WHEN
                      IJOB = 0, COMPUTE EIGENVALUES ONLY
                      IJOB = 1, COMPUTE EIGENVALUES AND EIGENVECTORS
                      IJOB - 2, COMPUTE EIGENVALUES, EIGENVECTORS AND
                        PERFORMANCE INDEX.
                      IJOB = 3, COMPUTE PERFORMANCE INDEX ONLY.
                      IF THE PERFORMANCE INDEX IS COMPUTED, IT IS
                      RETURNED IN WK (1).  THE ROUTINES HAVE PER-
                      FORMED (WELL, SATISFACTORILY, POORLY) IF
                      WK(1) IS (LESS THAN 1, BETWEEN 1 AND 100,
                      GREATER THAN 100).
            W       - THE OUTPUT COMPLEX VECTOR OF LENGTH N,
                        CONTAINING THE EIGENVALUES OF A.
                      NOTE - THE ROUTINE TREATS W AND A REAL VECTOR
                        OF LENGTH 2*N.  AN APPROPRIATE EQUIVALENCE
                        STATEMENT MAY BE REQUIRED.  SEE DOCUMENT EXAMPLE.
            Z       - THE OUTPUT N BY N COMPLEX MATRIX CONTAINING THE
                        EIGENVECTORS OF A.
                        THE EIGENVECTOR IN COLUMN J OF Z CORRESPONDS
                        TO THE EIGENVALUE W(J).
                        IF IJOB = 0, Z IS NOT USED.
                      NOTE - THE ROUTINE TREATS Z AS A REAL VECTOR OF
                        LENGTH 2*N*N.  AN APPROPRIATE EQUIVALENCE STATE-
                        MENT MAY BE REQUIRED.  SEE DOCUMENT EXAMPLE.
            IZ      - THE INPUT ROW DIMENSION OF MATRIX Z EXACTLY AS
                        SPECIFIED IN THE DIMENSION STATEMENT IN THE CALL-
                        ING PROGRAM.  IZ MUST BE GREATER THAN OR EQUAL TO
                        N IF IJOB IS NOT EQUAL TO ZERO.
            WK      - WORK AREA, THE LENGTH OF WK DEPENDS ON THE VALUE OF
                        IJOB, WHEN
                        IJOB = 0, THE LENGTH OF WK IS AT LEAST N.
                        IJOB = 1, THE LENGTH OF WK IS AT LEAST ZN.
                        IJOB = 2, THE LENGTH OF WK IS AT LEAST (2+N)N.
                        IJOB = 3, THE LENGTH OF WK IS AT LEAST 1.
```

Table D.3 List of the EIGRF Routine for the Computer Program

Table D.3 (Continued):

```
            IER    -  ERROR PARAMETER.  (OUTPUT)
                      TERMINAL ERROR
                         IER = 128+J, INDICATES THAT EQRH3F FAILED
                         TO CONVERGE ON EIGENVALUE J.  EIGENVALUES
                         J=1,J=2,...,N HAVE BEEN COMPUTED CORRECTLY.
                         EIGENVALUES 1,...,J ARE SET TO ZERO.
                         IF IJOB = 1 OR 2 EIGENVECTORS ARE SET TO
                         ZERO.  THE PERFORMANCE INDEX IS SET TO 1000.
                      WARNING ERROR (WITH FIX)
                         IER = 66, INDICATES IJOB IS LESS THAN 0 OR
                            IJOB IS GREATER THAN 3.  IJOB SET TO 1.
                         IER = 67, INDICATES IJOB IS NOT EQUAL TO
                            ZERO, AND IZ IS LESS THAN THE ORDER OF
                            MATRIX A.  IJOB IS SET TO ZERO

PRECISION/HARDWARE-   SINGLE AND DOUBLE/H32
                  -   SINGLE/H36,H48,H60

REQD. IMSL ROUTINES-  EBALAF,EBBCKF,EHBCKF,EHESSF,EQRH3F,UERTST, UGETIO

NOTATION            - INFORMATION ON SPECIAL NOTATION AND
                        CONVENTIONS IS AVAILABLE IN THE MANUAL
                        INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
```

Algorithm

EIGRF computes eigenvalues and (optionally) eigenvectors of a real matrix. It can also compute a performance index.

EIGRF calls IMSL routine EBALAF to balance the matrix. Then, EHESSF and EQRH3F are called to compute eigenvalues and (optionally) eigenvectors. When eigenvectors are computed, EHBCKF and EBBCKF are called to backtransform the eigenvectors.

The performance index is defined as follows

$$P = \max_{1 \leq j \leq n} \frac{\| Az^j - w_j z^j \|_1}{\|A\|_1 \; \|z^j\|_1 \; 10(N)\,(EPS)} \qquad (D.1)$$

where the max is taken over the j eigenvalues w_j and associated eigenvectors z^j. EPS specifies the relative precision of floating point arithmetic. When P is less than 1, the performance of the routines is considered to be excellent in the sense that the residuals Az-wz are as small as can be expected. When P is between 1 and 100 the performance is good. When P is greater than 100 the performance is considered poor.

The performance index was first developed and used by the EISPACK project at Argonne National Laboratory.

3. Weights of Tree Nodes by Saaty

QUESTIONNAIRE

WEIGHTS OF TREE NODES BY SAATY METHOD

December 2, 1981

Dear _______:

I would like to express my appreciation for your prompt response to the questionnaire related to the construction of the tree.

With answers from thirteen experts the tree was constructed using the hierarchical concept. This concept includes a group of elements organized in levels; each level's elements are controlled by at least one element in the immediately superior level and controls at least one element in the immediately inferior level. So, a hierarchy is complete if each element of one level is controlled by any element of the next higher level. However, a finite group of elements that are in the base level are not controlled.

Therefore, the evaluation can be made in two consecutive steps. The first consists of evaluating the study's goals from the point of view of their contribution to the attainment of the base level's elements as defined by the experts. The next step consists of weighting the contribution of these base elements to the elements of the immediately superior level, and so forth until arriving, level by level, to the established maximum, the system's goal, i.e., the development of the country.

As you know, the systemic approach applied in the tree construction does not require too many successive questionnaires in order to reach a consensus among the panelists. Attached is the resultant hierarchical tree applied to the Costa Rica case.

Having learned of your interest in environmental matters, I am writing again to seek your assistance in my work. Specifically, this letter is meant to explain the attached questionnaire, which I hope you can find time to complete and return.

The purpose of the questionnaire is to determine the weights of the tree nodes by using the scale proposed by Thomas L. Saaty for the relative degree of importance between pairs of factors. The scale is included in the questionnaire. The questionnaire is divided into four parts. Part one is an optional personal profile; part two contains general instructions. Part three determines (a) the relative importance of pairs of institutional goals to the development of the country, (b) the relative importance of the pairs of activities to the accomplishment of the goals, and (c) the relative importance of pairs of functions to the accomplishment of each activity. Finally, part four is a miscellaneous section which may include any concerns not specifically addressed earlier.

Knowing your interest in environmental affairs, I will appreciate your assistance in completing and returning the questionnaire. Your cooperation will not only further my studies, but it will help in solving a growing problem in countries of Latin America. I thank you in advance and look forward to your reply.

Yours sincerely,

Harry Castillo
Doctoral Candidate

Carson Engineering Building
The University of Oklahoma at Norman
Norman, Oklahoma 73019

HCV/hcv

Attachments

QUESTIONNAIRE

WEIGHTS OF TREE NODES BY SAATY METHOD

DESIGN OF A GENERAL METHODOLOGY FOR THE
EVALUATION AND CATEGORIZATION OF AN
ENVIRONMENTAL PROGRAM WITH SPECIAL
REFERENCE TO COSTA RICA

Name:__________________________ Postal Address:____________

____

____

Telephone Number___________

PART I: PERSONAL (Optional)

(1) Please name your country and institution ______________

____

(2) In what sector are you employed?

( ) Government Service ( ) Education ( ) Industry

( ) Private

(3) What is your highest level of formal education?

( ) Pre-University ( ) Vocational Training

( ) Bachelor's Degree ( ) Master's Degree

( ) Doctor's Degree ( ) Post Doctoral

(3) Do you have specialized training in environmental science?

( ) YES ( ) NO

PART 2: GENERAL INSTRUCTIONS TO DETERMINE RELATIVE WEIGHTS OF THE TREE NODES

In the following sections please make your judgment with the understanding that: First, an environmental program will be implemented, i.e., the government will provide the institutions (1) the necessary advisory assistance, (2) technology, and (3) enactment and enforcement of equitable laws and regulations. Second, your judgment should be based on the needs of the future.

Please base your judgment on the scheme attached as Figure F.1, corresponding to the hierarchical tree, and use the following scale for the comparison between pairs:

1 = equal importance. The activities contribute equally to the goals.

2 = weak importance. The judgment favors one activity over the other, but not conclusively.

5 = strong importance. The judgment strongly favors one activity over the other.

7 = demonstrated importance. Conclusive judgment of the importance of one activity over the other.

9 = absolute importance. The judgment favors one activity over the other in the highest order possible.

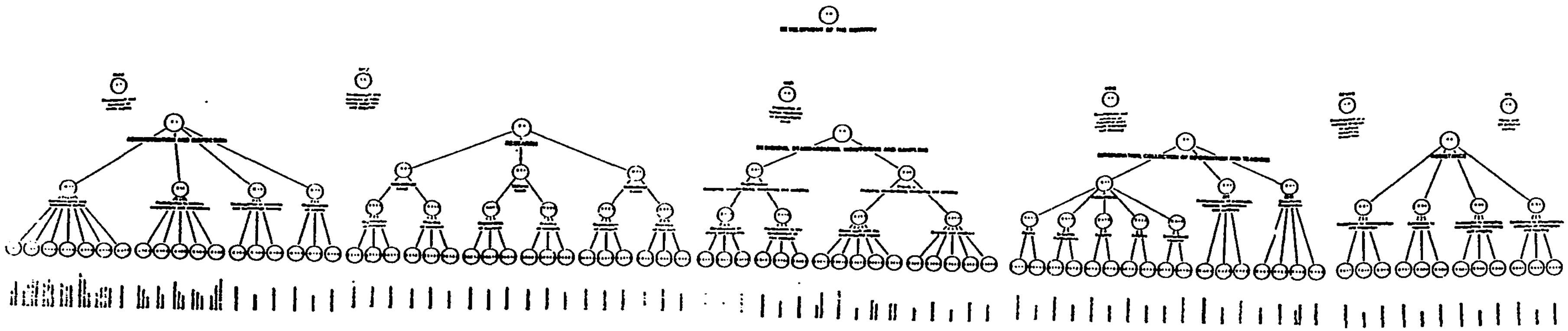


Figure D.3 TREE WITH THE HIERARCHICAL RELATIONS BETWEEN OBJECTIVES, ACTIVITIES AND FUNCTIONS OF AN ENVIRONMENTAL PROGRAM RESULTING FROM THE EXPERTS' ANSWERS TO THE QUESTIONNAIRE.

PART 3: RELATIVE IMPORTANCE OF PAIRS OF GOALS, ACTIVITIES, AND FUNCTIONS

By using the preceding scheme shown in Figure D.3 and the scale, evaluate the relative weights of the nodes based on a series of comparisons between pairs of activities. First of all, the relative importance to the development of the country of pairs of institutional goals will be compared.

For each pair of nodes circle the activity which you consider more important, and then circle the number in the scale which corresponds to the degree of importance of that activity. Example:

	SCORE				
I.1 - I.2 respect A	1	3	5	7	9

In the example I.1 is favored over I.2 by 5 points.

COMPARISONS	SCORE				
I.1 - I.2 respect A	1	3	5	7	9
I.1 - I.3 respect A	1	3	5	7	9
I.1 - I.4 respect A	1	3	5	7	9
I.1 - I.5 respect A	1	3	5	7	9
I.1 - I.6 respect A	1	3	5	7	9
I.2 - I.3 respect A	1	3	5	7	9
1.2 - I.4 respect A	1	3	5	7	9
I.2 - 1.5 respect A	1	3	5	7	9
I.2 - 1.5 respect A	1	3	5	7	9

COMPARISON	SCORE				
I.3 - I.4 respect A	1	3	5	7	9
I.3 - I.5 respect A	1	3	5	7	9
I.3 - I.6 respect A	1	3	5	7	9
I.4 - I.5 respect A	1	3	5	7	9
I.4 - I.6 respect A	1	3	5	7	9
I.5 - I.6 respect A	1	3	5	7	9
II.1 - II.2 respect I.1	1	3	5	7	9
II.1 - II.3 respect I.1	1	3	5	7	9
II.1 - II.4 respect I.1	1	3	5	7	9
II.1 - II.5 respect I.1	1	3	5	7	9
II.2 - II.3 respect I.1	1	3	5	7	9
II.2 - II.4 respect I.1	1	3	5	7	9
II.2 - II.5 respect I.1	1	3	5	7	9
II.3 - II.4 respect I.1	1	3	5	7	9
II.3 - II.5 respect I.1	1	3	5	7	9
II.4 - II.5 respect I.1	1	3	5	7	9
II.1 - II.2 respect I.2	1	3	5	7	9
II.1 - II.3 respect I.2	1	3	5	7	9
II.1 - II.4 respect I.2	1	3	5	7	9
II.1 - II.5 respect I.2	1	3	5	7	9
II.2 - II.3 respect I.2	1	3	5	7	9
II.2 - II.4 respect I.2	1	3	5	7	9
II.2 - II.5 respect I.2	1	3	5	7	9

COMPARISONS			SCORE		
II.3 - II.4 respect I.2	1	3	5	7	9
II.3 - II.5 respect I.2	1	3	5	7	9
II.4 - II.5 respect 1.2	1	3	5	7	9
II.1 - II.2 respect I.3	1	3	5	7	9
II.1 - II.3 respect I.3	1	3	5	7	9
II.1 - II.4 respect I.3	1	3	5	7	9
II.1 - II.5 respect I.3	1	3	5	7	9
II.2 - II.3 respect I.3	1	3	5	7	9
II.2 - II.4 respect I.3	1	3	5	7	9
II.2 - II.5 respect I.3	1	3	5	7	9
II.3 - II.4 respect I.3	1	3	5	7	9
II.3 - II.5 respect I.3	1	3	5	7	9
II.4 - II.5 respect I.3	1	3	5	7	9
II.1 - II.2 respect I.4	1	2	5	7	9
II.1 - II.3 respect I.4	1	2	5	7	9
II.1 - II.4 respect I.4	1	2	5	7	9
II.1 - II.5 respect 1.4	1	2	5	7	9
II.2 - II.3 respect I.4	1	2	5	7	9
II.2 - II.4 respect I.4	1	2	5	7	9
II.2 - II.5 respect I.4	1	2	5	7	9
II.3 - II.4 respect I.4	1	2	5	7	9
II.3 - II.5 respect I.4	1	2	5	7	9
II.4 - II.5 respect I.4	1	2	5	7	9

COMPARISON	SCORE				
II.1 - II.2 respect I.5	1	3	5	7	9
II.1 - II.3 respect I.5	1	3	5	7	9
II.1 - II.4 respect I.5	1	3	5	7	9
II.1 - II.5 respect I.5	1	3	5	7	9
II.2 - II.3 respect I.5	1	3	5	7	9
II.2 - II.4 respect I.5	1	3	5	7	9
II.2 - II.5 respect I.5	1	3	5	7	9
II.3 - II.4 respect I.5	1	3	5	7	9
II.3 - II.5 respect I.5	1	3	5	7	9
II.4 - II.5 respect I.5	1	3	5	7	9
II.1 - II.2 respect I.6	1	3	5	7	9
II.1 - II.3 respect I.6	1	3	5	7	9
II.1 - II.4 respect I.6	1	3	5	7	9
II.1 - II.5 respect I.6	1	3	5	7	9
II.2 - II.4 respect I.6	1	3	5	7	9
II.2 - II.5 respect I.6	1	3	5	7	9
II.3 - II.4 respect I.6	1	3	5	7	9
II.3 - II.5 respect I.6	1	3	5	7	9
II.4 - II.5 respect I.6	1	3	5	7	9
II 1.1 - II 1.2 respect II.1	1	3	5	7	9
II 1.1 - II 1.3 respect II.1	1	3	5	7	9
II 1.1 - II 1.4 respect II.1	1	3	5	7	9
II 1.2 - II 1.3 respect II.1	1	3	5	7	9

COMPARISONS	SCORE				
II 1.2 - II 1.4 respect II.1	1	3	5	7	9
II 1.3 - II 1.4 respect II.1					
II 1.1.1 - II 1.1.2 respect II 1.1	1	3	5	7	9
II 1.1.1 - II 1.1.3 respect II 1.1	1	3	5	7	9
II 1.1.1 - II 1.1.4 respect II 1.1	1	3	5	7	9
II 1.1.1 - II 1.1.5 respect II 1.1	1	3	5	7	9
II 1.1.1 - II 1.1.6 respect II 1.1	1	3	5	7	9
II 1.1.1 - II 1.1.7 respect II 1.1	1	3	5	7	9
II 1.1.2 - II 1.1.3 respect II 1.1	1	3	5	7	9
II 1.1.2 - II 1.1.4 respect II 1.1	1	3	5	7	9
II 1.1.2 - II 1.1.5 respect II 1.1	1	3	5	7	9
II 1.1.2 - II 1.1.6 respect II 1.1	1	3	5	7	9
II 1.1.2 - II 1.1.7 respect II 1.1	1	3	5	7	9
II 1.1.3 - II 1.1.4 respect II 1.1	1	3	5	7	9
II 1.1.3 - II 1.1.5 respect II 1.1	1	3	5	7	9
II 1.1.3 - II 1.1.6 respect II 1.1	1	3	5	7	9
II 1.1.3 - II 1.1.7 respect II 1.1	1	3	5	7	9
II 1.1.4 - II 1.1.5 respect II 1.1	1	3	5	7	9
II 1.1.4 - II 1.1.6 respect II 1.1	1	3	5	7	9
II 1.1.4 - II 1.1.7 respect II 1.1	1	3	5	7	9
II 1.1.5 - II 1.1.6 respect II 1.1	1	3	5	7	9
II 1.1.5 - II 1.1.7 respect II 1.1	1	3	5	7	9
II 1.1.6 - II 1.1.7 respect II 1.1	1	3	5	7	9

COMPARISON	SCORE				
II 1.2.1 - II 1.2.2 respect II 1.2	1	3	5	7	9
II 1.2.1 - II 1.2.3 respect II 1.2	1	3	5	7	9
II 1.2.1 - II 1.2.4 respect II 1.2	1	3	5	7	9
II 1.2.1 - II 1.2.5 respect II 1.2	1	3	5	7	9
II 1.2.2 - II 1.2.3 respect II 1.2	1	3	5	7	9
II 1.2.2 - II 1.2.4 respect II 1.2	1	3	5	7	9
II 1.2.2 - II 1.2.5 respect II 1.2	1	3	5	7	9
II 1.2.3 - II 1.2.4 respect II 1.2	1	3	5	7	9
II 1.2.3 - II 1.2.5 respect II 1.2	1	3	5	7	9
II 1.2.4 - II 1.2.5 respect II 1.2	1	3	5	7	9
II 1.3.1 - II 1.3.2 respect II 1.3	1	3	5	7	9
II 1.3.1 - II 1.3.3 respect II 1.3	1	3	5	7	9
II 1.3.2 - II 1.3.3 respect II 1.3	1	3	5	7	9
II 1.4.1 - II 1.4.2 respect II 1.4	1	3	5	7	9
II 1.4.1 - II 1.4.3 respect II 1.4	1	3	5	7	9
II 1.4.2 - II 1.4.3 respect II 1.4	1	3	5	7	9
II 2.1 - II 2.2 respect II.2	1	3	5	7	9
II 2.1 - II 2.3 respect II.2	1	3	5	7	9
II 2.2 - II 2.3 respect II.2	1	3	5	7	9
II 2.1.1 - II 2.1.2 respect II 2.1	1	3	5	7	9
II 2.1.1 - II 2.1.3 respect II 2.1	1	3	5	7	9

COMPARISON	SCORE				
II 2.3.1 - II 2.3.2 respect II 2.1	1	3	5	7	9
II 2.1.1 - II 2.1.2 respect II 2.1	1	3	5	7	9
II 2.1.1 - II 2.1.3 respect II 2.1	1	3	5	7	9
II 2.1.1 - II 2.1.4 respect II 2.1	1	3	5	7	9
II 2.1.2 - II 2.1.3 respect II 2.1	1	3	5	7	9
II 2.1.2 - II 2.1.4 respect II 2.1	1	3	5	7	9
II 2.1.3 - II 2.1.4 respect II 2.1	1	3	5	7	9
II 3.1 - II 3.2 respect II.3	1	3	5	7	9
II 3.1.1 - II 3.1.2 respect II 3.1	1	3	5	7	9
II 3.1.1.1 - II 3.1.1.2 respect II 3.1.1	1	3	5	7	9
II 3.1.1.1 - II 3.1.1.3 respect II 3.1.1	1	3	5	7	9
II 3.1.1.1 - II 3.1.1.4 respect II 3.1.1	1	3	5	7	9
II 3.1.1.1 - II 3.1.1.5 respect II 3.1.1	1	3	5	7	9
II 3.1.1.2 - II 3.1.1.3 respect II 3.1.1	1	3	5	7	9
II 3.1.1.2 - II 3.1.1.4 respect II 3.1.1	1	3	5	7	9
II 3.1.1.2 - II 3.1.1.5 respect II 3.1.1	1	3	5	7	9
II 3.1.1.3 - II 3.1.1.4 respect II 3.1.1	1	3	5	7	9
II 3.1.1.3 - II 3.1.1.5 respect II 3.1.1	1	3	5	7	9
II 3.1.1.4 - II 3.1.1.5 respect II 3.1.1	1	3	5	7	9

COMPARISON	SCORE				
II 3.1.2.1 - II 3.1.2.2 respect II 3.1.2	1	3	5	7	9
II 3.1.2.1 - II 3.1.2.3 respect II 3.1.2	1	3	5	7	9
II 3.1.2.1 - II 3.1.2.4 respect II 3.1.2	1	3	5	7	9
II 3.1.2.1 - II 3.1.2.5 respect II 3.1.2	1	3	5	7	9
II 3.1.2.2 - II 3.1.2.3 respect II 3.1.2	1	3	5	7	9
II 3.1.2.2 - II 3.1.2.4 respect II 3.1.2	1	3	5	7	9
II 3.1.2.2 - II 3.1.2.5 respect II 3.1.2	1	3	5	7	9
II 3.1.2.3 - II 3.1.2.4 respect II 3.1.2	1	3	5	7	9
II 3.1.2.3 - II 3.1.2.5 respect II 3.1.2	1	3	5	7	9
II 3.1.2.4 - II 3.1.2.5 respect II 3.1.2	1	3	5	7	9
II 3.2.1 - II 3.2.2 respect II 3.2	1	3	5	7	9
II 3.2.1.1 - II 3.2.1.2 respect II 3.2.1	1	3	5	7	9
II 3.2.1.1 - II 3.2.1.3 respect II 3.2.1	1	3	5	7	9
II 3.2.1.2 - II 3.2.1.3 respect II 3.2.1	1	3	5	7	9
II 3.2.2.1 - II 3.2.2.2 respect II 3.2.2	1	3	5	7	9
II 3.2.2.1 - II 3.2.2.3 respect II 3.2.2	1	3	5	7	9
II 3.2.2.2 - II 3.2.2.3 respect II 3.2.2	1	3	5	7	9
II 4.1 - II 4.2 respect II.4	1	3	5	7	9
II 4.1 - II 4.3 respect II.4	1	3	5	7	9
II 4.2 - II 4.3 respect II.4	1	3	5	7	9

COMPARISON	SCORE				
II 4.1.1 - II 4.1.2 respect II 4.1	1	3	5	7	9
II 4.1.1 - II 4.1.3 respect II 4.1	1	3	5	7	9
II 4.1.1 - II 4.1.4 respect II 4.1	1	3	5	7	9
II 4.1.1 - II 4.1.5 respect II 4.1	1	3	5	7	9
II 4.1.2 - II 4.1.3 respect II 4.1	1	3	5	7	9
II 4.1.2 - II 4.1.3 respect II 4.1	1	3	5	7	9
II 4.1.2 - II 4.1.4 respect II 4.1	1	3	5	7	9
II 4.1.2 - II 4.1.5 respect II 4.1	1	3	5	7	9
II 4.1.3 - II 4.1.4 respect II 4.1	1	3	5	7	9
II 4.1.3 - II 4.1.5 respect II 4.1	1	3	5	7	9
II 4.1.4 - II 4.1.5 respect II 4.1	1	3	5	7	9
II 4.2.1 - II 4.2.2 respect II 4.2	1	3	5	7	9
II 4.2.1 - II 4.2.3 respect II 4.2	1	3	5	7	9
II 4.2.2 - II 4.2.3 respect II 4.2	1	3	5	7	9
II 4.1.5.1 - II 4.1.5.2 respect II 4.1.5	1	3	5	7	9
II 4.3.1 - II 4.3.2 respect II 4.3	1	3	5	7	9
II 4.3.1 - II 4.3.3 respect II 4.3	1	3	5	7	9
II 4.3.1 - II 4.3.4 respect II 4.3	1	3	5	7	9
II 4.3.1 - II 4.3.5 respect II 4.3	1	3	5	7	9
II 4.3.2 - II 4.3.4 respect II 4.3	1	3	5	7	9
II 4.3.3 - II 4.3.4 respect II 4.3	1	3	5	7	9

COMPARISON	SCORE				
II 5.1.1 - II 5.1.2 respect II 5.1	1	3	5	7	9
II 5.1.1 - II 5.1.3 respect II 5.1	1	3	5	7	9
II 5.1.2 - II 5.1.3 respect II 5.1	1	3	5	7	9
II 5.2.1 - II 5.2.2 respect II 5.2	1	3	5	7	9
II 5.2.1 - II 5.2.3 respect II 5.2	1	3	5	7	9
II 5.2.2 - II 5.2.3 respect II 5.2	1	3	5	7	9
II 5.3.1 - II 5.3.2 respect II 5.3	1	3	5	7	9
II 5.3.1 - II 5.3.3 respect II 5.3	1	3	5	7	9
II 5.3.2 - II 5.3.3 respect II 5.3	1	3	5	7	9
II 5.4.1 - II 5.4.2 respect II 5.4	1	3	5	7	9
II 5.4.1 - II 5.4.3 respect II 5.4	1	3	5	7	9
II 5.4.2 - II 5.4.3 respect II 5.4	1	3	5	7	9

PART 4: MISCELLANEOUS

Are there any other comments that you wish to make? Please include additional sheets as needed.

Please return completed questionnaire to:

Harry Castillo
1118-A McGee Drive
Norman, Oklahoma 73069
Phone: 405-321-3254

From the experts' answers to the preceding questionnaire, in which thirteen experts participated, five outside the country and eight inside, answers for each item were added and divided by the number of experts. Then that data was set up on the matrices shown on Tables D.4 through D.46.

4. Judgment Matrices from the Experts' Answers to Questionnaire. Characteristic Vectors

DATE: Nov., 1981

LEVEL I-O: COUNTRY DEVELOPMENT

	C_1	C_2	C_3	C_4	C_5	C_6	CV*
C_1	1	65/13	55/13	65/13	63/13	65/13	0.437
C_2	13/15	1	24/13	55/13	263/13	65/13	0.0263
C_3	13/55	13/24	1	60/13	81/13	50/13	0.155
C_4	13/65	13/55	13/60	1	43/13	55/13	0.0736
C_5	13/63	13/263	13/81	13/43	1	39/13	0.0377
C_6	13/65	13/65	13/50	13/55	13/39	1	0.0346

*CV refers to characteristic vectors

$\lambda_{max}=$ 7.1665

Table D.4: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-0

CONTRIBUTORY FACTORS:

C_1: I.1 Development and services of water supply (INAA)

C_2: I.2 Development and services of solid waste collection and disposal (MSJ)

C_3: I.3 Preparation of human resources at postgraduate level (UCR)

C_4: I.4 Development and services of industrial solid waste treatment and disposal (MEIC)

C_5: I.5 Development of a national program of natural resources protection (SENAS)

C_6: I.6 Noise and air pollution control (MS)

DATE: Nov., 1981

LEVEL I-1: DEVELOPMENT AND SERVICES OF WATER SUPPLY

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	34/13	13/32	13/24	60/13	0.197
C_2	13/34	1	13/44	13/26	42/13	0.114
C_3	32/13	44/13	1	34/13	68/13	0.412
C_4	24/13	26/13	13/34	1	50/13	0.226
C_5	13/60	13/42	13/68	13/50	1	0.0514

*CV refers to characteristic vectors

λ max= 5.1896

Table D.5: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-1

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information, and teaching

C_5: II.5 Assistance

DATE: Nov., 1981

LEVEL I-2: DEVELOPMENT AND SERVICE OF SOLID WASTE COLLECTION AND DISPOSAL (MST)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	45/13	86/13	65/13	65/13	0.488
C_2	13/45	1	65/13	50/13	13/37	0.163
C_3	13/86	13/65	1	13/39	13/68	0.0402
C_4	13/65	13/50	39/13	1	13/44	0.0752
C_5	13/65	37/13	68/13	44/13	1	0.234

*CV refers to characteristic vectors

$\lambda_{max}=$ 5.3833

Table D.6: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-2

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: Nov., 1981

LEVEL I-3: PREPARATION OF HUMAN RESOURCES AT POSTGRADUATE LEVEL (UCR)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/45	71/13	60/13	50/13	0.270
C_2	45/13	1	76/13	65/13	60/13	0.478
C_3	13/71	13/79	1	13/47	13/76	0.0380
C_4	13/60	13/65	47/13	1	13/42	0.0738
C_5	13/50	13/60	76/13	42/13	1	0.140

*CV refers to characteristic vectors

$\lambda_{max} \doteq$ 5.5372

Table D.7: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-3

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: Nov., 1981

LEVEL I-4: DEVELOPMENT AND SERVICES OF INDUSTRIAL SOLID WASTE TREATMENT AND DISPOSAL

(MEIC)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/42	65/13	50/13	50/13	0.262
C_2	42/13	1	65/13	76/13	68/13	0.487
C_3	13/65	13/65	1	13/34	13/29	0.0521
C_4	13/50	13/76	34/13	1	13/55	0.0707
C_5	13/50	13/68	24/13	55/13	1	0.128

*CV refers to characteristic vectors

λ max= 5.4962

Table D.8: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-4

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information, and teaching

C_5: II.5 Assistance

DATE: Nov., 1981

LEVEL I-5: DEVELOPMENT OF A NATIONAL PROGRAM OF NATURAL RESOURCES PROTECTION (SENAS)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	13/47	76/13	45/13	50/13	0.242
C_2	47/13	1	91/13	68/13	81/13	0.508
C_3	13/76	13/91	1	13/65	13/86	0.0322
C_4	13/45	13/68	65/13	1	13/50	0.0777
C_5	13/50	13/81	86/13	50/13	1	0.140

*CV refers to characteristic vectors

$\lambda_{max}=$ 5.6869

Table D.9: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE. AT LEVEL I-5

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: Nov., 1981

LEVEL I-6: NOISE AND AIR POLLUTION CONTROL

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	71/13	65/13	13/45	71/13	0.281
C_2	13/71	1	13/27	13/68	21/13	0.0618
C_3	13/65	37/13	1	13/81	34/13	0.0989
C_4	45/13	68/13	81/13	1	97/13	0.514
C_5	13/71	13/21	13/34	13/97	1	0.0449

*CV refers to characteristic vectors

λ max= 5.3686

Table D.10: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL I-6

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information, and teaching

C_5: II.5 Assistance

DATE: Dec., 1981

LEVEL II-1: ADMINISTRATION AND INSPECTION

	C_1	C_2	C_3	C_4	CV*
C_1	1	42/13	34/13	60/13	0.493
C_2	13/42	1	39/13	39/13	0.265
C_3	13/34	13/39	1	52/13	0.170
C_4	13/60	13/39	13/52	1	0.0718

*CV refers to characteristic vectors

λ max= 4.3130

Table D.11: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-1

CONTRIBUTORY FACTORS:

C_1: II.1.1 Administrative and inspection

C_2: II.1.2 Participation on various commissions and committees

C_3: II.1.3 Participation of the institution in scientific and technological societies

C_4: II.1.4 Organizations for events

 DATE: Dec., 1981

LEVEL II-1.1: ADMINISTRATION AND INSPECTION DUTIES

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	CV*
C_1	1	50/13	63/13	73/13	86/13	97/13	112/13	0.437
C_2	13/50	1	39/13	50/13	68/13	84/13	84/13	0.232
C_3	13/63	13/39	1	29/13	39/13	60/13	65/13	0.126
C_4	13/73	13/50	13/29	1	32/13	47/13	60/13	0.0882
C_5	13/86	13/68	13/39	13/32	1	32/13	50/13	0.0567
C_6	13/97	13/84	13/60	13/47	13/32	1	32/13	0.0352
C_7	13/112	13/84	13/65	13/60	13/50	13/32	1	0.0246

*CV refers to characteristic vectors

λ_{max} = 7.5164

Table D.12: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-1.1

CONTRIBUTORY FACTORS:

C_1: II.1.1.1 General management

C_2: II.1.1.2 General Director of administration and inspection

C_3: II.1.1.3 Chairman of administrative department

C_4: II.1.1.4 Chairman of inspection department

C_5: II.1.1.5 Vice chairman of administrative section

C_6: II.1.1.6 Chief of laboratory section for inspection

C_7: II.1.1.7 Coordinator

DATE: Dec., 1981

LEVEL II-1.2: PARTICIPATION ON VARIOUS COMMISSIONS AND COMMITTEES

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	42/13	71/13	89/13	109/13	0.522
C_2	13/42	1	42/13	63/13	81/13	0.255
C_3	13/71	13/42	1	39/13	58/13	0.123
C_4	13/89	13/63	13/39	1	37/43	0.0636
C_5	15/109	13/81	13/58	13/37	1	0.0358

*CV refers to characteristic vectors

λ max= 5.2735

Table D.13: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-1.2

CONTRIBUTORY FACTORS:

C_1: II.1.2.1 Governmental executive board

C_2: II.1.2.2 Institutional council

C_3: II.1.2.3 Administrative technical council

C_4: II.1.2.4 Inspectory technical council

C_5: II.1.2.5 Special commissions and committees

DATE: Dec., 1981

LEVEL II-1.3: PARTICIPATION OF THE INSTITUTION IN SCIENTIFIC AND TECHNOLOGICAL SOCIETIES

	C_1	C_2	C_3	CV*
C_1	1	68/13	102/13	0.733
C_2	13/68	1	58/13	0.202
C_3	13/102	13/58	1	0.0650

*CV refers to characteristic vectors

λ max= 3.1335

Table D.14: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-1.3

CONTRIBUTORY FACTORS:

C_1: II.1.3.1 International

C_2: II.1.3.2 Internal

C_3: II.1.3.3 Institutional

DATE: Dec., 1981

LEVEL II-1.4 ORGANIZATION FOR EVENTS

	C_1	C_2	C_3	CV*
C_1	1	76/13	86/13	0.743
C_2	13/76	1	39/13	0.176
C_3	13/86	13/39	1	0.0811

λ_{max}= 3.1066

Table D.15: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-1.4

CONTRIBUTORY FACTORS:

C_1: II.1.4.1 International

C_2: II.1.4.2 National

C_3: II.1.4.3 Institutional

DATE: Dec., 1981

LEVEL II-2 RESEARCH

	C_1	C_2	C_3	CV*
C_1	1	52/13	81/13	0.698
C_2	13/52	1	34/13	0.207
C_3	13/81	13/34	1	0.0943

*CV refers to characteristic vectors

λ max= 3.0299

Table D.16: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2

CONTRIBUTORY FACTORS:

C_1: II.2.1 International level

C_2: II.2.2 National level

C_3: II.2.3 Institutional level

DATE: Dec., 1981

LEVEL II-2.1: RESEARCH AT INTERNATIONAL LEVEL

	C_1	C_2	CV*
C_1	1	39/13	0.750
C_2	13/34	1	0.250

*CV refers to characteristic vectors

λ_{max}= 2.000

Table D.17: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.1

CONTRIBUTORY FACTORS:

C_1: II.2.1.1 Organization of research

C_2: II.2.1.2 Practice of research

DATE: Dec., 1981

LEVEL II-2.1.1 ORGANIZATION OF RESEARCH

AT INTERNATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	52/13	95/13	0.688
C_2	13/52	1	69/13	0.246
C_3	13/95	13/69	1	0.0660

*CV refers to characteristic vectors

λ max= 3.1277

Table D.18: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.1.1

CONTRIBUTORY FACTORS:

C_1: II.2.1.1.1 ~~Coordinator~~

C_2: II.2.1.1.2 Supervisor

C_3: II.2.1.1.3 Researcher

DATE: Dec., 1981

LEVEL II-2.1.2 PRACTICE OF RESEARCH

AT INTERNATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	42/13	95/13	0.662
C_2	13/42	1	67/13	0.270
C_3	13/95	13/67	1	0.0688

*CV refers to characteristic vectors

λ max= 3.0758

Table D.19: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.1.2

CONTRIBUTORY FACTORS:

C_1: II.2.1.2.1 Supervisor

C_2: II.2.1.2.2 Researcher

C_3 II.2.1.2.3 Assistant

DATE: Dec., 1981

LEVEL II-2.2 RESEARCH AT NATIONAL LEVEL

	C_1	C_2	CV*
C_1	1	39/13	0.750
C_2	13/39	1	0.250

*CV refers to characteristic vectors λ max= 2.000

Table D.20: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.2

CONTRIBUTORY FACTORS:

C_1: II.2.2.1 Organization of research

C_2: II.2.2.2 Practice of research

DATE: Dec., 1981

LEVEL II-2.2.1: ORGANIZATION OF RESEARCH AT NATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	49/13	91/13	0.679
C_2	13/49	1	65/13	0.251
C_3	13/91	13/65	1	0.0698

*CV refers to characteristic vectors

$\lambda_{max} =$ 3.110

Table D.21: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.2.1

CONTRIBUTORY FACTORS:

C_1: II.2.2.1.1 Coordinator

C_2: II.2.2.1.2 Supervisor

C_3: II.2.2.1.3 Researcher

DATE: Dec., 1981

LEVEL II-2.2.2 PRACTICE OF RESEARCH

AT NATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	39/13	91/13	0.651
C_2	13/39	1	63/13	0.277
C_3	13/91	13/63	1	0.0728

*CV refers to characteristic vectors

λ_{max}= 3.0546

Table D.22: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.2.2

CONTRIBUTORY FACTORS:

C_1: II.2.2.2.1 Supervisor

C_2: II.2.2.2.2 Researcher

C_3: II.2.2.2.3 Assistant

DATE: Dec., 1981

LEVEL II-2.3: RESEARCH AT INSTITUTIONAL LEVEL

	C_1	C_2	CV*
C_1	1	39/13	0.750
C_2	13/39	1	0.250

*CV refers to characteristic vectors λ max= 2.000

Table D.23: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.3

CONTRIBUTORY FACTORS:

C_1: II.2.3.1 Organization of research

C_2: II.2.3.2 Practice of research

DATE: Dec., 1981

LEVEL II-2.3.1: ORGANIZATION OF RESEARCH AT INSTITUTIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	47/13	89/13	0.675
C_2	13/47	1	60/13	0.251
C_3	13/89	13/60	1	0.0733

*CV refers to characteristic vectors

$\lambda_{max} = 3.0888$

Table D.24: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.3.1

CONTRIBUTORY FACTORS:

C_1: II.2.3.1.1 Coordinator

C_2: II.2.3.1.2 Supervisor

C_3: II.2.3.1.3 Researcher

DATE: Dec., 1981

LEVEL II-2.3.2: PRACTICE OF RESEARCH

AT INSTITUTIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	37/13	89/13	0.645
C_2	13/37	1	58/13	0.278
C_3	13/89	13/58	1	0.0767

*CV refers to characteristic vectors

λ max= 3.0426

Table D.25: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-2.3.2

CONTRIBUTORY FACTORS:

C_1: II.2.1.2.1 Supervisor

C_2: II.2.1.2.2 Researcher

C_3: II.2.1.2.3 Assistant

DATE: Dec., 1981

LEVEL II-3: DESIGNING, STANDARDIZING, MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	24/13	0.649
C_2	13/24	1	0.351

*CV refers to characteristic vectors λ max= 1.0000

Table D.26: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-3

CONTRIBUTORY FACTORS:

C_1: II.3.1 Organization of designing, standardizing, monitoring, sampling

C_2: II.3.2 Practice of designing, standardizing, monitoring, sampling

DATE: Dec., 1981

LEVEL II-3.1: ORGANIZATION OF DESIGNING, STANDARDIZING, MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	42/13	0.764
C_2	13/42	1	0.236

*CV refers to characertistic vectors λ max= 2.0000

Table D.27 JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-3.1

CONTRIBUTORY FACTORS:

C_1: II.3.1.1. Development of plans and programs for designing, standardizing, monitoring and sampling by studying, improving and implementing the program

C_2: II.3.1.2 Participation in development of method for designing, standardizing, monitoring and sampling

DATE: Dec., 1981

LEVEL II-3.1.1: DEVELOPMENT OF PLANS AND PROGRAMS FOR DESIGNING, STANDARDIZING, MONITORING, AND SAMPLING BY STUDYING, IMPROVING AND IMPLEMENTING PROGRAM

	C_1	C_2	C_3	CV*
C_1	1	13/63	13/94	0.0721
C_2	63/13	1	13/37	0.282
C_3	94/13	37/13	1	0.646

*CV refers to characteristic vectors

$\lambda_{max} =$ 3.0465

Table D.28: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESNAIRE AT LEVEL II-3.1.1

CONTRIBUTORY FACTORS:

C_1: II.3.1.1.1 International

C_2: II.3.1.1.2 National

C_3: II.3.1.1.3 Institutional

DATE: Dec., 1981

LEVEL II-3.1.2: PARTICIPATION IN THE JUDGMENT OF METHODS FOR DESIGNING, STANDARDIZING, MONITORING, AND SAMPLING

	C_1	C_2	C_3	CV*
C_1	1	13/60	13/41	0.0714
C_2	60/13	1	13/52	0.238
C_3	91/13	52/13	1	0.640

*CV refers to characteristic vectors

λ_{max} = 3.1054

Table D.29: JUDGMENT MATRIX FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRE. AT LEVEL II-3.1.2

CONTRIBUTORY FACTORS:

C_1: II.3.1.2.1 International

C_2: II.3.1.2.2 National

C_3: II.3.1.2.3 Institutional

DATE: Dec., 1981

LEVEL II-3.2: PRACTICE OF DESIGNING, STANDARDIZING, MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	39/13	0.750
C_2	13/39	1	0.250

*CV refers to characteristic vectors

λ max= 2.0000

Table D.30: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-3.2

CONTRIBUTORY FACTORS:

C_1: II.3.2.1 Direct work with environmental aspect

C_2: II.3.2.2 Courses and seminars

DATE: Dec., 1981

LEVEL II-3.2.1: DIRECT WORK WITH THE ENVIRONMENTAL ASPECT

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	60/13	94/13	94/13	117/13	0.577
C_2	13/60	1	55/13	65/13	55/13	0.228
C_3	13/94	13/55	1	26/13	52/13	0.0938
C_4	13/94	13/65	13/26	1	37/13	0.0637
C_5	13/117	13/55	13/52	13/37	1	0.0374

*CV refers to characteristic vectors

λ max= 5.3791

Table D.31: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-3.2.1

CONTRIBUTORY FACTORS:

C_1: II.3.2.1.1 Standard laws

C_2: II.3.2.1.2 Design requirements

C_3: II.3.2.1.3 Norms

C_4: II.3.2.1.4 Monitoring methods

C_5: II.3.2.1.5 Sampling methods

DATE: Dec., 1981

LEVEL II-3.2.2 COURSES AND SEMINARS

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	63/13	89/13	94/13	117/13	0.570
C_2	13/63	1	60/13	89/13	94/13	0.256
C_3	13/89	13/60	1	26/13	45/13	0.0829
C_4	13/94	13/89	13/26	1	42/13	0.0589
C_5	13/117	13/94	13/45	13/42	1	0.0319

*CV refers to characteristic vectors

λ max= 5.4248

Table D.32: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-3.2.2

CONTRIBUTORY FACTORS:

C_1: II.3.2.2.1 Design

C_2: II.3.2.2.2 Standards

C_3: II.3.2.2.3 Norms

C_4: II 3.2.2.4 Monitoring

C_5: II 3.2.2.5 Sampling

DATE: Dec., 1981

LEVEL II-4: DISSEMINATION, COLLECTION OF INFORMATION, AND TEACHING

	C_1	C_2	C_3	CV*
C_1	1	60/13	86/13	0.715
C_2	13/60	1	42/13	0.203
C_3	13/86	13/42	1	0.0824

*CV refers to characteristic vectors

λ_{max}= 3.0738

Table D.33: JUDGMENT MATRIX FROM EXPERTS ANSWERS TO QUESTIONNAIRE AT LEVEL II-4

CONTRIBUTORY FACTORS:

C_1: II.4.1 Publications

C_2: II.4.2 Proposals, lectures, conferences, and seminar presentations

C_3: II.4.3 Document preparations

DATE: Dec., 1981

LEVEL II-4.~~1:~~ PUBLICATIONS

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	37/13	63/13	89/13	102/13	0.487
C_2	13/37	1	50/13	52/13	76/13	0.266
C_3	13/63	13/50	1	50/13	81/13	0.143
C_4	13/89	13/52	13/50	1	60/13	0.0718
C_5	13/102	13/76	13/81	13/60	1	0.0324

*CV refers to characteristic vectors

λ max= 5.5135

Table D.34: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.1

CONTRIBUTORY FACTORS:

C_1: II.4. .1 Books

C_2: II.4. .2 Scientific publications

C_3: II.4. .3 Patents

C_4: II.4. .4 Articles

C_5: II.4. .5 Instructional material

DATE: Dec., 1981

LEVEL II-4.1.1 PUBLICATION OF BOOKS

	C_1	C_2	CV*
C_1	1	13/65	0.167
C_2	65/13	1	0.833

*CV refers to characteristic vectors λ max= 2.0000

Table D.35: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.1.1

CONTRIBUTORY FACTORS:

C_1: II.4.1.1.1 National

C_2: II.4.1.1.2 International

DATE: Dec., 1981

LEVEL II-4.1.2 SCIENTIFIC PUB-
LICATIONS

	C_1	C_2	CV*
C_1	1	13/63	0.171
C_2	63/13	1	0.829

*CV refers to characteristic vectors

λ max= 2.0000

Table D.36: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.1.2

CONTRIBUTORY FACTORS:

C_1: II.4.1.2.1 National

C_2: II.4.1.2.2 International

DATE: Dec., 1981

LEVEL II-4.1.3 REGISTRATION

OF PATENTS

	C_1	C_2	CV*
C_1	1	13/61	0.176
C_2	61/13	1	0.824

*CV refers to characteristic vectors λ max= 2.000

Table D.37: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRES AT LEVEL II-4.1.3

CONTRIBUTORY FACTORS:

C_1: II.4.1.3.1 National

C_2: II.4.1.3.2 International

DATE: Dec., 1981

LEVEL II-4.1.4: PUBLICATION OF ARTICLES

	C_1	C_2	CV*
C_1	1	13/51	0.203
C_2	51/13	1	0.797

*CV refers to characteristic vectors λ max= 2.0000

Table D.38: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.1.4

CONTRIBUTORY FACTORS:

C_1: II.4.1.4.1 National

C_2: II.4.1.4.2 International

DATE: Dec., 1981

LEVEL II-4.1.5 INSTRUCTIONAL MATERIAL

	C_1	C_2	CV*
C_1	1	13/46	0.220
C_2	46/13	1	0.780

*CV refers to characteristic vectors λ max= 2.0000

Table D.39: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE. AT LEVEL II-4.1.5

CONTRIBUTORY FACTORS:

C_1: II.4.1.5.1 National

C_2: ~~II.4.1.5.2 Institutional~~

DATE: Dec., 1981

LEVEL II-4.2: PROPOSALS, CONFERENCES AND SEMINAR PRESENTATIONS

	C_1	C_2	C_3	CV*
C_1	1	78/13	110/13	0.752
C_2	13/78	1	63/13	0.189
C_3	13/110	13/63	1	0.0589

*CV refers to characteristic vectors

λ_{max}= 3.1717

Table D.40: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.2

CONTRIBUTORY FACTORS:

C_1: II.4.2.1 International

C_2: ~~II.4.2.2 National~~

C_3: II.4.2.3 Institutional

DATE: Dec., 1981

LEVEL II-4.3: DOCUMENTS PREPARATION

	C_1	C_2	C_3	C_4	CV*
C_1	1	63/13	84/13	106/13	0.636
C_2	13/63	1	47/13	65/13	0.220
C_3	13/84	13/47	1	47/13	0.0992
C_4	13/106	13/65	13/47	1	0.0457

*CV refers to characteristic vectors

λ_{max}= 4.2692

Table D.41: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-4.3

CONTRIBUTORY FACTORS:

C_1: II.4.3.1 Reports

C_2: II.4.3.2 Proposals

C_3: II.4.3.3 Outline of proposals

C_4: II.4.3.4 Summaries

DATE: Dec., 1981

LEVEL II-5: ASSISTANCE

	C_1	C_2	C_3	C_4	CV*
C_1	1	47/13	89/13	117/13	0.572
C_2	13/47	1	86/13	107/13	0.299
C_3	13/89	13/86	1	87/13	0.0968
C_4	13/117	13/107	13/87	1	0.0322

*CV refers to characteristic vectors

λ max= 4.5549

Table D.42: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-5

CONTRIBUTORY FACTORS:

C_1: II.5.1 Assistance to administration and inspection

C_2: II.5.2 Assistance to research

C_3: II.5.3 Assistance to designing, standardizing, monitoring, sampling

C_4: II.5.4 Assistance to dissemination, collection of information, and teaching

DATE: Feb., 1981

LEVEL II-5.1: ASSISTANCE TO ADMINISTRATION AND INSPECTION

	C_1	C_2	C_3	CV*
C_1	1	76/13	109/13	0.744
C_2	13/76	1	73/13	0.200
C_3	13/109	13/76	1	0.0558

*CV refers to characteristic vectors

λ_{max}= 3.2022

Table D.43: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-5.1

CONTRIBUTORY FACTORS:

C_1: II.5.1.1 International

C_2: II.5.1.2 National

C_3: II.5.1.3 Institutional

DATE: Dec., 1981

LEVEL II-5.2: ASSISTANCE TO RESEARCH

	C_1	C_2	C_3	CV*
C_1	1	86/13	107/13	0.763
C_2	13/86	1	58/13	0.177
C_3	13/107	13/58	1	0.0606

*CV refers to characteristic vectors

λ max= 3.1839

Table D.44: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-5.2

CONTRIBUTORY FACTORS:

C_1: ~~II.5.2.1~~ International

C_2: II.5.2.2 National

C_3: II.5.2.3 Institutional

DATE: Dec., 1981

LEVEL II-5.3: ASSISTANCE TO DESIGNING, STANDARDIZING, MONITORING, AND SAMPLING

	C_1	C_2	C_3	CV*
C_1	1	65/13	104/13	0.727
C_2	13/65	1	65/13	0.210
C_3	13/104	13/63	1	0.0628

*CV refers to characteristic vectors

λ max= 3.1380

Table D.45: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE AT LEVEL II-5.3

CONTRIBUTORY FACTORS:

C_1: II.5.3.1 International

C_2: II.5.3.2 National

C_3: II.5.3.3 Institutional

DATE: Dec., 1981

LEVEL II-5.4: ASSISTANCE TO DISSEMINATION, COLLECTION OF INFORMATION, AND TEACHING

	C_1	C_2	C_3	CV*
C_1	1	76/13	107/13	0.750
C_2	13/76	1	58/13	0.188
C_3	13/107	13/58	1	0.0620

*CV refers to characteristic vectors

λ max= 3.1496

Table D.46: JUDGMENT MATRIX FROM EXPERTS' ANSWERS TO QUESTIONNAIRE

CONTRIBUTORY FACTORS:

C_1: II.5.4.1. International

C_2: II.5.4.2 National

C_3: II.5.4.3 Institutional

5. Tree in Detail with the Absolute Values

5. Tree in Detail with the Absolute Values

In Chapter III, Section C, the application of the systemic approach to construct the tree of factors was described, which is necessary for the determination of the activities' weights.

From the experts' answers to the questionnaires the tree of factors was constructed and was particularized for Costa Rica. Appendix C shows the tree with different levels containing the specific factors involved that correspond to the main goal, the objectives of the institutions and their activities and functions.

The results from the experts' answers which constitute the judgment matrices are shown in Appendix D, Section 4. With the data of the judgment matrices, and by applying the computer program, the characteristic vectors and values that are used as absolute weights of the tree factors were obtained. Figure D.4 shows the absolute values at the highest level obtained from the multiplication of vertically successive node values. For instance, the absolute value of node A to the highest level node C is obtained by multiplying $A * B$. The values that are found in the circles of the nodes are the absolute weights. These weights are then multiplied by 100 in order to obtain the scale with a range from 0 to 100 that will be used in the evaluation of a particular environmental problem.

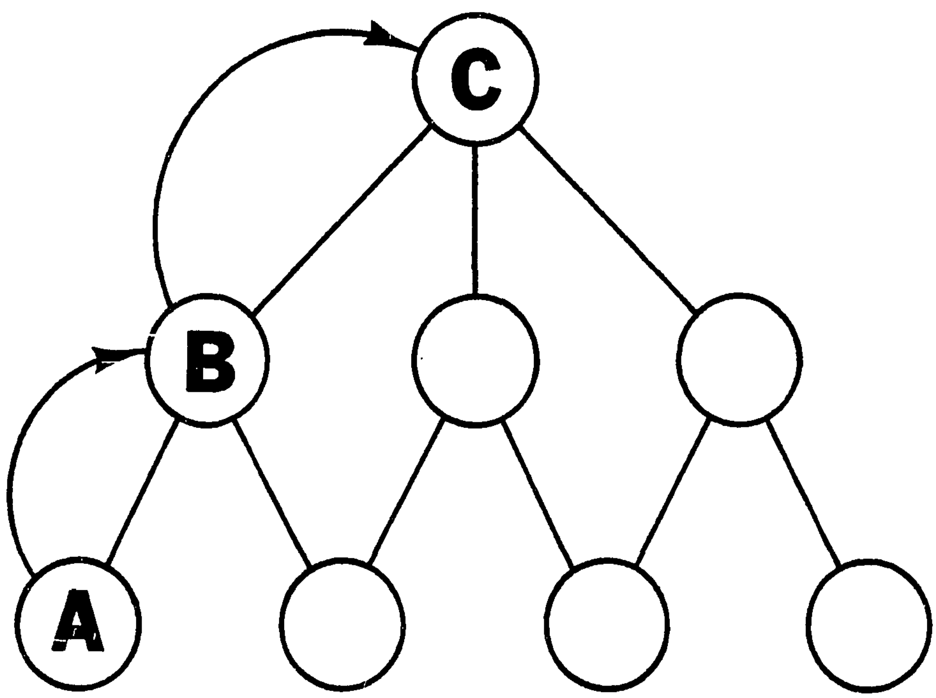


Figure D.4 Absolute value of mode A to the highest level C obtained by multiplying values A x B

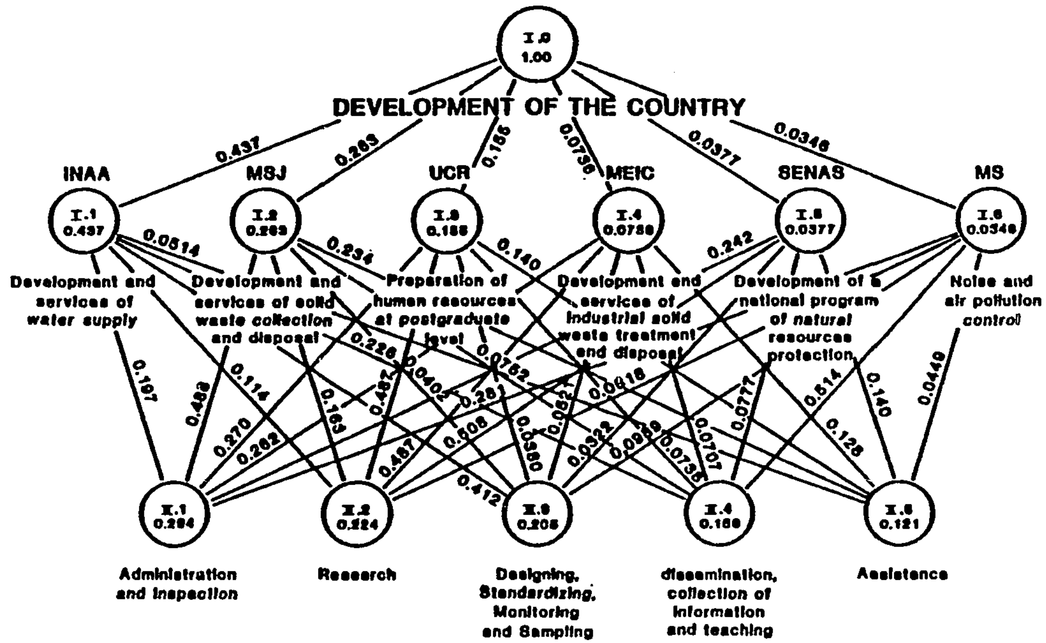
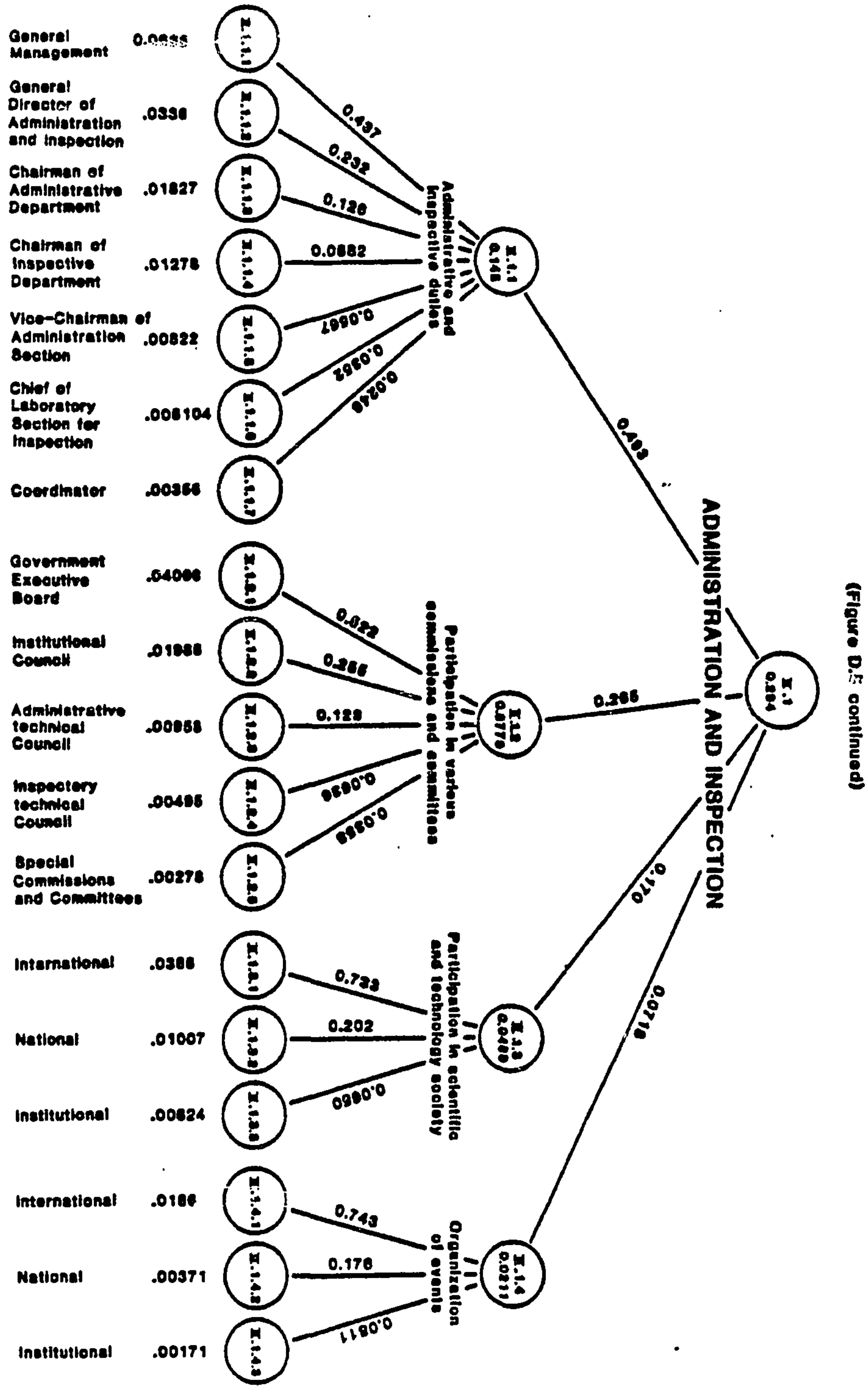
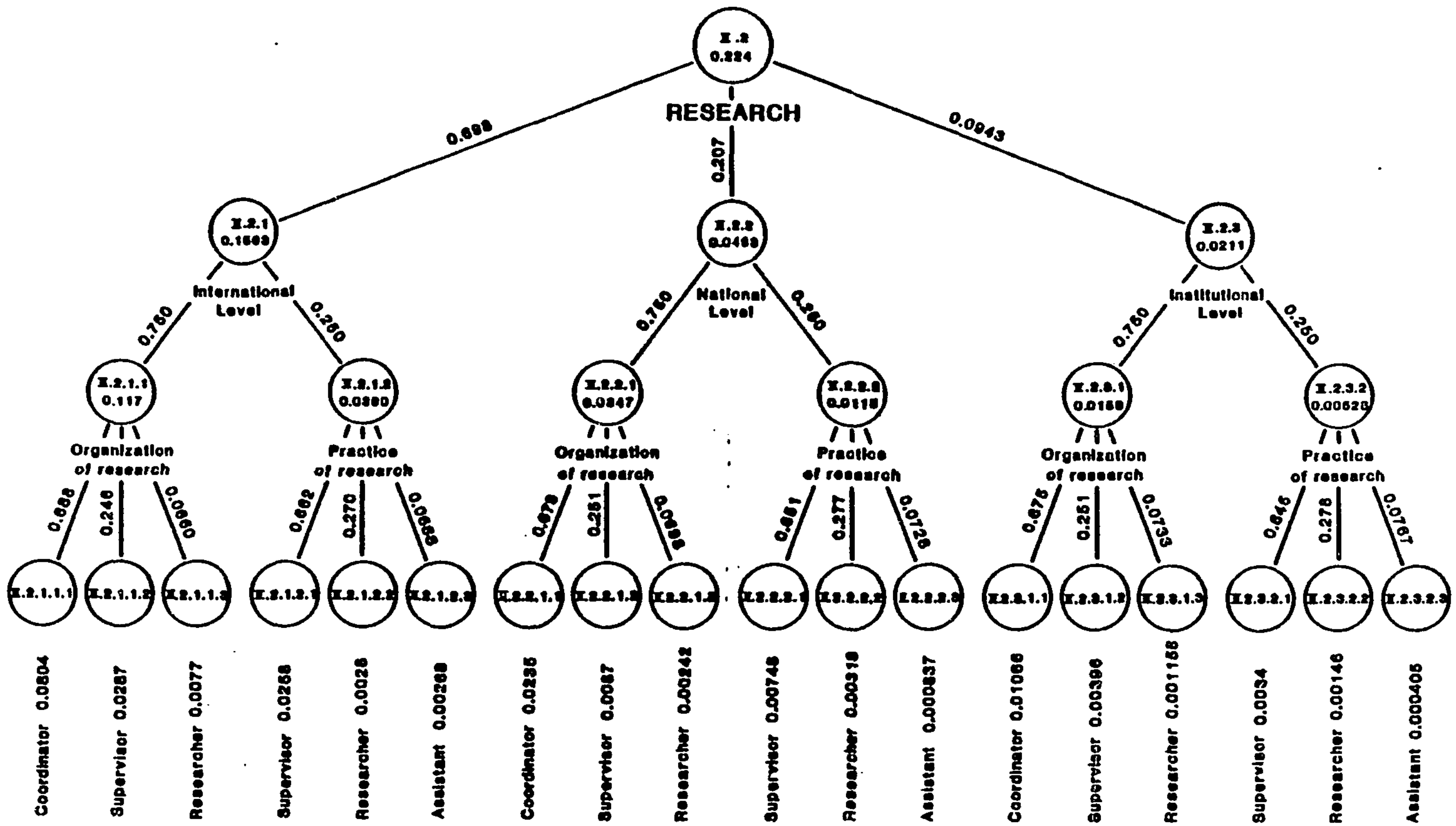


Figure D.5 Tree with the absolute values applied to the Costa Rica case resulting from the experts' answers questionnaire.



(Figure D.5 continued)

(Figure D.5 continued)



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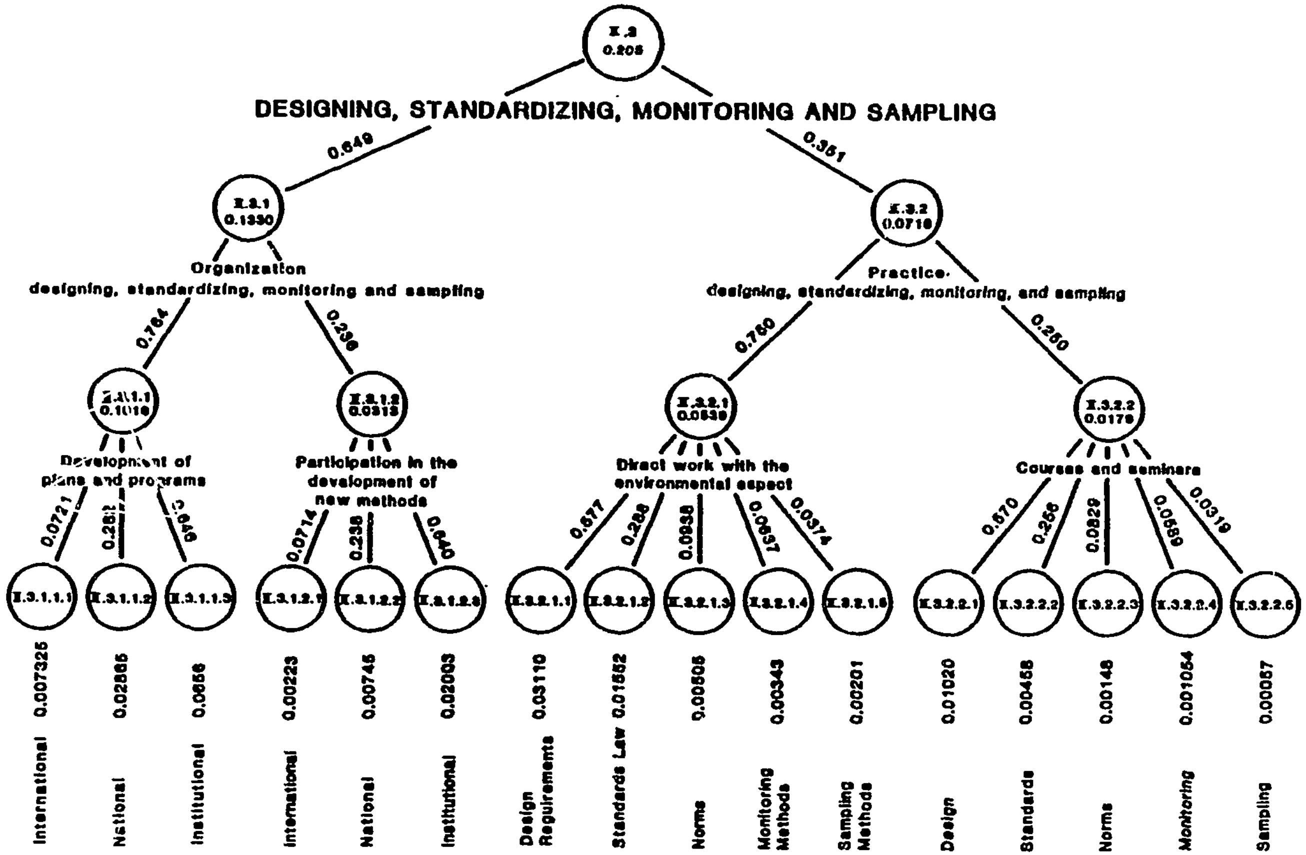

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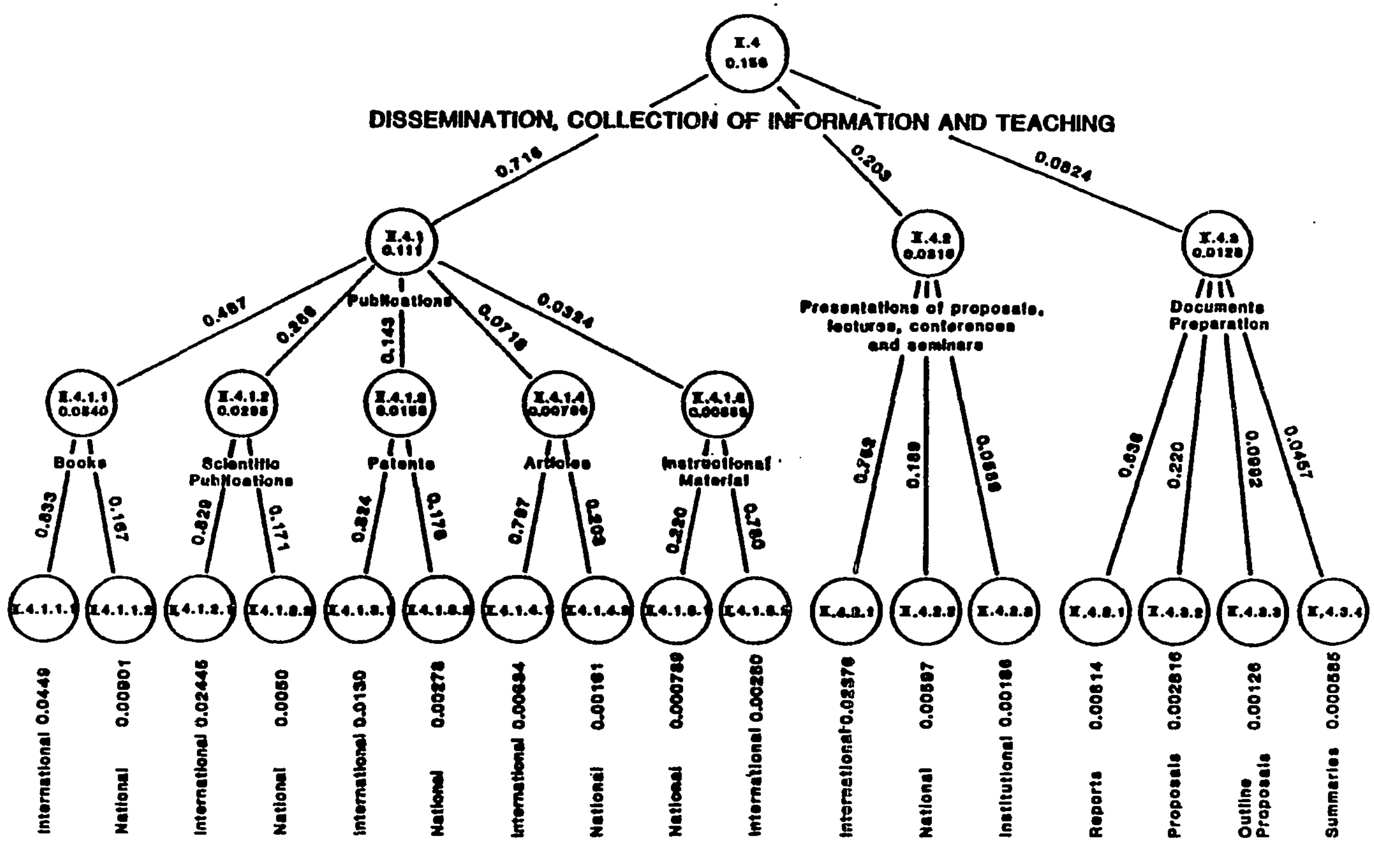
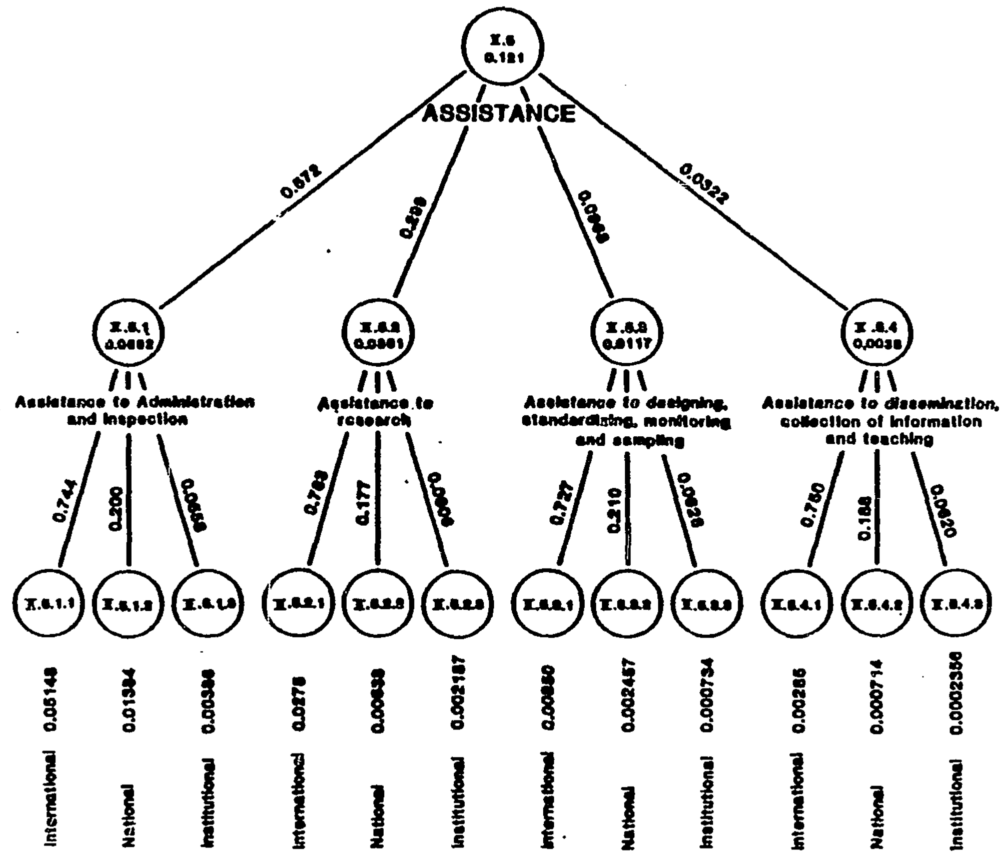


(Figure D.5 continued)



APPENDIX E

INFORMATION PERTAINING TO THE INSTITUTIONS RELATED TO THE CATEGORIES OF ENVIRONMENTAL AFFAIRS FOR EQUATING THESE CATEGORIES AND THE CORRESPONDING CATEGORIES DETERMINED FROM THE PROPOSED METHODOLOGY TO A FINAL COMMON SCALE

1. Introduction
2. Status of Environmental Affairs Evaluation and Categorization Questionnaire
3. Current Status of Environmental Affairs of the Institutions' Judgment Matrices from Experts' Answers to the Questionnaire
4. Tree in Detail with the Absolute Values of the Current Status from the Experts' Answers

APPENDIX E

INFORMATION PERTAINING TO THE INSTITUTIONS RELATED TO THE CATEGORIES OF ENVIRONMENTAL AFFAIRS FOR EQUATING THESE CATEGORIES AND THE CORRESPONDING CATEGORIES DETERMINED FROM THE PROPOSED METHODOLOGY TO A FINAL COMMON SCALE

1. Introduction

Although the information collected from the institutions shows that very little has been done in the field of environmental problems, a scale has been constructed from that information. Also the suggestions for the equivalencies of this scale and the methodology scale to a final scale are included.

2. Status of Environmental Affairs

Evaluation and Categorization

Questionnaire

QUESTIONNAIRE

STATUS OF ENVIRONMENTAL AFFAIRS

EVALUATION AND CATEGORIZATION

December 5, 1981

Dear __________:

Having learned of your interest in environmental matters, I am writing to seek your assistance in my work. Specifically, this letter is meant to explain the attached questionnaire, which I hope you can find the time to complete and return.

The purpose of the questionnaire is to determine the status of the environmental affairs in your country and more specifically in your institution. The government of Costa Rica has stated the need for a formal procedure for the evaluation and categorization of an environmental program that will provide a better understanding of the environmental, legal, technical, and economic complexities of dealing with the resources.

The questionnaire is divided into four parts. Part one is an optional personal profile, and part two addresses the current general status of environmental aspects in your country. Part three is a list of environmental activities and functions, which you are asked to rate; and part four is a miscellaneous section where you are asked to evaluate your institution's efficiency in function of employees' educational level, suggest a scale to evaluate the institution's experience in environmental problems, and finally you may include any concerns which were not specifically addressed earlier.

The aggregate response to the questionnaire will determine the current status of environmental affairs in your institution and in your country.

I hope you can find the time to complete and return the questionnaire. My work depends quite heavily on your cooperation. Your cooperation will not only further my studies, but it will help in solving a growing problem in Latin American countries. I thank you in advance and look forward to your reply.

Yours sincerely,

Harry Castillo
Doctoral Candidate

Carson Engineering Building
The University of Oklahoma at Norman
Norman, Oklahoma 73069

HCV/hcv

Attachments

QUESTIONNAIRE

STATUS OF ENVIRONMENTAL AFFAIRS

EVALUATION AND CATEGORIZATION

DESIGN OF A GENERAL METHODOLOGY FOR THE
EVALUATION AND CATEGORIZATION OF AN
ENVIRONMENTAL PROGRAM WITH SPECIAL
REFERENCE TO COSTA RICA

NAME________________________ Postal Address______________

____

Telephone Number____________

PART 1: PERSONAL (Optional)

(1) Please name your country and/or institution___________

____

(2) In what sector are you employed?

( ) Government service ( ) Education ( ) Industry

( ) Private

(3) What is your highest level of formal education?

( ) Pre-University ( ) Vocational Training

( ) Bachelor's Degree ( ) Master's Degree

( ) Doctoral Degree ( ) Post Doctoral

PART 2: GENERAL STATUS OF ENVIRONMENTAL AFFAIRS (Please circle the answer)

(1) Are there laws in your country which are related directly to environmental affairs?

YES NO DO NOT KNOW

(2) Have the environmental effects of any major project been evaluated and categorized prior to its implementation in your country?

YES NO DO NOT KNOW

(3) Are present efforts to protect your country's environment adequate?

YES NO DO NOT KNOW

(4) Is a methodology for the evaluation and categorization of the environmental problems in your country necessary at this time?

YES NO DO NOT KNOW

(5) Are there enough trained people in your country to conduct environmental research on major projects at this time?

YES NO DO NOT KNOW

(6) How will that methodology significantly affect project costs?

INCREASE NO EFFECT DECREASE DO NOT KNOW

(7) How will that methodology affect development in your country?

ENHANCE NO EFFECT RETARD DO NOT KNOW

(8) How will that methodology affect overall project planning?

ENHANCE NO EFFECT RETARD DO NOT KNOW

PART 3: STATUS OF THE ENVIRONMENTAL ACTIVITIES AND FUNCTIONS

The following activities and functions were taken from a consensus of the expertise group. Please use the following scale to make a comparison between the activities and functions designed to accomplish the principal environmental goal of your department and the activities and functions in the most developed department in your institution. Some activities or functions do not exist in your institution, in which case your answer will be zero. The scale is:

0 = Indicates that the activity or function does not exist.

1 = Indicates that the environmental activity or function contributes equally to the goals of the institution.

3 = Indicates weak importance. The judgment favors one activity or function over the other, but not conclusively.

5 = Indicates strong importance. The judgment strongly favors one activity or function over the other one.

7 = Indicates demonstrated importance. Conclusive judgment of the importance of one activity or function over the other one.

9 = Indicates absolute importance. The judgment favors one activity or function over the other one in the highest order possible.

<u>How to report your score</u>:

Example:

In your institution, is administration and inspection related to environmental affairs?

Your answer should compare the activity or function with the same activity or function of the most important department of your institution. If the activity or function does not exist in your institution, your answer will be zero. If it exists, compare it by using the preceding scale in this way:

If it exists and if the comparison with the same activities in the most important department of your institution shows equal importance, your answer should be 1.

If your judgment indicates that the activity or function of your environmental department compares with the same activity or function in the most important department of your institution are slightly more important, the answer should be 3.

But, if your judgment indicates that the activity or function in the most important department are slightly more important than the same activity or function in your environmental department, your answer should be 1/3.

If your judgment indicates that the activity or function of your environmental department are clearly more important than those of the most important department of your institution, your answer should be 7. But in the reverse situation, the answer should be 1/7; and so forth.

If the following environmental activities and functions exist in your department, compare them with the same activities and functions in the most developed department of your institution. If an activity or function does not exist in your department circle "zero." Make the comparison according to the previous example and scale.

Compare the development services of water supply at different levels between your institution and the same goal in the most developed institution of any developed country.

I-1 Development and services of water supply

II.1	Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2	Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3	Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4	Dissemination, collection of information and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5	Assistance	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the development and services of solid waste collection and disposal at different levels between your institution and the same goal in the most developed institution of any developed country.

I-2 Development and services of solid waste collection and disposal

II.1	Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.2 Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3 Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4 Dissemination, collection of information, and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5 Assistance	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the preparation of human resources at postgraduate level in environmental affairs between your institution and the same goal in the most developed institution of any developed country.

I-3 Preparation of human resources at postgraduate level

II.1 Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2 Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3 Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4 Dissemination, collection of information, and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5 Assistance	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the development and services of industrial solid waste treatment and disposal at different levels between your institution and the same goal in the most developed institution of any developed country.

I-4 Development and services of industrial solid waste treatment and disposal

II.1	Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2	Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3	Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4	Dissemination, collection of information, and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5	Assistance	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the development of a national program of natural resources protection at different levels between your institution and the same goal in the most developed institution of any developed country.

I-5 Develoment of a national program of natural resource protection

I.1	Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2	Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3	Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4	Dissemination, collection of information, and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5	Assistance	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the noise and air pollution control at different levels between your institution and the same goals in the most developed institution of any developed country.

I-6 Noise and air pollution control

II.1	Administration and inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2	Research	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3	Designing, standardizing, monitoring and sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4	Dissemination, collection of information, and teaching	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the activity administrative and inspective duties at different levels between your department and the same activity in the most developed department of your institution.

II-1.1 Administrative and inspective duties

II-1.1.1	General management	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.2	General Director of Administration and Inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.3	Chairman of Administrative Department	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.4	Chairman of Inspection Department	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.5	Vice Chairman of Administrative Section	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.6	Chief of Laboratory Section for Inspection	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II-1.1.7	Coordinator	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the participation on various commissions and committees between your department and the same functions in the most developed department of your institution. Also express how long the people participated on the various commissions and committees.

II 1.2 Participation on various commissions and committtees.

II.1.2.1	Government Executive Board	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.2.2	Institutional council	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.2.3	Administrative technical council	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.2.4	Inspectory technical council	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.2.5	Special commissions and committees	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the participation of your department in scientific and technological societies with the same activity in the most developed department of your institution. Also express how many times participation usually takes place.

II 1.3 Participation of the institution in scientific and technological societies

II.1.3.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.3.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.3.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the organization for events as in the preceding questions. Also express how many times a year that activity usually takes place.

II 1.4 Organization for events

II.1.4.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.4.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.1.4.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the organization and practice of research in various levels of environmental affairs as in the preceding questions. Also express how long the people have held those positions.

II-2 Research

II 2.1 International level

II.2.1.1 Organization of research

II.2.1.1.1	Coordinator	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.1.1.2	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.1.1.3	Assistant	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.2.1.2 Practice of research

II.2.1.2.1	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.1.2.2	Researcher	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.1.2.3	Assistant	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II 2.2 National Level

II.2.2.1 Organization of research

II.2.2.1.1	Coordinator	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.2.1.2	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.2.1.3	Researcher	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.2.2.2 Practice of Research

II.2.2.2.1	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.2.2.2	Researcher	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.2.2.3	Assistant	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II 2.3 Institutional Level

II.2.3.1 Organization of Research

II.2.3.1.1	Coordinator	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.3.1.2	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.3.1.3	Researcher	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.2.3.2 Practice of Research

II.2.3.2.1	Supervisor	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.3.2.2	Researcher	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.2.3.2.3	Assistant	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare the organization and practice of designing, standardizing, monitoring and sampling at different levels of environmental affairs as in the preceding question. Also express how many times that activity is usually participated in every year.

II-3 Designing, standardizing, monitoring and sampling

II.3.1 Organization of designing, standardizing, monitoring and sampling

II.3.1.1 Development of plans and programs for designing, standardizing, monitoring and sampling by studying, improving and implementing the program

II.3.1.1.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.1.1.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3,1.1.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.3.1.2 Participation in the development of methods for designing, standardizing, monitoring and sampling

II.3.1.2.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.1.2.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.1.2.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.3.2 Practice of designing, standardizing, monitoring and sampling

II.3.2.1 Direct work with the environmental aspect

II.3.2.1.1	Design requirements	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.3.2.1.2	Standards law	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.1.3	Norms	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.1.4	Monitoring methods	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.1.5	Sampling methods	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II 3.2.2 Courses and Seminars

II.3.2.2.1	Design	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.2.2	Standards	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.2.3	Norms	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.2.4	Monitoring	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.3.2.2.5	Sampling	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare dissemination, collection of information, and teaching in various levels of environmental affairs as in the preceding questions. Also express how many of the publications, etc., are usually done in a year.

II.4 Dissemination, collection of information, and teaching

II.4.1 Publications

II.4.1.1 Books

II.4.1.1.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.1.1.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.4.1.2 Scientific Publications

II.4.1.2.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.1.2.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.4.1.3 Patents

II.4.1.3.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.1.3.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.4.1.4 Articles

II.4.1.4.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.1.4.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.4.1.5 Instructional Material

II.4.1.5.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.1.5.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II 4.2 Presentation of proposals, lectures, conferences and seminars

II.4.2.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.2.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.2.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II 4.3 Documents preparation

II.4.3.1	Reports	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.3.2	Proposals	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.4.3.3	Outline of proposals	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.4.3.4	Summaries	0	1	3 1/3	5 1/5	7 1/7	9 1/9

Compare assistance in various levels of environmental affairs as in the preceding questions. Also express how much time is given that assistance each year.

II-5 Assistance

II.5.1 Assistance to administration and inspection

II.5.1.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.1.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.1.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.5.2 Assistance to research

II.5.2.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.2.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.2.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.5.3 Assistance to designing, standardizing, monitoring and sampling

II.5.3.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.3.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.3.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.5.4 Assistance to dissemination, collection of information, and teaching

II.5.4.1	International	0	1	3 1/3	5 1/5	7 1/7	9 1/9

II.5.4.2	National	0	1	3 1/3	5 1/5	7 1/7	9 1/9
II.5.4.3	Institutional	0	1	3 1/3	5 1/5	7 1/7	9 1/9

PART IV. MISCELLANEOUS

To evaluate the institution's efficiency in function of employees' education level, by comparison between pairs circle the one you are in favor of and the number of your judgment, using the same scale as in the preceding sections.

* Post Doctoral Service - Doctoral Degree Service	0	1	3	5	7	9
* Post Doctoral Service - Master's Degree Service	0	1	3	5	7	9
* Post Doctoral Service - Bachelor's Degree Service	0	1	3	5	7	9
* Post Doctoral Service - Vocational Training Service	0	1	3	5	7	9
* Post Doctoral Service - Pre-University Service	0	1	3	5	7	9
* Master's Degree Service - Bachelor's Degree Service	0	1	3	5	7	9
* Master's Degree Service - Vocational Training Service	0	1	3	5	7	9
* Master's Degree Service - Pre-University Service	0	1	3	5	7	9
* Bachelor's Degree Service - Vocational Training Service	0	1	3	5	7	9
* Bachelor's Degree Service - Pre-University Service	0	1	3	5	7	9
* Vocational Training Service - Pre-University Service	0	1	3	5	7	9

To evaluate the institution's experience in environmental problems would you please suggest a scale qualitative and quantitative from zero to one.

Are there any other comments that you wish to make? Please attach additional sheets as needed.

Please return completed questionnaire to:

Harry Castillo
1118-A McGee Drive
Norman, Oklahoma 73069/ U.S.A.
Telephone: 405-321-3254

Eight experts completed and returned the questionnaire, all of them from inside the country. Their answers for each item were added and divided by the number of experts, and then the data were set up on the matrices which are shown on Tables E.1 to E.42.

By using the experts' answers it was not necessary in this case to use the support tables for the evaluation of the functions because there were evaluated in the questionnaires.

3. Current Status of Environmental Affairs of the Institutions--Judgment Matrices from Experts' Answers to Questionnaires

DATE: January, 1982

LEVEL I-0: COUNTRY DEVELOPMENT

	C_1	C_2	C_3	C_4	C_5	C_6	CV*
C_1	1	72/8	72/8	72/8	72/8	72/8	0.600
C_2	8/72	1	8/24	56/8	40/8	72/8	0.135
C_3	8/72	24/8	1	40/8	24/8	56/8	0.157
C_4	8/72	8/56	8/40	1	8/40	8/8	0.0256
C_5	8/72	8/40	8/24	40/8	1	24/8	0.0579
C_6	8/72	8/72	8/56	8/8	8/24	1	0.0248

*CV refers to characteristic vectors

$\lambda_{max} = 7.0119$

Table E.1: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-0

CONTRIBUTORY FACTORS:

C_1: I.1 Development and services of water supply (INAA)

C_2: I.2 Development and services of solid waste collection and disposal (MSI)

C_3: I.3 Preparation of human resources at postgraduate level (UCR)

C_4: I.4 Development and services of industrial solid waste treatment and disposal (MEIC)

C_5: I.5 Development of a national program of natural resources protection (SENAS)

C_6: I.6 Noise and air pollution control (MS)

DATE: January, 1982

LEVEL I-1: DEVELOPMENT AND SERVICES OF WATER SUPPLY

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	56/8	40/8	72/8	72/8	0.561
C_2	8/56	1	8/72	8/40	8/24	0.0285
C_3	8/40	72/8	1	56/8	40/8	0.261
C_4	8/72	40/8	8/56	1	56/8	0.106
C_5	8/72	24/8	8/40	8/56	1	0.0425

*CV refers to characteristic vectors

$\lambda_{max} =$ 6.0720

Table E.2: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-1

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information, and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL I-2: DEVELOPMENT AND SERVICE OF SOLID WASTE COLLECTION AND DISPOSAL (MSJ)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	56/8	72/8	56/8	40/8	0.618
C_2	8/56	1	8/40	8/24	8/8	0.0413
C_3	8/72	40/8	1	40/8	72/8	0.218
C_4	8/56	24/8	8/40	1	24/8	0.0792
C_5	8/40	8/8	8/72	8/24	1	0.0440

*CV refers to characterixtic vectors

λ max= 5.8965

Table E.3: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-2

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL I-3: PREPARATION OF HUMAN RESOURCES AT POSTGRADUATE LEVEL (UCR)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	56/8	24/8	8/72	56/8	0.283
C_2	8/56	1	40/8	56/8	24/8	0.311
C_3	8/24	8/40	1	8/56	40/8	0.0360
C_4	72/8	8/56	56/8	1	72/8	0.348
C_5	8/56	8/24	8/40	8/72	1	0.0217

*CV refers to characteristic vectors

λ_{max}= 9.7441

Table E.4: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-3

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL I-4: DEVELOPMENT AND SERVICES OF INDUSTRIAL SOLID WASTE TREATMENT AND DISPOSAL (MEIC)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	72/8	56/8	72/8	40/8	0.607
C_2	8/72	1	8/56	8/56	8/40	0.0242
C_3	8/56	56/8	1	40/8	56/8	0.224
C_4	8/72	56/8	8/40	1	8/40	0.0580
C_5	8/40	40/8	8/56	40/8	1	0.0869

*CV refers to characteristic vectors

$\lambda_{max} =$ 6.1589

Table E.5: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-4

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information, and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL I-5: DEVELOPMENT OF A NATIONAL PROGRAM OF NATURAL RESOURCES PROTECTION (SENAS)

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	56/8	24/8	24/8	40/8	0.409
C_2	8/56	1	8/56	8/40	8/40	0.0307
C_3	8/24	56/8	1	40/8	72/8	0.342
C_4	8/24	40/8	8/40	1	56/8	0.158
C_5	8/40	40/8	8/72	8/56	1	0.0601

*CV refers to characteristic vectors

λ max= 5.9228

Table E.6: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-5

CONTRIBUTORY FACTORS:

C_1: II.1 Administration and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL I-6: NOISE AND AIR POLLUTION CONTROL

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	24/8	24/8	24/8	24/8	0.377
C_2	8/24	1	8/40	8/56	24/8	0.0700
C_3	8/24	40/8	1	8/40	40/8	0.157
C_4	8/24	56/8	40/8	1	56/8	0.349
C_5	8/24	8/24	8/40	8/56	1	0.0465

*CV refers to characteristic vectors

λ max= 5.9511

Table E.7: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL I-6

CONTRIBUTORY FACTORS:

C_1: II.1 Administrative and inspection

C_2: II.2 Research

C_3: II.3 Designing, standardizing, monitoring and sampling

C_4: II.4 Dissemination, collection of information and teaching

C_5: II.5 Assistance

DATE: January, 1982

LEVEL II-1: ADMINISTRATION AND INSPECTION

	C_1	C_2	C_3	C_4	CV*
C_1	1	72/8	72/8	56/8	0.671
C_2	8/72	1	24/8	8/24	0.108
C_3	8/72	8/24	1	24/8	0.109
C_4	8/56	24/8	8/24	1	0.112

*CV refers to characteristic vectors

λ max= 5.0782

Table E.8: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTIONS AT LEVEL II-1

CONTRIBUTORY FACTORS:

C_1: II.1.1 Administration and inspection

C_2: II.1.2 Participation on various commissions and committees

C_3: II.1.3 Participation of the institution in scientific and technological societies

C_4: II.1.4 Organizations for events

DATE: January, 1982

LEVEL II-1.1: ADMINISTRATION AND INSPECTION DUTIES

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	CV*
C_1	1	24/8	24/8	40/8	8/8	72/8	56/8	0.328
C_2	8/24	1	48/8	24/8	24/8	56/8	40/8	0.258
C_3	8/24	8/40	1	24/8	24/8	56/8	24/8	0.151
C_4	8/40	8/24	8/24	1	24/8	24/8	40/8	0.103
C_5	8/8	8/24	8/24	8/24	1	24/8	24/8	0.0960
C_6	8/72	8/56	8/56	8/24	8/24	1	24/8	0.0347
C_7	8/56	8/40	8/24	8/40	8/24	8/24	1	0.0296

*CV refers to characteristic vectors

λ max= 8.1985

Table E.9: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-1.1

CONTRIBUTORY FACTORS:

C_1: II.1.1.1 General management

C_2: II.1.1.2 General Director of administration and inspection

C_3: II.1.1.3 Chairman of administrative department

C_4: II.1.1.4 Chairman of inspection department

C_5: II.1.1.5 Vice chairman of administrative section

C_6: II.1.1.6 Chief of Laboratory section for inspection

C_7: II.1.1.7 Coordinator

DATE: January, 1982

LEVEL II-1.2: PARTICIPATION ON VARIOUS COMMISSIONS AND COMMITTEES

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	56/8	72/8	72/8	72/8	0.568
C_2	8/56	1	56/8	40/8	8/24	0.170
C_3	8/72	8/56	1	8/24	24/8	0.0670
C_4	8/72	8/40	24/8	1	24/8	0.0956
C_5	8/72	24/8	8/24	8/24	1	0.100

*CV refers to characteristic vectors

λ max= 7.2577

Table E.10: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-1.2

CONTRIBUTORY FACTORS:

C_1: II.1.2.1 Governmental executive board

C_2: II.1.2.2 Institutional council

C_3: II.1.2.3 Administrative technical council

C_4: II.1.2.4 Inspectory technical council

C_5: II.1.2.5 Special commissions and committees

DATE: January, 1982

LEVEL II-1.3: PARTICIPATION OF THE INSTITUTION IN SCIENTIFIC AND TECHNOLOGICAL SOCIETIES

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/40	0.0972
C_2	24/8	1	8/40	0.202
C_3	40/8	40/8	1	0.701

*CV refers to characteristic vectors

λ_{max}= 3.1356

Table E.11: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II.1.3

CONTRIBUTORY FACTORS:

C_1: II.1.3.1 International

C_2: II.1.3.2 Internal

C_3: II.1.3.3 Institutional

DATE: January, 1982

LEVEL II-1.4: ORGANIZATION FOR EVENTS

	C_1	C_2	C_3	CV*
C_1	1	8/40	8/72	0.0545
C_2	40/8	1	8/56	0.173
C_3	72/8	56/8	1	0.772

*CV refers to characteristic vectors

λ max= 3.2085

Table E.12: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-1.4

CONTRIBUTORY FACTORS:

C_1: II.1.4.1 International

C_2: II.1.4.2 National

C_3: II.1.4.3 Institutional

DATE: January, 1982

LEVEL II-2: RESEARCH

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/24	0.135
C_2	24/8	1	8/24	0.281
C_3	24/8	24/8	1	0.584

*CV refers to characteristic vectors

λmax= 3.1356

Table E.13: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2

CONTRIBUTORY FACTORS:

C_1: II.2.1 International level

C_2: II.2.2 National level

C_3: II.2.3 Institutional level

DATE: January, 1982

LEVEL II-2.1: RESEARCH AT

INTERNATIONAL LEVEL

	C_1	C_2	CV*
C_1	1	8/24	0.250
C_2	24/8	1	0.750

*CV refers to characteristic vectors

λ max= 2.000

Table E.14: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.1

CONTRIBUTORY FACTORS:

C_1: II.2.1.1 Organization of research

C_2: II.2.1.2 Practice of research

DATE: January, 1982

LEVEL II-2.1.1: ORGANIZATION OF RESEARCH AT INTERNATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	26/8	59/8	0.662
C_2	8/26	1	41/8	0.270
C_3	8/59	8/41	1	0.0688

*CV refers to characteristic vectors

λ 3.0758

Table E.15: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.1.1

CONTRIBUTORY FACTORS:

C_1: II.2.1.1.1 Coordinator

C_2: II.2.1.1.2 Supervisor

C_3: II.2.1.1.3 Researcher

DATE: January, 1982

LEVEL II-2.1.~~2.~~ PRACTICE OF RESEARCH AT INTERNATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	32/8	59/8	0.688
C_2	8/32	1	42/8	0.246
C_3	8/59	8/42	1	0.0660

*CV refers to characteristic vectors

λ_{max} = 3.1277

Table E.16: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.1.2

CONTRIBUTORY FACTORS:

C_1: II.2.1.2.1 Supervisor

C_2: II.2.1.2.2 Researcher

C_3: II.2.1.2.3 Assistant

DATE: January, 1982

LEVEL II-2.2 RESEARCH AT NATIONAL LEVEL

	C_1	C_2	CV*
C_1	1	24/8	0.750
C_2	8/24	1	0.250

*CV refers to characteristic vectors λ max= 2.000

Table E.17: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.2

CONTRIBUTORY FACTORS:

C_1: II.2.2.1 Organization of research

C_2: II.2.2.2 Practice of research

DATE: January, 1982

LEVEL II-2.2.1 ORGANIZATION OF RESEARCH AT NATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	24/8	56/8	0.651
C_2	8/24	1	39/8	0.277
C_3	8/56	8/39	1	0.0128

*CV refers to characteristic vectors

λ_{max}= 3.0596

Table E.18: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.2.1

CONTRIBUTORY FACTORS:

C_1: II.2.2.1.1 Coordinator

C_2: II 2.2.1.2 Supervisor

C_3: II 2.2.1.3 Researcher

DATE: January, 1982

LEVEL II-2.2.2: PRACTICE OF RESEARCH AT NATIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	30/8	56/8	0.679
C_2	8/30	1	40/8	0.251
C_3	8/56	8/40	1	0.0618

*CV refers to characteristic vectors

λ max= 3.1100

Table E.19: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.2.2

CONTRIBUTORY FACTORS:

C_1: II.2.2.2.1 Supervisor

C_2: II.2.2.2.2 Researcher

C_3: II.2.2.2.3 Assistant

DATE: January, 1982

LEVEL II-2.3: RESEARCH AT INSTITUTIONAL LEVEL

	C_1	C_2	CV*
C_1	1	8/23	0.250
C_2	23/8	1	0.750

*CV refers to characteristic vectors

λ max= 2.000

Table E.20: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.3

CONTRIBUTORY FACTORS:

C_1: II.2.3.1 Organization of research

C_2: II.2.3.2 Practice of research

DATE: January, 1982

LEVEL II-2.3.1: ORGANIZATION OF RESEARCH AT INSTITUTIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	25/8	55/8	0.645
C_2	8/23	1	36/8	0.278
C_3	8/55	8/36	1	0.0767

*CV refers to characteristic vectors

$\lambda_{max} =$ 3.0426

Table E.21: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.3.1

CONTRIBUTORY FACTORS:

C_1: II.2.3.1.1 Coordinator

C_2: II.2.3.1.2 Supervisor

C_3: II.2.3.1.3 Researcher

DATE: January, 1982

LEVEL II-2.3.2: PRACTICE OF RESEARCH AT INSTITUTIONAL LEVEL

	C_1	C_2	C_3	CV*
C_1	1	29/8	55/8	0.675
C_2	8/29	1	37/8	0.751
C_3	8/55	8/37	1	0.0733

*CV refers to characteristic vectors

λ 3.0888

Table E.22: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-2.3.2

CONTRIBUTORY FACTORS:

C_1: II-2.3.2.1 Supervisor

C_2: II-2.3.2.2 Researcher

C_3: II-2.3.2.3 -Assistant

DATE: January, 1982

LEVEL II-3: DESIGNING, STANDARDIZING, MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	8/24	0.250
C_2	8/24	1	0.750

*CV refers to characteristic vectors λ max= 2.0000

Table E.23: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-3

CONTRIBUTORY FACTORS:

C_1: II·3.1 Organization of designing, standardizing, monitoring, sampling

C_2: II·3.2 Practice of designing, standardizing, monitoring, sampling

DATE: January, 1982

LEVEL II-3.1: ORGANIZATION OF

DESIGNING, STANDARDIZING,

MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	8/24	0.250
C_2	24/8	1	0.750

*CV refers to characteristic vectors

λ max= 2.0000

Table E.24: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS

CONTRIBUTORY FACTORS:

C_1: II.3.1.1 Development of plans and programs for designing, standardizing, monitoring, sampling by studying, improving and implementing the program

C_2: II.3.1.2 Participation in development of methods for designing, standardizing, monitoring, sampling

DATE: January, 1982

LEVEL II-3.1.1. DEVELOPMENT OF PLANS AND PROGRAMS FOR DESIGNING, STANDARDIZING, MONITORING AND SAMPLING BY STUDYING, IMPROVING AND IMPLEMENTING THE PROGRAM

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/40	0.105
C_2	24/8	1	8/24	0.258
C_3	40/8	24/8	1	0.637

*CV refers to characteristic vectors

λ max= 3.0385

Table E.25: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-3.1.1

CONTRIBUTORY FACTORS:

C_1: II.3.1.1.1 International

C_2: II.3.1.1.2 National

C_3: II.3.1.1.3 Institutional

DATE: January, 1982

LEVEL II-3.1.2: PARTICIPATION IN THE DEVELOPMENT OF METHODS FOR DESIGNING, STANDARDIZING, MONITORING AND SAMPLING

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/40	0.0997
C_2	24/8	1	8/34	0.219
C_3	40/8	34/8	1	0.681

*CV refers to characteristic vectors

λ max= 3.0982

Table E.26: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-3.1.2

CONTRIBUTORY FACTORS:

C_1: II.3.1.2.1 International

C_2: II.3.1.2.2 National

C_3: II.3.1.2.3 Institutional

DATE: January, 1982

LEVEL II-3.2: PRACTICE OF DESIGNING, STANDARDIZING, MONITORING, SAMPLING

	C_1	C_2	CV*
C_1	1	8/24	0.250
C_2	24/8	1	0.750

*CV refers to characteristic vectors

λ max= 0.750

Table E.27: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS IN THE INSTITUTION AT LEVEL II-3.2

CONTRIBUTORY FACTORS:

C_1: II.3.2.1 Direct work with environmental aspect

C_2: II.3.2.2 Courses and seminars

DATE: January, 1982

LEVEL II-3.2.1: DIRECT WORK WITH THE ENVIRONMENTAL ASPECT

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	8/24	8/40	8/40	8/56	0.0427
C_2	24/8	1	8/24	8/24	8/40	0.0862
C_3	40/8	24/8	1	8/8	8/24	0.201
C_4	40/8	24/8	8/8	1	8/24	0.201
C_5	56/8	40/8	24/8	24/8	1	0.469

*CV refers to characteristic vectors

λ_{mas} = 5.1269

Table E.28: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS IN THE INSTITUTION AT LEVEL II-3.2.1

CONTRIBUTORY FACTORS:

C_1: II.3.2.1.1 Standard laws

C_2: II.3.2.1.2 Design requirements

C_3: II.3.2.1.3 Norms

C_4: II.3.2.1.4 Monitoring methods

C_5: II.3.2.1.5 Sampling methods

DATE: January, 1982

LEVEL II-3.2.2: COURSES AND SEMINARS

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	8/24	8/40	8/40	8/56	0.0413
C_2	24/8	1	8/24	8/24	8/40	0.0830
C_3	40/8	24/8	1	8/24	8/24	0.162
C_4	40/8	24/8	24/8	1	8/24	0.256
C_5	56/8	40/8	24/8	24/8	1	0.458

*CV refers to characteristic vectors

$\lambda_{max} =$ 5.2768

Table E.29: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS IN THE INSTITUTION AT LEVEL II-3.2.2

CONTRIBUTORY FACTORS:

C_1: II.3.2.2.1 Design

C_2: II.3.2.2.2 Standards

C_3: II.3.2.2.3 Norms

C_4: II.3.2.2.4 Monitoring

C_5: II.3.2.2.5 Sampling

DATE: January, 1982

LEVEL II-4: DISSEMINATION, COLLECTION OF INFORMATION AND TEACHING

	C_1	C_2	C_3	CV*
C_1	1	37/8	8/53	.0830
C_2	8/37	1	26/8	.203
C_3	53/8	8/26	1	.714

*CV refers to characteristic vectors

λ max= 3.072

Table E.30: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4

CONTRIBUTORY FACTORS:

C_1: II.4.1 Publications

C_2: II.4.2 Proposals, lectures, conferences, and seminar presentations

C_3: II.4.3 Document preparations

DATE: January, 1982

LEVEL II-4.1: PUBLICATIONS

	C_1	C_2	C_3	C_4	C_5	CV*
C_1	1	8/24	8/24	8/56	8/56	0.0397
C_2	24/8	1	24/8	8/40	8/40	0.121
C_3	24/8	8/24	1	8/24	8/24	0.0913
C_4	56/8	40/8	24/8	1	8/24	0.293
C_5	56/8	40/8	24/8	24/8	1	0.455

*CV refers to characteristic vectors

λ_{max}= 5.4753

Table E.31: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS IN THE INSTITUTION AT LEVEL II-4.1

CONTRIBUTORY FACTORS:

C_1: II.4.1.1 Books

C_2: II.4.1.2 Scientific publications

C_3: II.4.1.3 Patents

C_4: II.4.1.4 Articles

C_5: II.4.1.5 Instructional materials

DATE: January, 1982

LEVEL II-4.1.1 PUBLICATION OF BOOKS

	C_1	C_2	CV*
C_1	1	8/24	0.250
C_2	24/8	1	0.750

*CV refers to characteristic vectors λ max= 2.0000

Table E.32: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4.1.1

CONTRIBUTORY FACTORS:

C_1: II.4.1.1.1 National

C_2: II.4.1.1.2 International

DATE: January, 1982

LEVEL II-4.1.2: SCIENTIFIC PUBLICATIONS

	C_1	C_2	CV*
C_1	1	24/8	0.750
C_2	8/24	1	0.250

*CV refers to characteristic vectors λ max= 2.0000

Table E.33: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL- II 4.1.2

CONTRIBUTORY FACTORS:

C_1: II.4.1.2.1 National

C_2: II.4.1.2.2 International

DATE: January, 1982

LEVEL II-4.1.3: REGISTRATION

OF PATENTS

	C_1	C_2	CV*
C_1	1	26/8	0.705
C_2	8/26	1	0.235

*CV refers to characteristic vectors λ max= 2.0000

Table E.34: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4.1.3

CONTRIBUTORY FACTORS:

C_1: II.4.1.3.1 National

C_2: II.4.1.3.1 International

DATE: January, 1982

LEVEL II-4.1.4: PUBLICATION OF ARTICLES

	C_1	C_2	CV*
C_1	1	40/8	0.833
C_2	8/40	1	0.167

*CV refers to characteristic vectors λ max= 2.0000

Table E.35: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4.1.4

CONTRIBUTORY FACTORS:

C_1: II.4.1.4.1 National

C_2: II.4.1.4.2 International

DATE: January, 1982

LEVEL II-4.1.5: INSTRUCTIONAL MATERIAL

	C_1	C_2	CV*
C_1	1	56/8	0.875
C_2	8/56	1	0.125

*CV refers to characteristic vectors λ max= 2.0000

Table E.36: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II.4.1.5

CONTRIBUTORY FACTORS:

C_1: II.4.1.5.1 National

C_2: II.4.1.5.2 Institutional

DATE: January, 1982

LEVEL II-4.2 PROPOSALS, CONFERENCES AND SEMINAR PRESENTATIONS

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/40	0.105
C_2	24/8	1	8/24	0.258
C_3	40/8	24/8	1	0.637

*CV refers to characteristic vectors

λ max= 3.0385

Table E.37: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4.2

CONTRIBUTORY FACTORS:

C_1: II.4.2.1 International

C_2: II.4.2.2 National

C_3: II.4.2.3 Institutional

DATE: January, 1982

LEVEL II-4.3: DOCUMENTS PREPARATION

	C_1	C_2	C_3	C_4	CV*
C_1	1	40/8	56/8	8/56	0.258
C_2	8/40	1	8/24	8/40	0.0511
C_3	8/56	24/8	1	8/24	0.0977
C_4	56/8	40/8	24/8	1	0.593

*CV refers to characteristic vectors

λ max= 4.9695

Table E.38: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-4.3

CONTRIBUTORY FACTORS:

C_1: II.4.3.1 Reports

C_2: II.4.3.2 Proposals

C_3: II.4.3.3 Outlines of proposals

C_4: II.4.3.4 Summaries

DATE: January, 1982

LEVEL II-5: ASSISTANCE

	C_1	C_2	C_3	C_4	CV*
C_1	1	56/8	40/8	8/56	0.250
C_2	8/56	1	8/40	8/40	0.0446
C_3	8/40	40/8	1	8/24	0.118
C_4	56/8	40/8	24/8	1	0.587

*CV refers to characteristic vectors

λ_{max} = 4.9601

Table E.39: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-5

CONTRIBUTORY FACTORS:

C_1: II.5.1 Assistance to administration and inspection

C_2: II.5.2 Assistance to research

C_3: II.5.3 Assistance to designing, standardizing, monitoring and sampling

C_4: II.5.4 Assistance to dissemination, collection of information and teaching

DATE: January, 1982

LEVEL II-5.1: ASSISTANCE TO ADMINISTRATION AND INSPECTION

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/40	0.105
C_2	24/8	1	8/24	0.258
C_3	40/8	24/8	1	0.637

*CV refers to characteristic vectors

λ max= 3.0385

Table E.40: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-5.1

CONTRIBUTORY FACTORS:

C_1: II.5.1.1 International

C_2: II.5.1.2 National

C_3: II.5.1.3 Institutional

DATE: January, 1982

LEVEL II-5.2: ASSISTANCE TO RESEARCH

	C_1	C_2	C_3	CV*
C_1	1	8/26	8/28	0.121
C_2	26/8	1	8/24	0.281
C_3	28/8	24/8	1	0.598

*CV refers to characteristic vectors

λ max= 3.1178

Table E.41: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-5.2

CONTRIBUTORY FACTORS:

C_1: II.5.2.1 International

C_2: II.5.2.2 National

C_3: II.5.2.3 Institutional

DATE: January, 1982

LEVEL II-5.3: ASSISTANCE TO DESIGNING, STANDARDIZING, MONITORING AND SAMPLING

	C_1	C_2	C_3	CV*
C_1	1	8/24	8/56	0.0810
C_2	24/8	1	8/40	0.188
C_3	56/8	40/8	1	0.731

*CV refers to characteristic vectors

λ max= 3.0649

Table E.42: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-5.3

CONTRIBUTORY FACTORS:

C_1: II.5.3.1 International

C_2: II.5.3.2 National

C_3: II.5.3.3 Institutional

DATE: January, 1982

LEVEL II-5.4: ASSISTANCE TO DISSEMINATION, COLLECTION OF INFORMATION AND TEACHING

	C_1	C_2	C_3	CV*
C_1	1	8/40	8/72	0.0545
C_2	40/8	1	8/56	0.173
C_3	72/8	56/8	1	0.772

*CV refers to characteristic vectors

$\lambda_{max} =$ 3.2085

Table E.43: CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF THE INSTITUTION AT LEVEL II-5.4

CONTRIBUTORY FACTORS;

C_1: II.5.4.1 International

C_2: II.5.4.2 National

C_3: II.5.4.3 Institutional

4. Tree in Detail with the Absolute Values of the Current Status from the Experts' Answers

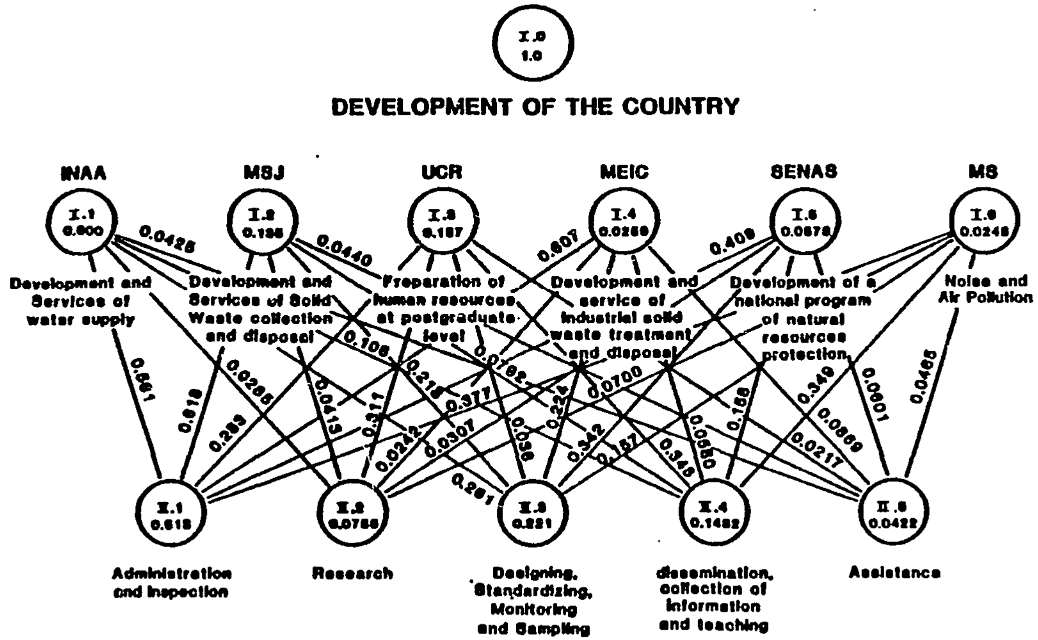
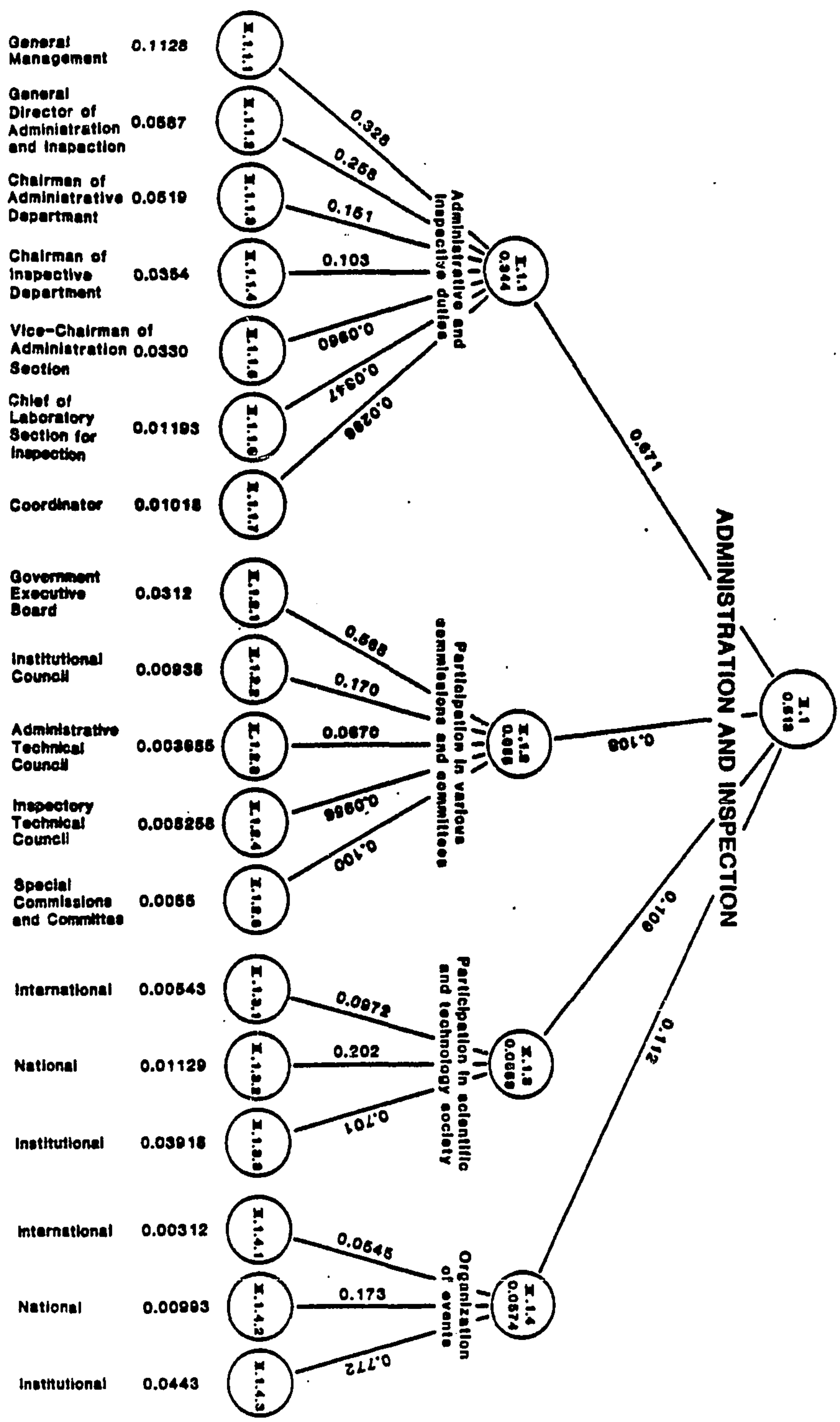
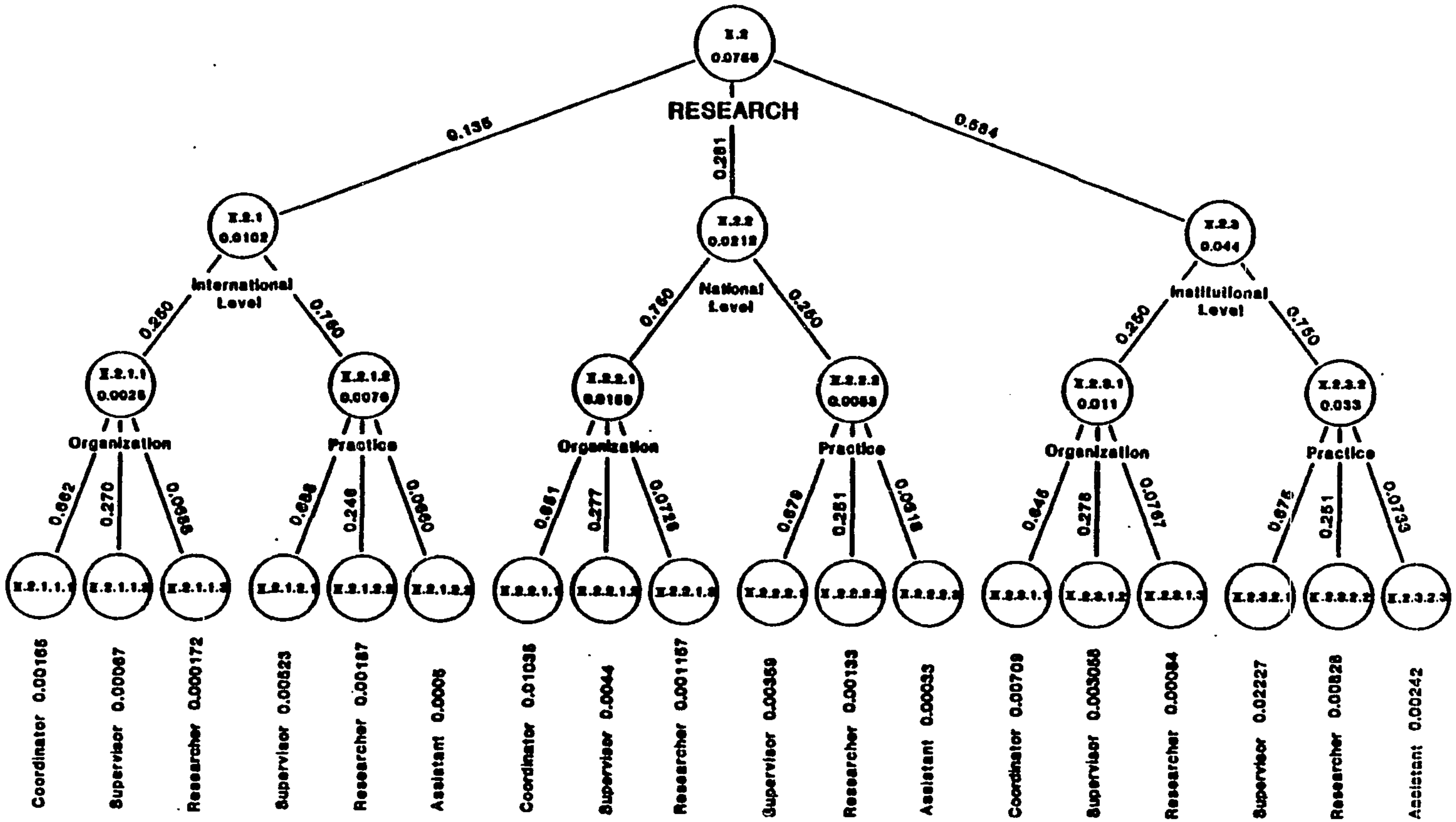


Figure E.1 Tree with absolute values of the current Status of Environmental affairs of the Costa Rica's Institutions, resulting from the expert's answers questionnaire.

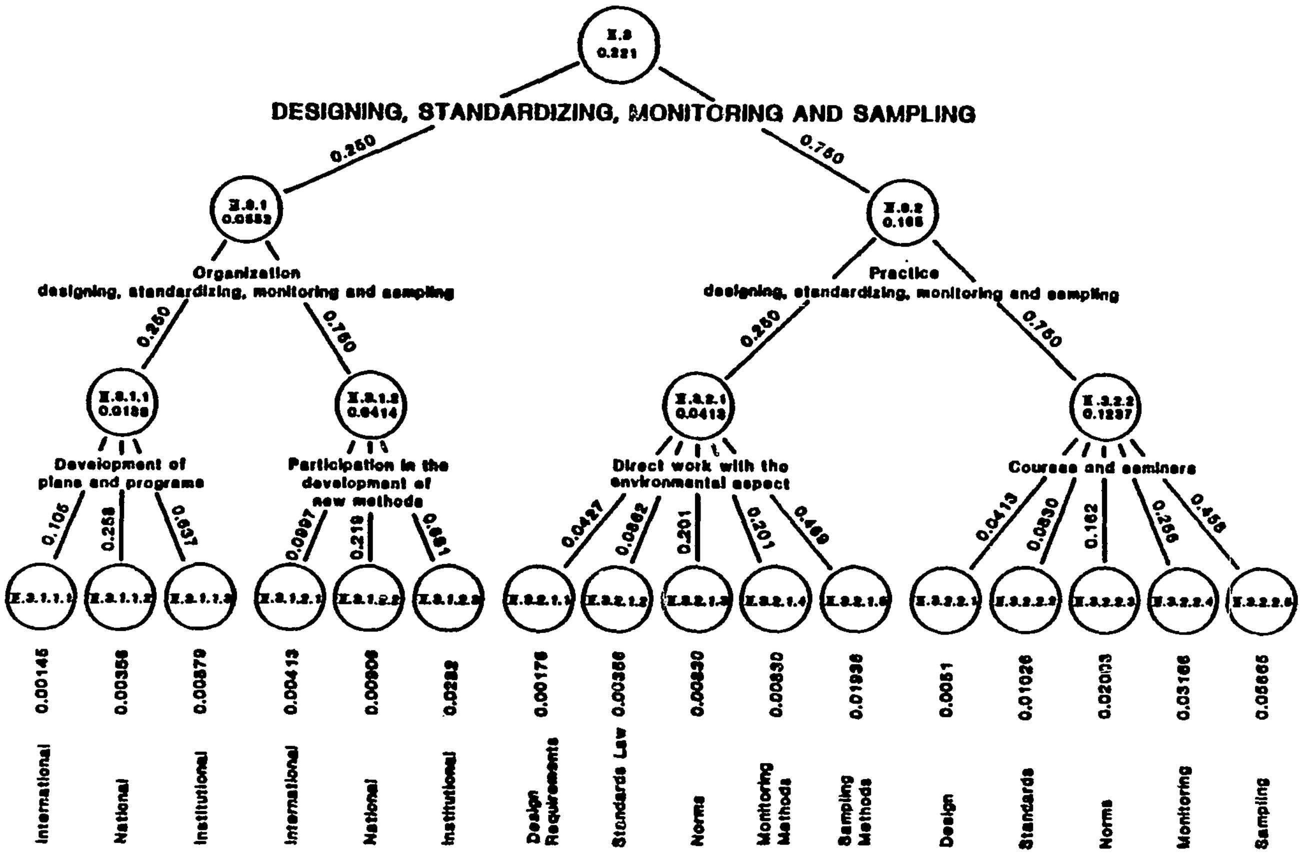
(Figure E.1 continued)



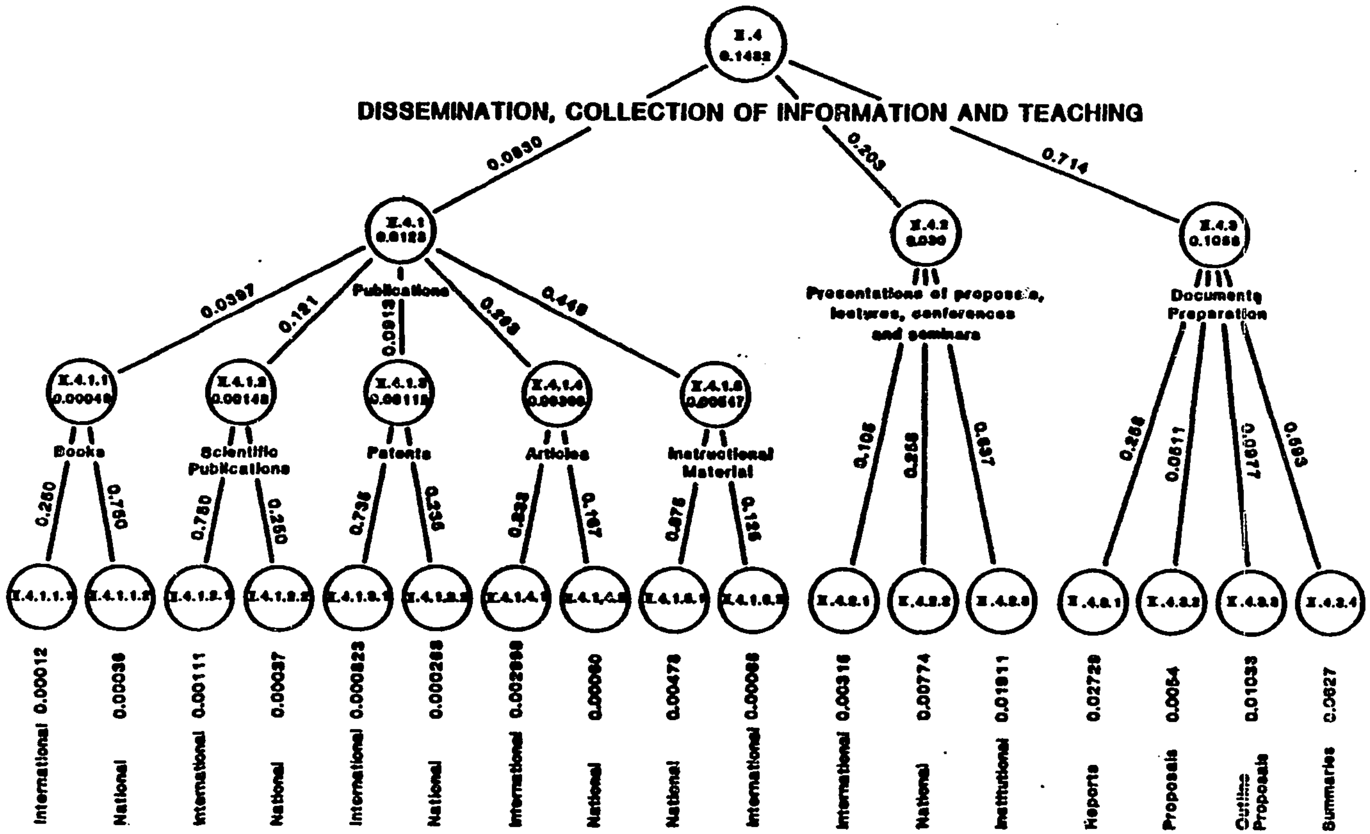
(Figure E.1 continued)



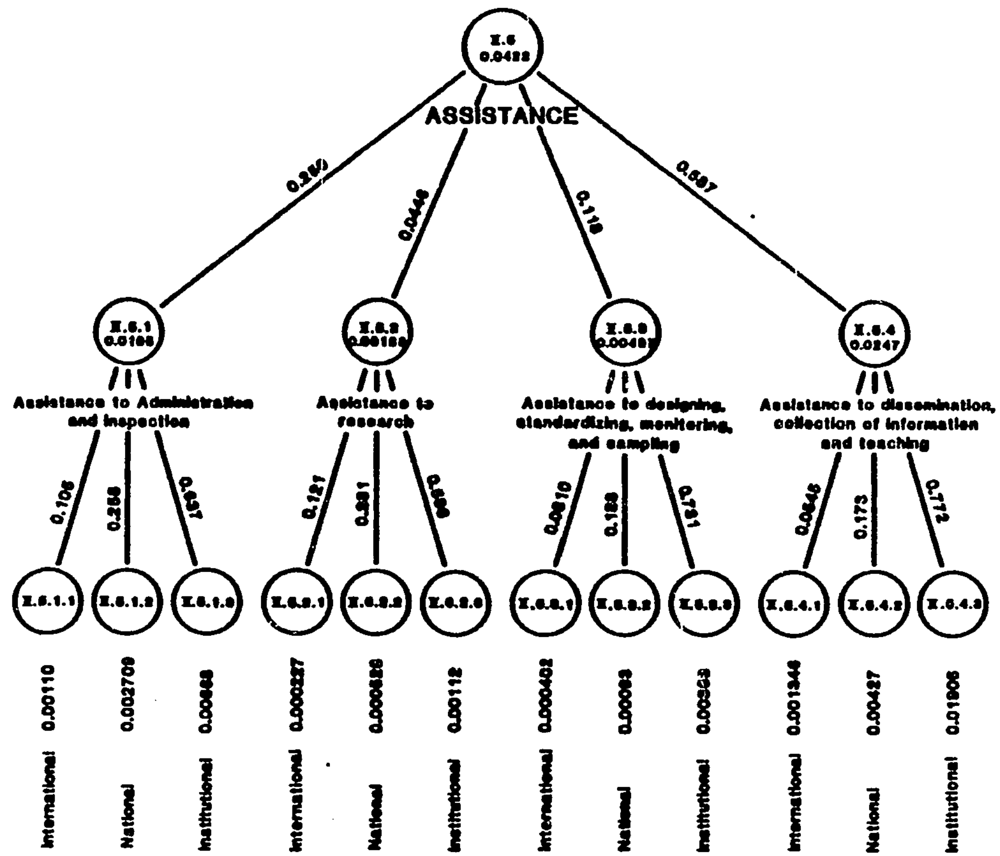
(Figure E.1 continued)



(Figure E.1 continued)



(Figure E.1 continued)



APPENDIX F

SUPPORT FORMS

1. General Support Forms
2. Support Forms filled out with the Current Status of Environmental Affairs in Costa Rica

APPENDIX F

SUPPORT FORMS

1. General Support Forms

Name	
Maximum Education	P D M B V U
Languages	E S F R G
Factor F_{mep} =	P=Post Doctoral; D=Doctoral; M=Master's;
	B=Bachelor's; V=Vocational Training; U=Pre-
	University.
	E=English; S=Spanish; F=French; R=Russian;
	G=German.

II.1 ADMINISTRATION AND INSPECTION

	$W_t \times 100$	F_{ie}	P
II.1.1 Administrative and Inspective duties			
II.1.1.1 General Management	6.33	t/4	
II.1.1.2 General Director of Adm and Insp	1.83	t/4	
II.1.1.3 Chairman of Administrative Dept	1.28	t/4	
II.1.1.4 Chairman of Inspection Department	0.13	t/4	
II.1.1.5 Vice-Chairman of Adm Section	0.82	t/4	
II.1.1.6 Chief of Lab Section for Insp	0.51	t/8	
II.1.1.7 Coordinator	0.36	t/8	
	Partial Summation		32.51

W_t = tree weights

F_{ie} = experience factor

P (Product) = $W_t \times F_{ie} \times F_{mep}$

Table F.1: GENERAL SUPPORT TABLES FOR THE EVALUATION COMMISSION

	W_tx100	F_{ie}		P
II.1.2 Participation in various commissions and committees				
II.1.2.1 Government Executive Board	4.07		t/4	
II.1.2.2 Institutional Council	1.99		t/4	
II.1.2.3 Adm technical council	0.96		t/4	
II.1.2.4 Inspectory technical council	0.49		t/4	
II.1.2.5 Sp commissions and committees	0.29		t/4	
II.1.3 Participation in scientific and technology societies		EC	ST	
II.1.3.1 International	3.65			
II.1.3.2 National	1.01			
II.1.3.3 Institutional	0.32			
II.1.4 Organization of events		EC	ST	
II.1.4.1 International	1.56			
II.1.4.2 National	0.37			
II.1.4.3 Institutional	0.17			
	Partial Summation			14.71

EC = Evaluation Commission

ST = Support table

(Table F.1 Continued)

II.2 RESEARCH

	W_tx100	F_{ie}		P
II.2.1 International Level				
II.2.1.1 Organization of Research				
II.2.1.1.1 Coordinator	8.04			
II.2.1.1.2 Supervisor	2.87			
II.2.1.1.3 Researcher	0.77			
II.2.1.2 Practice of Research				
II.2.1.2.1 Supervisor	2.58			
II.2.1.2.2 Researcher	0.28			
II.2.1.2.3 Assistant	0.27			
II.2.2 National Level				
II.2.2.1 Organization of Research				
II.2.2.1.1 Coordinator	2.35			
II.2.2.1.2 Supervisor	0.87			
II.2.2.1.3 Researcher	0.24			
	Partial Summation			18.03

(Table F.1 Continued)

	W_tx100	F_{ie}		P
II.2.2.2 Practice of Research				
II.2.2.2.1 Supervisor	0.75			
II.2.2.2.2 Researcher	0.32			
II.2.2.2.3 Assistant	0.08			
II.2.3 Institutional Level				
II.2.3.1 Organization of Research				
II.2.3.1.1 Coordinator	1.06			
II.2.3.1.2 Supervisor	0.39			
II.2.3.1.3 Researcher	0.12			
II.2.3.2 Practice of Research				
II.2.3.2.1 Supervisor	0.34			
II.2.3.2.2 Researcher	0.15			
II.2.3.2.3 Assistant	0.04			

(Table F.1 Continued)

II.3 DESIGNING, STANDARDIZING, MONITORING AND SAMPLING

	W_tx100	F_{ie}		P
II.3.1 Organization of Designing, Standardizing,				
Monitoring and Sampling				
II.3.1.1 Development of Plans and Programs				
II.3.1.1.1 International	0.73			
II.3.1.1.2 National	2.86			
II.3.1.1.3 Institutional	6.56			
II.3.1.1 Participation in the development				
of new methods				
II.3.1.2.1 International	0.22			
II.3.1.2.2 National	0.74			
II.3.1.2.3 Institutional	2.00			
II.3.2 Practice of Designing, Standardizing, Monitoring and Sampling				
II.3.2.1 Direct wrk w/environmental aspect				
II.3.2.1.1 Design requirements	3.11			
II.3.2.1.2 Standards law	1.55			
II.3.2.1.3 Norms	0.50			
II.3.2.1.4 Monitoring methods	0.34			
II.3.2.1.5 Sampling methods	0.20			
	Partial Summation			18.81

(Table F.1 Continued)

	W_tx100	F_{ie}		P
II.3.2.2 Courses and Seminars				
II.3.2.2.1 Design	1.02			
II.3.2.2.2 Standards	0.46			
II.3.2.2.3 Norms	0.15			
II.3.2.2.4 Monitoring	0.10			
II.3.2.2.5 Sampling	0.06			
	Partial Summation			4.94

II.4 DISSEMINATION, COLLECTION OF INFORMATION AND TEACHING

	W_tx100	F_{ie}		P
II.4.1 Publications				
II.4.1.1 Books		n		
II.4.1.1.1 International	4.49		n/5	
II.4.1.1.2 National	0.90		n/15	
II.4.1.2 Scientific Publications		n		
II.4.1.1.1 International	2.45		n/40	
II.4.1.1.2 National	0.50		n/40	
II.4.1.3 Patents		n		
II.4.1.3.1 International	1.30		n/20	
II.4.1.3.2 National	0.28		n/40	
	Partial Summation			9.92

(Table F.1 Continued)

	W_tx100	F_{ie}		P
II.4.1.4 Articles		n		
II.4.1.4.1 International	0.63		n/20	
II.4.1.4.2 National	0.16		n/40	
II.4.1.5 Instructional Materials		n		
II.4.1.5.1 National	0.08		n/5	
II.4.1.5.2 International	0.28		n/15	
II.4.2 Presentation of proposals, lectures, conferences and seminars		EC	ST	
II.4.2.1 International	2.38			
II.4.2.2 National	0.59			
II.4.2.3 Institutional	0.19			
II.4.3 Documents preparations		EC	ST	
II.4.3.1 Reports	0.81			
II.4.3.2 Proposals	0.28			
II.4.3.3 Outline Proposals	0.13			
II.4.3.4 Summaries	0.06			
	Partial Summation			5.59

(Table F.1 Continued)

II.5 ASSISTANCE

	W_tx100	F_{ie}	P
II.5.1 Assistance to Administration, Inspection			
II.5.1.1 International	5.15		
II.5.1.2 National	1.38		
II.5.1.3 Institutional	0.39		
II.5.2 Assistance to Research			
II.5.2.1 International	2.75		
II.5.2.2 National	0.64		
II.5.2.3 Institutional	0.22		
II.5.3 Assistance to Designing, Standardizing, Monitoring and Sampling			
II.5.3.1 International	0.85		
II.5.3.2 National	0.25		
II.5.3.3 Institutional	0.07		
II.5.4 Assistance to Dissemination, Collection of information and teaching			
II.5.4.1 International	0.28		
II.5.4.2 National	0.07		
II.5.4.3 Institutional	0.02		
	Total Summation		96.80

(Table F.1 Continued)

2. Support Forms filled out with the Current Status of Environmental Affairs in Costa Rica

Name	
Maximum Education	P D M B V U
Languages	E S F R G
Factor F_{mep}	P=Post Doctoral; D=Doctoral; M=Master's;
	B=Bachelor's; V=Vocational Training; U=Pre-University
	E=English; S=Spanish; F=French; R=Russian; G=German

II.1 ADMINISTRATION AND INSPECTION

	W_tx100	F_{ie}		P
II.1.1 Administrative and Inspective duties		t		
II.1.1.1 General Management			t/4	11.28
II.1.1.2 General Director of Adm and Insp			t/4	8.87
II.1.1.3 Chairman of Administrative Dept			t/4	5.19
II.1.1.4 Chairman of Inspection Dept			t/4	3.54
II.1.1.5 Vice-Chairman of Adm Section			t/4	3.30
II.1.1.6 Chief of Lab Section for Insp			t/8	1.19
II.1.1.7 Coordinator			t/8	1.02
	Partial Summation			34.39

W_t = tree weights

F_{ie} = experience factor

P (Product) = $W_t \times F_{ie} \times F_{mep}$

Table F.2: SUPPORT TABLES FOR THE EVALUATION COMMISSION OBTAINED FROM THE CURRENT STATUS OF ENVIRONMENTAL AFFAIRS OF COSTA RICA'S INSTITUTIONS, RESULTING FROM THE EXPERTS' ANSWERS TO QUESTIONNAIRES

		W_tx100	F_{ie}		P
II.1.2	Participation in various commissions and committees		t		
	II.1.2.1 Government Executive Board			t/4	3.12
	II.1.2.2 Institutional Council			t/4	0.94
	II.1.2.3 Adm technical council			t/4	0.37
	II.1.2.4 Inspectory technical council			t/4	0.53
	II.1.2.5 Sp commissions and committees			t/4	0.55
II.1.3	Participation in scientific and technology societies		EC	ST	
	II.1.3.1 International				0.54
	II.1.3.2 National				1.13
	II.1.3.2 Institutional				3.92
II.1.4	Organization of events		EC	ST	
	II.1.4.1 International				0.31
	II.1.4.2 National				0.99
	II.1.4.3 Institutional				0.44
		Partial Summation			12.84

EC = Evaluation Commission

ST = Support table

(Table F.2 Continued)

II.2 RESEARCH

	W_tx100	F_{ie}		P
II.2.1 International Level				
II.2.1.1 Organization of Research				
II.2.1.1.1 Coordinator				0.16
II.2.1.1.2 Supervisor				0.07
II.2.1.1.3 Researcher				0.02
II.2.1.2 Practice of Research				
II.2.1.2.1 Supervisor				0.52
II.2.1.2.2 Researcher				0.19
II.2.1.2.3 Assistant				0.05
II.2.2 National Level				
II.2.2.1 Organization of Research				
II.2.2.1.1 Coordinator				0.10
II.2.2.1.2 Supervisor				0.44
II.2.2.1.3 Researcher				0.12
	Partial Summation			1.67

(Table F.2 Continued)

	W_tx100	F_{ie}	P
II.2.2.2 Practice of Research			
II.2.2.2.1 Supervisor			0.36
II.2.2.2.2 Researcher			0.13
II.2.2.2.3 Assistant			0.03
II.2.3 Institutional Level			
II.2.3.1 Organization of Research			
II.2.3.1.1 Coordinator			0.71
II.2.3.1.2 Supervisor			0.31
II.2.3.1.3 Researcher			0.12
II.2.3.2 Practice of Research			
II.2.3.2.1 Supervisor			2.23
II.2.3.2.2 Researcher			0.83
II.2.3.2.3 Assistant			0.24
	Partial Summation		4.96

(Table F.2 Continued)

II.3 DESIGNING, STANDARDIZING, MONITORING AND SAMPLING

	W_tx100	F_{ie}		P
II.3.1 Organization of Designing, Standardizing, Monitoring and Sampling				
II.3.1.1 Development of Plans and Program				
II.3.1.1.1 International				0.14
II.3.1.1.2 National				0.35
II.3.1.1.3 Institutional				0.88
II.3.1.2 Participation in the development of new methods				
II.3.1.2.1 International				0.41
II.3.1.2.2 National				0.91
II.3.1.2.3 Institutional				2.82
II.3.2 Practice of Designing, Standardizing, Monitoring and Sampling				
II.3.2.1 Direct wrk w/environmental aspect				
II.3.2.1.1 Design requirements				0.18
II.3.2.1.2 Standards law				0.36
II.3.2.1.3 Norms				0.83
II.3.2.1.4 Monitoring methods				0.83
II.3.2.1.5 Sampling methods				1.94
	Partial Summation			9.65

(Table F.2 Continued)

	W_tx100	F_{ie}	P
II.3.2.2 Courses and Seminars			
II.3.2.2.1 Design			0.51
II.3.2.2.2 Standards			1.03
II.3.2.2.3 Norms			2.00
II.3.2.2.4 Monitoring			3.17
II.3.2.2.5 Sampling			5.66
	Partial Summation		12.37

II.4 DISSEMINATION, COLLECTION OF INFORMATION AND TEACHING

	W_tx100	F_{ie}	P
II.4.1 Publications			
II.4.1.1 Books		n	
II.4.1.1.1 International		n/5	0.01
II.4.1.1.2 National		n/15	0.04
II.4.1.2 Scientific Publications		n	
II.4.1.2.1 International		n/40	0.01
II.4.1.2.2 National		n/40	0.04
II.4.1.3 Patents		n	
II.4.1.3.1 International		n/20	0.08
II.4.1.3.2 National		n/40	0.05
	Partial Summation		0.23

(Table F.2 Continued)

	W_tx100	F_{ie}		P
II.4.1.4 Articles		n		
II.4.1.4.1 International			n/20	0.03
II.4.1.4.2 National			n/40	0.06
II.4.1.5 Instructional Material		n		
II.4.1.5.1 National			n/5	0.46
II.4.1.5.2 International			n/15	0.07
II.4.2 Presentation of proposals, lectures,				
conferences and seminars		EC	ST	
II.4.2.1 International				0.31
II.4.2.2 National				0.77
II.4.2.3 Institutional				1.91
II.4.3 Documents preparations		EC	ST	
II.4.3.1 Reports				2.73
II.4.3.2 Proposals				0.54
II.4.3.3 Outline Proposals				1.03
II.4.3.4 Summaries				6.27
	Partial Summation			14.18

(Table F.2 Continued)

II.5 ASSISTANCE

	W_tx100	F_{ie}	P
II.5.1 Assistance to Administration, Inspection			
II.5.1.1 International			0.11
II.5.1.2 National			0.27
II.5.1.3 Institutional			0.67
II.5.2 Assistance to Research			
II.5.2.1 International			0.03
II.5.2.2 National			0.05
II.5.2.3 Institutional			0.11
II.5.3 Assistance to Designing, Standardizing, Monitoring and Sampling			
II.5.3.1 International			0.04
II.5.3.2 National			0.09
II.5.3.3 Institutional			0.36
II.5.4 Assistance to Dissemination, Collection of Information and Teaching			
II.5.4.1 International			0.13
II.5.4.2 National			0.43
II.5.4.3 Institutional			0.19
	Total Summation		92.77

(Table F.2 Continued)

APPENDIX G

LIST OF EXPERTS

APPENDIX G

LIST OF EXPERTS

The following is the list of experts who have participated in this research. The list of participants is composed of experts from both inside and outside Costa Rica.

TABLE G.1

LIST OF EXPERTS

No.	Name	Title-Address
Outside Country:		
1.	Carefoot, Eng. Neil	Project Manager PARO/WHO P. O. Box 508 Jemmotts Lane Bridgetown, Barbados West Indies
2.	Reyes, Dr. Wilfrido	Programme Coordinator CERE, WHO P. O. Box 302 Jakarta 46392, Indonesia
3.	Sperandio, Eng. Odyer A.	Director, CEPIS Organizacion Panamericana de la Salud Casilla Postal 4337 Lima, Peru
4.	Van Damme, Dr. J.M.G.	Director, WHO International Reference Center for Community Water Supply P. O. Box 140 Leidschendam, The Netherlands

TABLE G.1 (Continued)

No.	Name	Title-Address
5.	Wehman, Eng. Victor	Program Manager USAID Office of Health Development Support Bureau Washington, D.C. 20523
Inside Country:		
6.	Bolaños, Lic. Eladio	Chairman of Industries Economy, Industry and Commerce Ministry Ave. Central y Segunda Calle 10 (edificio anti- guo INS) San Jose, Costa Rica
7.	Calvosa, Dr. Carmelo	Health Minister Apartado 10123 San Jose San Jose, Costa Rica
8.	Constela, Dr. Manuel	Director Environmental Sciences Research Institute University of Costa Rica Chemistry School San Jose, Costa Rica
9.	Cordero, Eng. Olman	Executive President Drainage and Sewage National Institute Ave. Central, Calle 5 Edificio La Llacuna San Jose, Costa Rica
10.	Gomar, Eng. Mario	Sanitary Chairman Municipality of San Jose Apartado Postal #5102 San Jose, Costa Rica
11.	Schnell, Dr. Charles	Director Environmental Sciences School National University Heredia, Costa Rica