

## Geothermal Energy and Local Societies – A NIMBY Syndrome Contradiction?

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### ABSTRACT

The present work refers to the Geothermal Energy sector and focuses on the record, processing and assessment of the data that structure the relation between geothermal energy development and local societies. The study focuses on the islands of Milos and Nisiros that exhibit a rich geothermal potential capable of covering a wide range of applications, while it includes areas that provide historical data arising from similar activities.

The social study that took place during the spring of 2004 in the island of Milos and during the autumn of the same year in the island of Nisiros covered a significant sample of the two societies and multiple issues of the geothermal energy matter. Special attention was provided to the representational samples with regards to the age, the occupation and the cultural level.

The conclusions from each section are of particular interest, providing a framework for consideration that could form a creative basis for the development of geothermal energy applications with the aid of the local society.

### 1. INTRODUCTION

The industrial development and the rising living standards of the people generate new energy demands that should be satisfied by a rational utilization of available energy resources. The second energy crisis of 1979, the increasing prices of the liquid fuels and the gradual depletion of resources in combination with the greenhouse gas effect, accentuate the energy problem while intensify the interest for alternative forms of energy, with the geothermal energy being one of them.

Greece is a quite favored country as far as it concerns the geothermal energy, while significant research has taken place over the last 30 years on the location and characterization of a big number of geothermal fields (Andritsos, Karambelas & Fytikas, 1999). One of the most important research outcomes was the exploration of the low, medium and high enthalpy geothermal fields in the islands of Milos and Nisiros. Despite of the geothermal energy wealth of Greece, its development is still non-satisfactory compared to either the development of other Renewable Energy Sources or the progress that other countries exhibit in this sector.

The most important considerations for this delay are from one side the oppositions of the local societies and particularly in Milos and Nisiros and on the other side the total lack of regulatory and financing framework that practically "blocked" for almost 20 years any relevant discussion. Recently in 2003, the Law 3175 "Exploitation of geothermal potential, district heating, and other provisions" (Government Gazette A' 207) was voted, as well as a series of Ministerial Decisions that set the general terms of the development framework. However, many important issues need further and special configuration. For

example, the licensing procedures, the rights of research and exploitation within fields where such had been provided, the investment incentives, the research risk allocation, the compensatory benefits of the local society, the exact identification of the environmental issues during each stage of a geothermal project development, the inspection public mechanisms etc.

It is very clear that social acceptance constitutes one of the most important development aspects of a geothermal project. It is not possible to complete a successful implementation and completion of such a project, if initially not identifying the elements of the local environment, which can influence its social acceptance, and not designing proper organizational, technical, economic and other solutions in order to remove the negative opinions (Popovski, 2003). Social acceptance is attained if the project activities do not result in drastic changes from the regular conditions of the area and if the affected sectors can see some advantages issuing from the project (de Jesus, 1995, Cataldi, 2001). Social acceptability of a profit-purported project is the condition upon which the technical and economic objectives may be pursued in due time and with the consensus of the local communities; consensus to be gained by acting in consonance with the dynamic conditions of the environment and in the respect of the people's health, welfare and culture (Cataldi, 2002).

The complexity of understanding the social opinion and the way that is formed, altered or evolves, should never be underestimated. Studies that deal with the social behavior with respect to other types of renewable energy sources (RES) indicate that these behaviors can vary in terms of expression type, grade of influence, community involvement and they are usually very contradictory (Hansen, Hammarlund, Sørensen & Christensen, 2003). For example, the public majority supports the use of RES and especially the use of wind power. This kind of acceptance, though, reduces at the time that a new plant is to be installed at a neighboring area. In fact, these studies have indicated that in the case of wind power, the acceptance level of the public is very high prior the installation of the wind turbines, which lowers significantly during the construction phase of the project and becomes high again after the completion of the works (Krohn & Damborg, 1999).

The social acceptance of renewable energy sources is often characterized by the NIMBY (Not In My Back Yard) syndrome. The reference to the NIMBY syndrome is possibly a very simplified way to interpret the human behavior. Researchers use different types of analyses in order to interpret the NIMBY syndrome; some of researchers characterize the public reaction unreasonable. This type of analysis considers the public unwilling to accept any kind of risk in favor of the society. Those who support this theory conclude to the fact that the unreasonable reaction of the public is based on the lack of information. The argument does not acknowledge the fact that the uncertainty issues will be always part of any kind of

decision that relates to the natural environment (Krohn & Damborg, 1999).

Others consider the opposition of the public wise and valuable that contributes significantly to the whole procedure of the project impact assessment. The organized protest that contrast scientific studies could bring forward data or parameters that otherwise might not be considered by the scientists. Moreover, it can contribute to the understanding of the complete system that brings forth this opposition from the very first moment, by examining in detail the liability and the specific opposite opinions (Glickel, 2004).

Each type of approach generally not considers that the procedures for the implementation of such a project do not take into account the local society, and usually are imposed from people in higher places or are over proportioned for the planned area. According to the studies of Wolsink in 1996 and in 2000, people that exhibit the biggest opposition to the wind power projects are not generally opposed to the wind turbines but against the people that plan to install these wind turbines. The local societies are not part of the decision-making procedure. Some people are a priori opposed to the ones responsible for the development, the bureaucracy and/or the politicians (Polyzou, Menegaki & Stamataki, 2005). It should be considered that the social reactions produced against almost all types of sustainable energy sources, become even more intense in the case of electricity production activities.

The extent of the reactions is proportional to the scale of the project. Large scale projects equals to larger impacts and thus bigger oppositions. There are many relevant examples and especially from projects that deal with the wind power and the hydroelectric power sectors, despite the fact that these are characterized as widespread and mature technologies. As far as it concerns the geothermal energy, the Hawaiian case, is quite characteristic. In this case the exploitation of the geothermal field of the island begun in 1972, in order to construct an electricity production unit of 500MW. The conflicts were pretty intense. The study of these reactions indicated significant and much deeper issues. Canan (1986) notes that, the cooperation of the government and the industry put aside the local interests while the scale of the project was disproportional to the characteristics and the natural environment of the island community. The lack of sensitivity considered to be the most significant issue of the reactions, as a result of the change of the society structure of Hawaii and of the limitations set to the participation of the residents to the project and which finally was allowed to a limited number of people during its design phase. Since the reactions were already present, any efforts that were made afterwards in order for the residents to become more familiar with the project were unsuccessful, due to the resulted lack of confidence. As Canan comments: *"The absolute governmental persistence related to the development axes of geothermal energy, resulted to the degradation of the public confidence to renewable energy sources (including the geothermal energy) and the creation of a hostile environment in which any future conversations will have to take place. For these reasons it is important to carefully examine the main issues of the conflicts and the oppositions and wherever possible to provide clear answers in order to achieve a wider public consensus"*.

It is considered therefore absolutely necessary to record and analyze the local communities regarding the development issues of geothermal energy in order to locate and evaluate

the main issues that cause the reactions and set off afterwards the main axes of the intervention actions that will have to be followed. Especially in the case of our country, where on one side the geothermal energy wealth is quite significant, while on the other side the activities so far have mainly 'damaged' it, the above aspect constitutes an especial priority.

## 2. METHODOLOGY OF STUDY

The record of the attitude of Milos and Nisiros residents' was conducted using methodologies of social study and was implemented by means of telephone survey questionnaire. The specific technique was selected on the basis of the available funding resources for the implementation of the study, given that it fully covers the needs of the specific study while it has been proven that it provides as reliable results as any other type of survey questionnaires (Javeau, 1996, Stathakopoulos, 1997).

### 2.1 Selection of Population and Sample Definition

The target – population was selected to be the households of Milos and Nisiros. In the case of Milos, a number of 250 households form a representative sample from the 1,839 households of the island, according to the official results of the 2001 census (National Statistical Service of Greece) (the total population of the island was recorded to 4,771 residents). In the case of Nisiros, the respective sample was defined to 90 households from the 367 ones (the total population of the island was recorded to 948 residents). The size of the sample in both cases considers the rules of social research and the requirements of statistics, while it is consistent with the international experience and practice. This fact was also confirmed by the error estimated after the processing of the questionnaires, and which was less than 5% for a confidence level of 95%. The most suitable sampling technique was considered to be the "simple systematic sampling with lottery", by using the telephone directory of the island and selecting a telephone number every 10 numbers.

### 2.2 Questionnaire Elaboration

The questionnaire consists of seventeen questions. Six of them refer to the demographic details of the interviewee. The number of the questions was set according to the collection of all the necessary information within a reasonable interview time of approximately 10 minutes.

The questions used were simple and multiple choices questions and included the following types:

- a) Closed question with ordinal and nominal scale
- b) Open questions, and
- c) Semi-open questions, in combination with nominal scale.

The first three questions aimed to a double scope: the introduction of the interviewee in the subject of geothermal energy and the collection mainly of qualitative information regarding the awareness degree on this subject by the residents of the island. At the same time, it is indirectly intended to investigate the role of the educational system and the Mass Media in the informing of the residents.

The next four questions relate to the investigation of the possible annoyance of the residents by the exploitation of the geothermal potential of their area as well as the determination of the environmental problems that the residents consider that are possibly associated with the development of geothermal applications.

The eighth question intends to the evaluation of the impact, either positive or negative, to the economic activities of the area from the possible exploitation of the geothermal energy. The aim of the specific question is a primary approach of the susceptible degree of the people towards the reception and support of business development actions, along with the terms/conditions under which their position is either positive or negative.

The three next questions aim to the determination of the uses for which the geothermal fields could be exploited, according to the residents. In this way, it is possible to assess the development priorities of the island, as expressed by the local society, in combination with the possibility to be supported by the existing geothermal potential.

Finally, the basic demographic details of the interviewees are collected, in order to be utilized in the statistical processing of the results.

### 3. IDENTITY OF THE STUDY

The sample collected was representative in terms of the characteristics of the population of each area and its critical parameters (age, educational level, occupation).

The characteristics of the sample, in the case of Milos are presented in Figures 1 to 3, while for Nisiros, in Figures 4 to 6. The marks (M), (N) refer to results from Milos and Nisiros, respectively. Based on these data, it appears that the allocation of the population characteristics was quite similar for both areas.

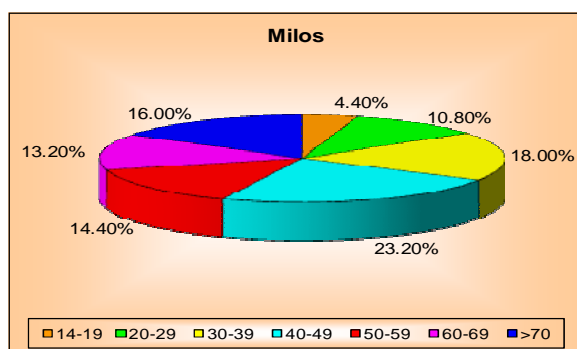


Figure 1: Allocation of sample per age groups (M)

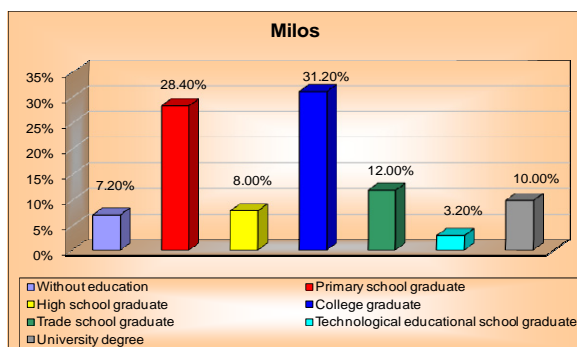


Figure 2: Allocation of sample per educational level (M)

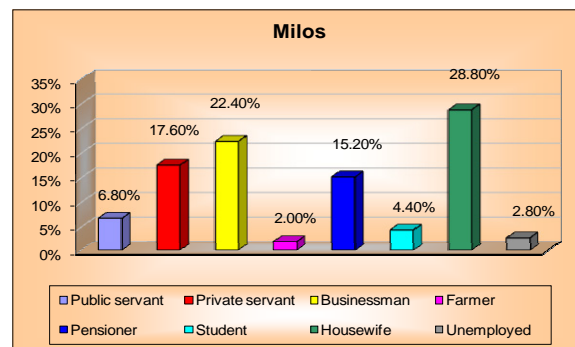


Figure 3: Allocation of sample per occupation (M)

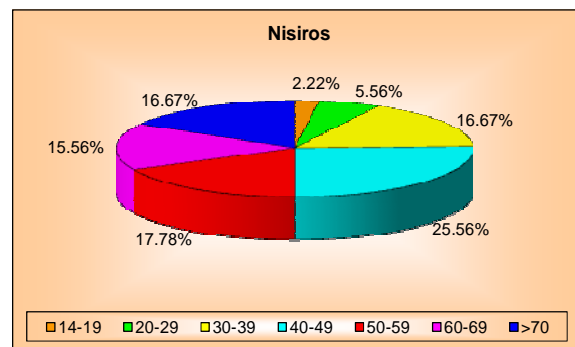


Figure 4: Allocation of sample per age group (N)

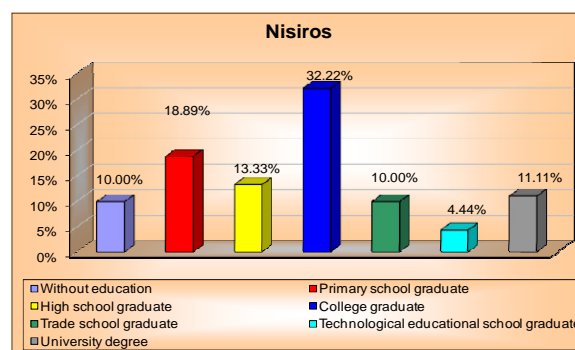


Figure 5: Allocation of sample per educational level (N)

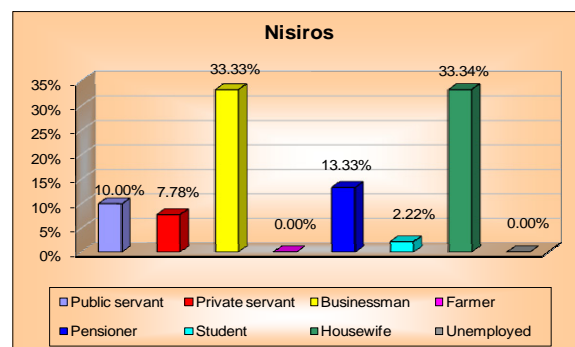


Figure 6: Allocation of sample per occupation (N)

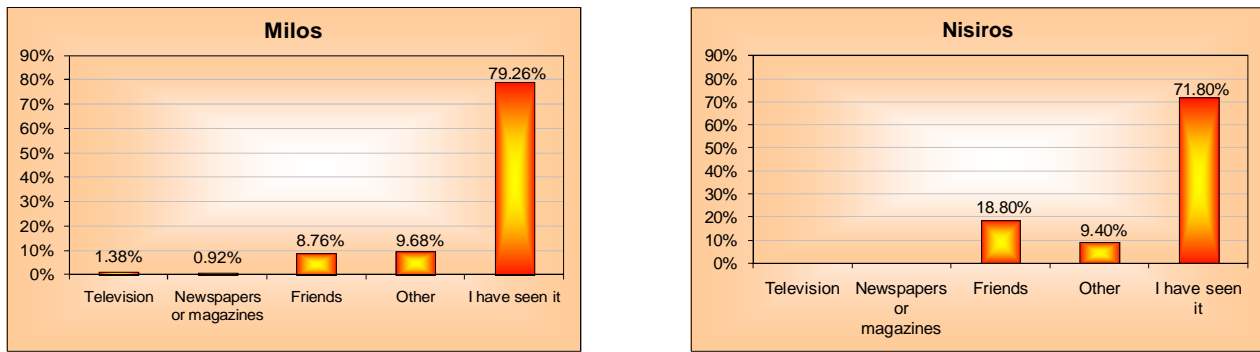


Figure 7: Sources of people knowledge a) Milos, b) Nisiros

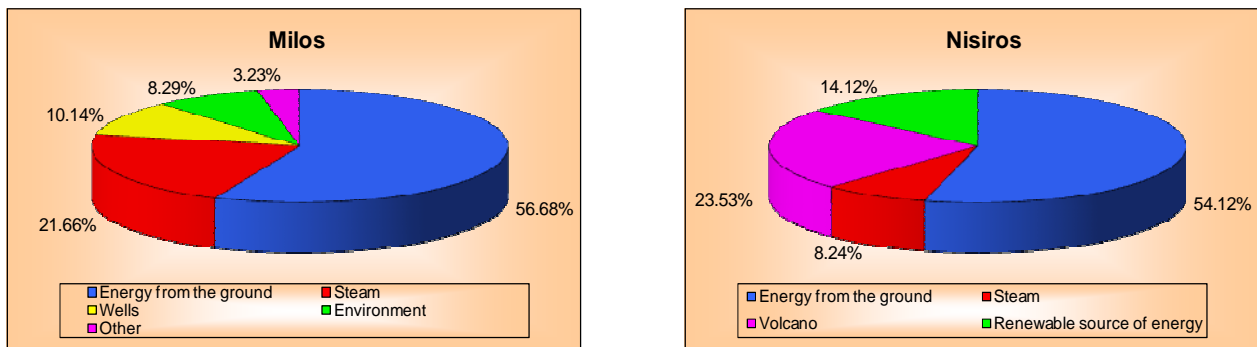


Figure 8: Knowledge about geothermal energy a) Milos, b) Nisiros

## 4. RESULTS OF THE STUDY

### 4.1 Knowledge about Geothermal Energy and Sources of Knowledge

The 86.8% of the interviewees in Milos and the 94.4% in Nisiros know about geothermal energy. The main source of knowledge at a percentage of 79% in Milos and 72% in Nisiros, as presented in Figure 7, is the people's personal experience from the activities taken place in both islands. It is remarkable that the contribution of the school and the occupational environment to the knowledge of the people is very small (a percentage of 9.7% and 9.4%, respectively) while the contribution of the mass media on this subject is almost negligible.

The knowledge of the local society about what is geothermal energy is estimated to be correct at both areas. In the case of Milos, a percentage of over 75% answered that it is "energy coming from the earth" or "vapor", while even the ones that used the term "wells" (10%) seem to have some knowledge of the corresponding technology. In the case of Nisiros, a percentage of over 76% answered that it is "energy coming from the earth", "sustainable energy source" or "vapor", while a significant part of the interviewees (a percentage of 23.5%) relate the geothermal

energy with the volcano activity of the island, an opinion that is absolutely correct (Figure 8).

### 4.2 Geothermal Energy and Environment

The overwhelming majority of the interviewees in Milos (80%) consider that geothermal energy is a polluting for the environment activity, with significant impacts. This picture is slightly different in Nisiros, where also the majority of the interviewees (85%) think that geothermal energy affects the environment ranging this impact from significant (57%) to enough (27.6%) (Figure 9).

As far as it concerns the impacts of geothermal energy to the environment, there was a possibility of multiple choice answers. The interviewees could select more than one answer. In both areas the most frequent answer was about the air pollution (a percentage of 46% in Milos and 58% in Nisiros), while the soil and ground water pollution followed by a percentage of 39.5% and 36.4%, respectively. The marine pollution (a percentage of 12.3% and 6%, respectively) comes after with a great difference from all previous answers. It appears that people do not account noise or visual impact issues related to the geothermal installations as a significant influence (Figure 10).

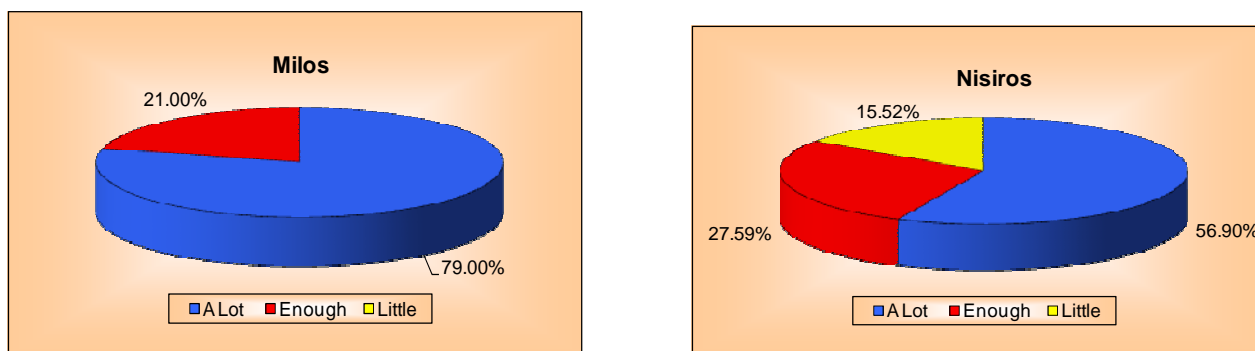


Figure 9: Geothermal energy and its impact magnitude onto the environment a) Milos, b) Nisiros

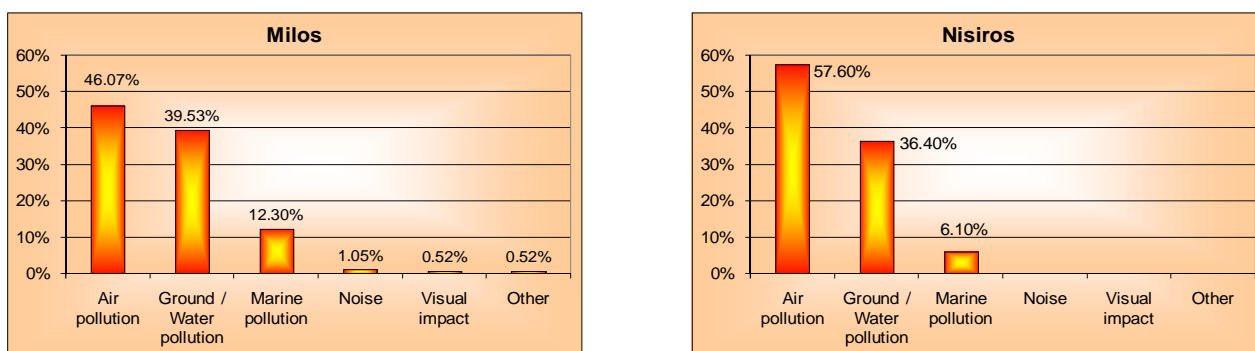


Figure 10: Geothermal energy impacts on the environment a) Milos, b) Nisiros

The aforementioned data were also confirmed by the answers provided by the interviewees regarding the type of impact that consider more significant. In this question, the case of Milos shows that the air pollution is considered more substantial at a percentage of 81%, then the soil and ground water pollution at a percentage of 14% and finally the marine pollution at a percentage of 5%. Corresponding and maybe more intense results come from the case of Nisiros, where the overwhelming majority (98%) thinks the air pollution is the most important impact, while the marine pollution follows with a very large difference at a percentage of 2% (Figure 11).

#### 4.3 Geothermal Energy Impact on the Existing Economic Activities

Tourism, trading as well as mining and industrial activities occupy a significant portion of the population and in fact, these activities constitute the basic income sources for the

island of Milos. Other activities in the island are fishery, farming and livestock farming that mainly cover the local needs.

The main income source for the island of Nisiros is tourism. For this reason, all projects under construction are directly related to the tourist development of the island. Another sector of activity is mining of pumice, which takes place at the island of Gyali (4 sea miles NW of Nisiros).

The greatest part of the interviewees considers that the development of geothermal activities at the island of Milos will have a negative impact on cultivations and fishery, at a percentage of 54.4% and 43.8%, respectively. The same applies in the case of Nisiros at a percentage of 56.5%. It should be noted that for the impacts on tourism, the opinions of the people are equally distributed in both islands (Figure 12).

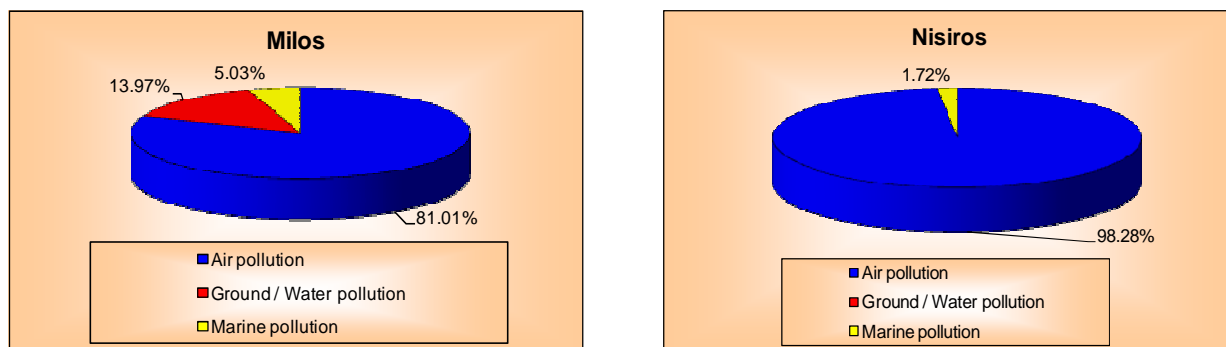


Figure 11: Main polluting parameters a) Milos, b) Nisiros

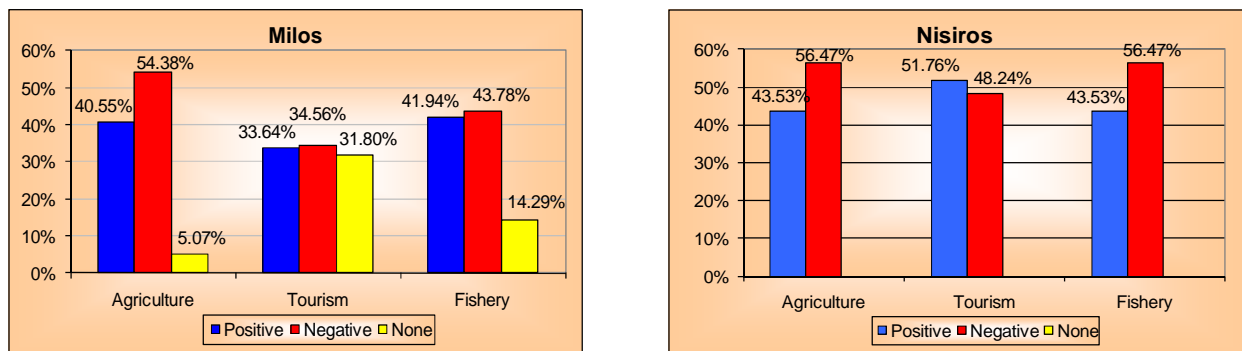


Figure 12: Impact of geothermal energy per economic activity sector a) Milos, b) Nisiros

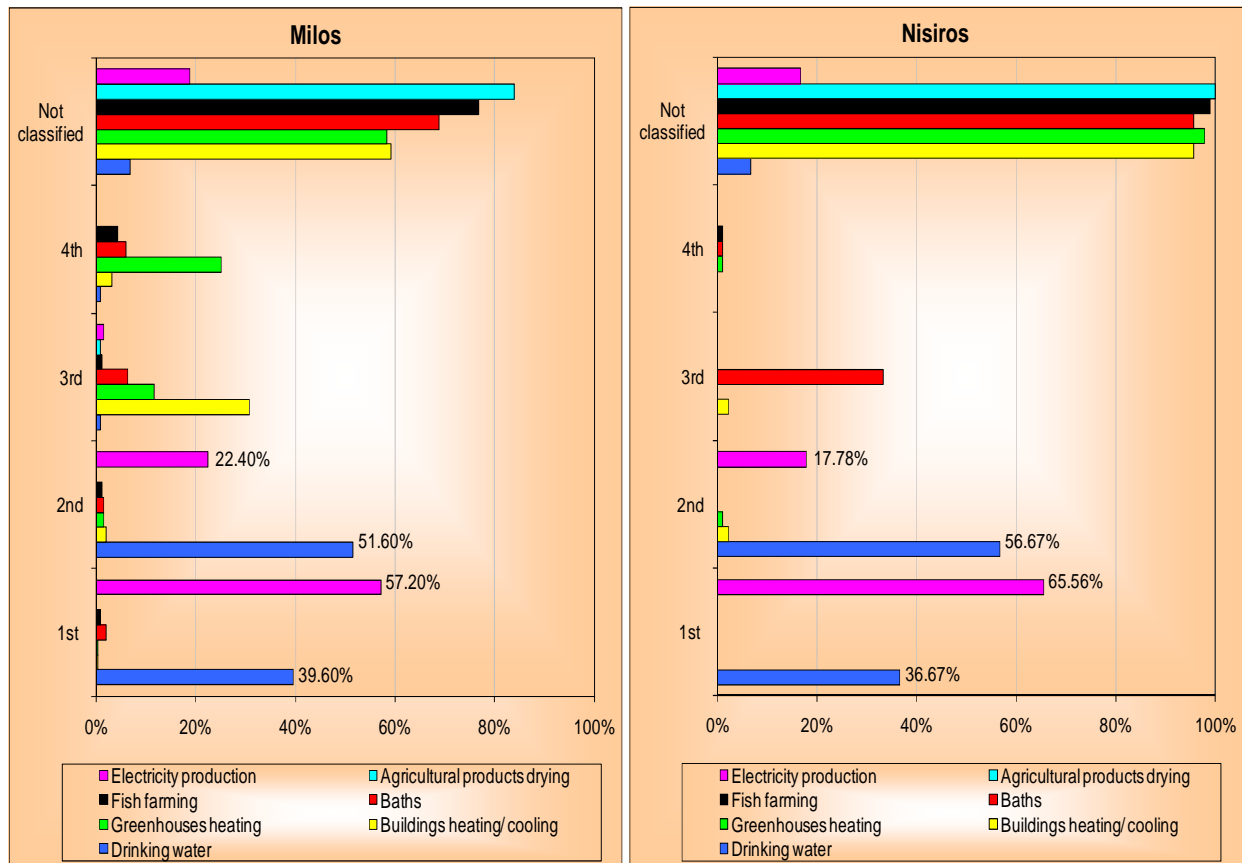


Figure 13: Classification of geothermal energy applications a) Milos, b) Nisiros

#### 4.4 Response to new activities

The most significant use of geothermal energy for the people of island Milos, as results from Figure 13, is the electricity production at a percentage of 57.2%, while desalination for drinking water follows at a percentage of 40%. It is interesting to note that these activities dominate the classification of the two primary choices of the interviewees and accumulate the majority of the public acceptance (percentage greater than 74%). Besides the fact that electricity and drinking water production reflect the substantial needs of the local society that appear to grow rapidly during the last years and especially during the summer months due to the tourist activities, these technologies are more familiar to the residents due to relevant projects already performed in the island. These are the electricity production plant of the Public Power Corporation during the '80s and the desalination plant that has recently begun to be constructed with the contribution of the Center of Renewable Energy Sources. The third place of choices holds the heating and cooling of buildings, but

far off the first two ones. Uses of geothermal energy in activities such as fish farming or drying of agriculture products do not seem to have any kind of response from the people. In fact, an appreciable part of the interviewees (greater than 75%) do not even include such uses in their evaluation. This position may be characterized by the unfamiliarity of the public with the technologies that can be applied and the corresponding benefits for the local society. The possibility of correlating the baths (spa) with the developing tourist activities in the area and their possible incorporation in an effort to upgrade and extend the tourist period (winter tourism), has never been considered by the interviewees.

As far as it concerns the island of Nisiros, the interviewees' opinions regarding the first two choices for the use of geothermal energy do not differ significantly from the ones presented in Milos. According to Figure 13, the first choice for the use of geothermal energy is the production of electricity at a percentage of 65.6% while desalination for the production of drinking water follows at a percentage of



36.7%. It should be noted that these activities are basically the only ones selected exhibiting a percentage of social acceptance of over 80%. The use of geothermal energy in baths (spa) is given as a third choice at an exceptionally small percentage of 3.5%. It is important though to note that the overwhelming majority of the interviewees (greater than 95%) do not include other uses of geothermal energy in their evaluation. Based on these positions, it seems that there is a complete ignorance of the people on other uses and applications of geothermal energy.

A question that addresses the people's will to a plant installation which shall serve the sector considered more significant, shows that in the case of Milos, the majority of the interviewees were positive (73%) against the negative percentage of 27%. In the case of Nisiros, the opinions of the interviewees were almost equally distributed (51% and 49%, respectively).

It appears that the majority of the interviewees expressed a negative attitude (the 70% in Milos and the 57%, in Nisiros) form their opinion on the impacts that geothermal development may causes on health and environment, while a significant percentage (16.2% and 22.7%, respectively) shows a lack of confidence on the way that a relevant project will take place. It should be mentioned that a part of the local community of Nisiros (a percentage of 13.7%) used the simple and not validated answer ....we don't want it... (Figure 14).

## 5. COMPARATIVE EVALUATION AND DISCUSSION OF THE RESULTS

Based on a primary treatment of the study results and the evaluation of the answers provided in the individual questions, the following remarks are given, in relation to the demographic characteristics of the samples.

All the age groups have knowledge about the geothermal energy issue at an important percentage and at both areas of study. This knowledge level increases in the case of Milos where, at the age group between 40-50 years-old, reaches a 95%, while in the case of Nisiros the same applies in the younger and middle ages (at the age groups between 40 years-old and lower, it corresponds to 100%). It is worth mentioning that there isn't a remarkable difference in this knowledge when examining the occupation as well as the educational level, even when the interviewees had a lower educational level (have never been to school or just finished the primary school). The most correct knowledge about what is geothermal energy exhibit the groups of the younger to middle ages, regardless of their educational

level. It is also interesting that the interviewees that have never been to school have knowledge and a pretty correct one, on this issue.

The main source of information and knowledge about geothermal energy in both islands is the experiential data of the public. This experience is more obvious in the middle and higher ages (over 30 years-old). At the younger ones (between 14 – 19 years-old), the main source of information seems to be the school. However, its contribution is pretty limited. The affect of the imprint and electronic mass media is negligible which is directly related with the fact that there is no state policy and interest in order to inform the public and to promote such intervention activities.

In Milos there is an intense consideration of the impacts of geothermal energy on the environment, from the total of the interviewees regardless of age. The overwhelming majority thinks that geothermal energy is a polluting activity. This position seems to be less intense in the groups of the unemployed and young students, possibly due to the fact that the first group hopes for new jobs in the case of new initiatives, while the second group has a better knowledge on the exploitation and management technologies of a geothermal application. The examination of the occupation and whether it relates with the tourism activities or not, do not signify any type of greater intense environmental sensitivity and thus there are no arguments to stand the position against geothermal energy which is usually highlighted due to prejudices around the tourist development of the island. Most of the interviewees, regardless of occupation, think that the air pollution is the main environmental problem while the soil and ground water pollution follow. In fact, the position that air pollution is the main environmental problem is completely supported by the younger ages. One could estimate that this position can be directly related to the experience of the residents in the past, but it seems that this opinion is transferred to the younger ones with the same intense. In Nisiros, the aforementioned situation is slightly different. The interviewees think that geothermal energy do have impact on the environment but to lesser degree. The younger ages (<30 years-old) though have a completely different position, which supports the fact that geothermal energy has significant impacts on the environment. Examining that the occupation and whether it is related or not with tourism, there appears to have accordingly a greater environmental sensitivity. Air pollution constitutes the environmental problem in the case of Nisiros as well, according to the total of the interviewees, while the older ages (>70 years-old) and the women, consider the marine pollution as the most significant environmental problem.

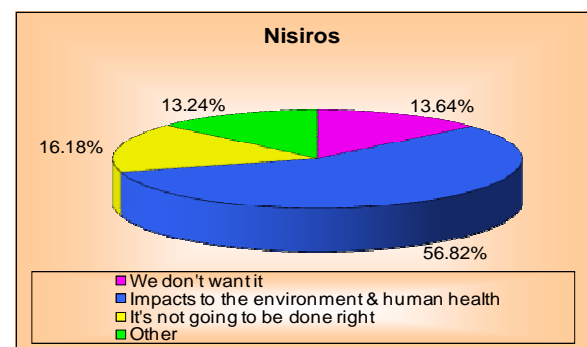
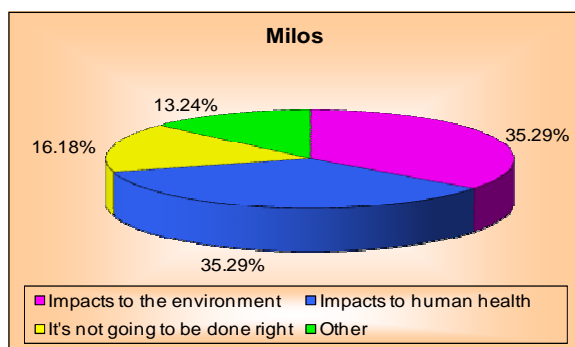


Figure 14: Main reasons for the people's negative position a) Milos, b) Nisiros

The agriculture and fishery sectors are the economic activities that are more sensitive towards the development of geothermal energy in both islands. Considering the answers provided about the parameters that affect the environment, a significant contradiction arises: While the greatest percentage of the people considers that the air pollution is the main environmental problem, a parameter that would mainly affect the tourist activity, at the same time thinks that the main impact will be received by sectors that could actually be related with environmental problems (soil, ground water and marine pollution), which have been previously evaluated and ranked in much lower places in their answers.

In the case of Milos, the general categorization of the potential uses of geothermal energy as far as it concerns the first two applications (electricity production and desalination), is directly related to the age of the people. The older ages (> 50 years-old) consider drinking water as the most important need that must be fulfilled, possibly due to the fact that for many years these ages have experienced the problem of drinking water supply. In fact, a significant percentage of greater than 55% of these people believe that any other activity will be worthless for their island. On the other hand, the younger ages (mainly between 14 – 19 years-old) show a more balanced position towards all uses of geothermal energy, a behavior that can be attributed to their knowledge and informing on the geothermal energy issues. In the case that occupations are examined, the farmers think that uses of geothermal energy related to their work (drying – greenhouse conditioning) are useless. In Nisiros the only options providing for the use of geothermal energy is electricity production and desalination. The middle to older ages (> 40 years-old) think that the most important need to be covered is electricity production, while the younger ages (between 14 – 19 years-old) consider that drinking water is their primary need. In both areas, people whose occupation is based on the tourism, seems to be unable to connect applications such as buildings conditioning or baths with their business interests. These remarks conclude to the fact that knowledge on the multiple and combinatorial uses of geothermal energy and especially of low enthalpy geothermal energy, is pretty low for the total of the local societies.

All the age groups think positively for initiatives that would aim to the development of geothermal energy in the island of Milos, at a percentage of greater than 70%. This position seems to be less positive in the middle and older ages. Some social groups, such as farmers, retired employees and housewives seem to be more conservative towards development activities. The rest of the groups are more susceptible. In Nisiros, the aforementioned situation is much different. The public opinion seems to be more divergent. The ages involved in production are rather negative to development activities, while the age group of 20 – 29 years is absolutely negative. It is noted that a significant part of the population in both islands that expresses a positive attitude for development activities, indicates that new initiatives should never be taken on by the bodies that have been involved in the relevant past activities.

The greatest part of interviewees that is negative to the implementation of new business plans for the development of geothermal energy in both islands, base this position on the pollution of the environment and impacts on the health of the residents. A significant part thinks that the project implementation will be inadequate. This attitude shows the lack of confidence to the state and to the inspection public

mechanisms as well as to the conditions of monitoring and control of the projects operation.

Summarizing the aforementioned data, it can be noted that the results of the studies between the work areas exhibit much similarities and less differences. Similarities are found at the issues of geothermal energy knowledge and sources of information, the possible effects of geothermal energy on the environment as well as the effect of geothermal energy on the existing economic activities. All these issues are treated with almost the same behavior in both islands. The differences found between the two islands are mainly focused on the response to new activities. The most significant one is in the case of geothermal energy development initiatives in these islands; where in Milos the majority of the public seems generally positive, while in Nisiros there is a divergent position of the people.

## 7. SYSTEMATIC EVALUATION OF THE STUDY RESULTS

The results presented in the previous section concluded after a primary treatment of the answers provided by the interviewees, which is mainly based on a classical statistical treatment of data coming from questionnaires. This evaluation provides the main tendencies, without revealing any interrelations that may exist.

This section presents conclusions of the study through a systematic evaluation of the results using the logistic regression method. Its application was considered necessary since it can provide quantitative results on the possible relations between the questions and the demographic details of the interviewees.

Logistic regression is a method of multi-parameter statistical analysis that uses a total of independent variables for the examination of the activity of a categorical dependent variable. It is a useful method especially in cases where the prediction of the existence or no-existence of a characteristic or event is desirable. Besides the prediction part, the application of a logistic regression model gives you the possibility to define the independent variables that affect the value of the dependent one (Howitt & Cramer, 2006).

The analyses were performed using the Binary Logistic Regression since in all cases there was a medial dependent variable, that is, its value was either 0 or 1. In this study, the dependent variables are the questions presented on Table 1 and the possible answers as shown for each question correspond to 0 or to 1. The nominal independent variables are sex, age (all age groups), education level, and type of occupation. Specific bisectional variable was the involvement in the touristic activities. The regression equation is as follows:

$$\pi_i = \frac{e^{\alpha + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_v X_v}}{1 + e^{\alpha + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_v X_v}}$$

where  $\pi_i$ ,  $\alpha$ ,  $\beta$ ,  $X$ ,  $v$ , are: the possibility of the event  $i$  to occur, a constant, the regression coefficient, the independent variable and the number of the independent variables, respectively.

The assumptions of the binary logistic regression method relate with the factors of independency of cases, multi-collinearity (high correlation between the independent variables of the regression model), and the outliers and influential points of the regression model solution.



The results of the logistic regression model application for both cases of Milos and Nisiros are presented on Table 1, showing the variables that are significant in each one of the questions asked, while the different colors used signify the magnitude of their importance.

The knowledge of the residents about geothermal energy seems to be affected in the case of Milos only by the sex variable. In the case of women the probability of having knowledge about geothermal energy, is reduced per 70%. In the case of Nisiros, none of these variables seem to affect the knowledge of residents about geothermal energy.

In the question of whether geothermal energy affects the environment, in the case of Milos the critical variables are age and education, with the age being the most important one. One unit increase of age (the next age group) increases the probability of the residents to believe that it affects the environment. In the case of Nisiros though, the most important variable is sex, although all three of the variables affect the specific position. Quantitatively it shows that in the case of women the probability of believing that geothermal energy affects the environment is increased by three times.

How much is the environment affected by geothermal energy? None of the three variables examined influence the answer in the case of Nisiros. In Milos, the above effect is different for the age groups. Going up the age groups, the probability of believing that it significantly affects the environment is increased by 30%.

The impact of geothermal energy on agriculture, tourism and fishery is generally dependent in the case of Milos by all three variables. However, the most important is education. Quantifying these effects, one unit increase of the educational level (as displayed in the aforementioned analyses) of the residents, correspond to 30%, 70% and 40% increase of probability of the people pinion that the according sectors will be affected positively.

In the case of Nisiros the affect of these sectors from geothermal energy is mainly dependent on the sex variable. When women are the interviewees, the probabilities are reduced per 80% in believing that agriculture and fishery will be affected positively and 70% respectively for the sector of tourism.

**Table 1. Variables statistical important for each question**

Question	Statistically important variables		
	Sex	Age	Education
<b>Milos</b>			
Question 1 (Do you know what is geothermal energy? NO, YES)	-		
Question 4a (Do you think that geothermal energy affects the environment? NO, YES)		+	-
Question 4b (If answer to 4a is yes, How much does it affect the environment, ENOUGH, A LOT)		+	
Question 7a (How would geothermal energy affect the agriculture? NEGATIVELY, POSITIVELY)	-	-	+
Question 7b (How would geothermal energy affect tourism? NEGATIVELY, POSITIVELY)		-	+
Question 7c (How would geothermal energy affect fishery? NEGATIVELY, POSITIVELY)	-	-	+
Question 8a (Drinking water, 2 <sup>nd</sup> PLACE, 1 <sup>st</sup> PLACE)	+	+	
Question 8h (Electricity production, 2 <sup>nd</sup> PLACE, 1 <sup>st</sup> PLACE)	-	-	
Question 9a (Do you wish the installation of a plant on the island? NO, YES)		-	+
<b>Nisiros</b>			
Question 1 (Do you know what is geothermal energy? NO, YES)			
Question 4a (Do you think that geothermal energy affects the environment? NO, YES)	+	-	-
Question 4b (If answer to 4a is yes, How much does it affect the environment, ENOUGH, A LOT)			
Question 7a (How would geothermal energy affect the agriculture? NEGATIVELY, POSITIVELY)	-		
Question 7b (How would geothermal energy affect tourism? NEGATIVELY, POSITIVELY)	-		
Question 7c (How would geothermal energy affect fishery? NEGATIVELY, POSITIVELY)	-		
Question 8a (Drinking water, 2 <sup>nd</sup> PLACE, 1 <sup>st</sup> PLACE)			
Question 8h (Electricity production, 2 <sup>nd</sup> PLACE, 1 <sup>st</sup> PLACE)			
Question 9a (Do you wish the installation of a geothermal plant on the island? NO, YES)	-		
<b>Note:</b> The colors represent the statistic importance of the variables in descending order of magnitude. Red represents the most important ones, followed by the yellow, the green and finally the white that signifies the variables that are not considered statistically important. The symbols (+) and (-) indicate the followings: the (+) symbol shows that one unit increase of the independent variable value, increases the possibility of an event to occur, that means the value of the dependent variable to be 1, corresponding to the answer that is given as a second option in every question of the present table. The decreasing probability is implied with the (-) symbol, correspondingly			

In terms of geothermal energy applications, ranking of desalination for the production of drinking water in the 1<sup>st</sup> place of the people's opinion, sex variable appears most important in Milos, where the probability of women setting desalination in the 1<sup>st</sup> place is increased by 80%. The corresponding classification of electricity is mainly affected by the age variable. One unit increase of the age reduces the probability per 20% for the people to place this application in the 1<sup>st</sup> place. In Nisiros, the 1<sup>st</sup> place of either the desalination or the electricity production is not affected by any of these variables.

The residents' attitude for the installation of a geothermal plant in Milos is generally affected by the education and the age, with the education being the most important one. One unit increase of the educational level, results to a 30% probability increase for the residents to wish for the installation of a geothermal unit. The results of the analysis in this question exhibit a combinatorial role with previous questions. In fact, it appears that their will for a geothermal plant is not affected by their opinion that geothermal energy has a significant impact onto the environment. Furthermore, when examining their position on installation of a plant for the application that they consider more significant, this attitude is affected by their opinion about the effect of the geothermal energy on tourism and fishery. In the case that the opinion is that tourism will be affected negatively from geothermal energy, there is a 96% reduction of probability in accepting a plant in their island. Correspondingly, in the case of fishery, the respective reduction reaches to 98%.

In Nisiros, residents' desire for a geothermal plant is affected only by the sex variable. Women exhibit almost 60% less probability to accept a geothermal installation in their island. In general, the wish of the residents for such a plant is neither affected by their opinion on the effect of geothermal energy onto the environment, nor on the corresponding effects on agriculture, tourism and fishery.

## 8. CONCLUSIONS

The exploitation of the very important geothermal fields of Milos and Nisiros becomes a quite complex issue, due to the intense disbelief of the local society, a result of the fruitless activities of the past in combination with the environmental setbacks in the case of Milos and the reverberation of these problems in the case of Nisiros.

According to the results of the social study, it appears that in Milos island there is a significant potential to inverse the existing position since the arguments used against new actions for the development of specific applications are not absolute, such as the argument regarding their effect on the tourist development of the island. In the case of Nisiros though, more persistence will be required towards a systematic and better informing of the population on the geothermal energy issues and mainly on the possibilities of a full scale exploitation of the geothermal potential of the island. It is clear though that all negative misimpressions in the people's minds need time, effort and cost in order to be weathered or even tempered.

Initiatives should mainly focus on the informing and knowledge (scientific facts never harms) and the redefinition of the prior applications in each island. Special emphasis should be provided to actions that are in harmony with the area conditions and the environmental characteristics, with respect to human health, human prosperity, culture and education. It seems impossible to proceed to large scale infrastructures and this is fully justified. Societies are more receptive to "soft" kind actions that can satisfy instant and

local needs, contributing at the same time to the people's acquaintance with the new operations.

Special attention should be given to certain categories of people according to the specific findings from this work in each island in order to fill in the gap among them and normalize the arguments.

Moreover, active participation of the local society should be ensured from the very beginning and before forming any decision. People will never accept of being entrapped to plans imposed from public or private bodies ignoring their acquiescence. Same public active role is essential during all phases of a project design, implementation and control. This will be achieved with the clear definition of the terms and the conditions under which a project can be initiated and successfully fulfilled.

Nevertheless, a major initiative still remains to be taken on by the state: To win the lost public confidence and to recover its credibility.

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