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AN INNOVATIVE ENVIRONMENTAL IMPACT ASSESSMENT APPLIED TO THE CHINAMECA DEEP EXPLORATION PROJECT

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ABSTRACT

The Environmental Management Plan (EMP) of geothermal projects in El Salvador has been developed according to the traditional Environmental Impact Assessment (EIA), focusing the mitigation measures established based on the potential environmental impacts evaluation. After 10 years of law enforcement such as Environmental Impact Studies (EIS) in different geothermal activities it has been concluded that the sensitivity of the environment and social issues have not yet reconciled and found the balance to achieve sustainable development, because those activities are seen as negative impacts only.

New tools for the environmental assessment process based on environmental aspects are being developed in order to prevent or control potential environmental impacts. One of these tools is the DASI method which is being used in many projects in South America and it is based on forced national regulatory and sensitive environment analysis through criteria similar to those applied in the conventional methods. The differentiation between “environmental aspects” and “environmental impacts” is the key to this method.

As a case study, DASI is applied in a deep exploration well in the Chinameca geothermal field with the expectation that the monitoring and control stage results will be successful.

1. INTRODUCTION

Beyond the Environmental Management Plan (EMP) compliance and contained in the environmental permit for geothermal projects, they require an exhaustive analysis where environmental standards (even those not exclusively for geothermal activities) with social and environmental sensitivity should reconcile with the stakeholders such as the developer, contractor, communities, local organizations, etc., to make sure that these activities are seen as opportunities and not as a threat. Conventional methods for environmental impact assessment have been applied under traditional concepts, focusing on the damage, but with the modern tools it focuses on the environmental aspect evaluation which allows for the making of an EMP with a preventive philosophy in the early project stages.

This paper shows the El Salvadorian overview concerning geothermal and potential impacts, its regulatory framework, a description DASI method and the Chinameca deep exploration application as new way for environmental impact assessment in projects.

2. OVERVIEW OF GEOTHERMAL AND THE ENVIRONMENT IN EL SALVADOR

There are two geothermal fields in El Salvador that have operating power plants, Ahuachapán and Berlín, both owned and operated by LaGeo, a spinoff privatized company of the government electric utility. Their combined installed capacity is 195.2 MW in 2007. The Ahuachapán geothermal field, in the Western part of the country, has been exploited over the last 32 years; it was one of the first geothermal resources utilized to produce power for a developing country. The Berlín field is located in the Eastern part of El Salvador and started commercial operation in 1992. (Padilla,2007).

At present, there are exploration and resource evaluation projects in Chinameca, located at the Eastern part of the country, where a new geothermal power plant could be constructed in case of a successful exploration. The location of the geothermal fields in El Salvador is shown in Figure 1.

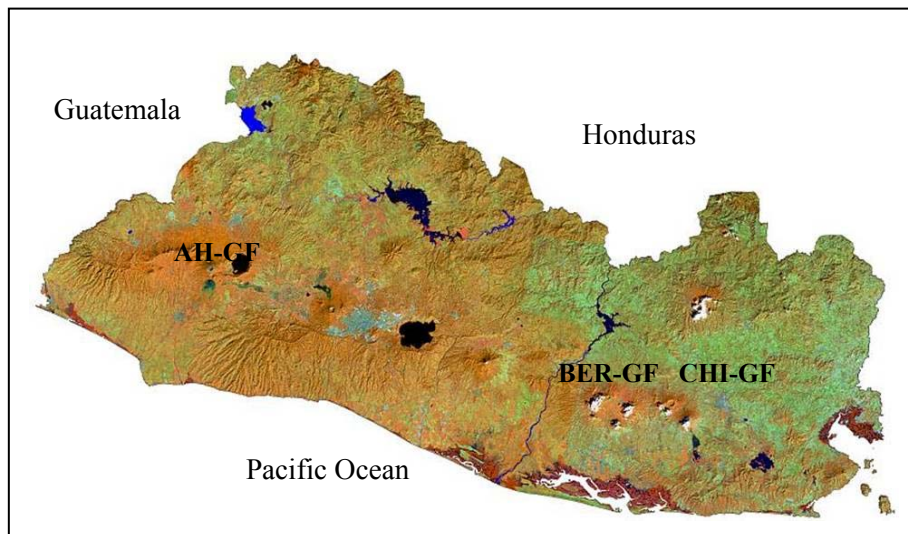


FIGURE 1: Location of El Salvador geothermal fields

2.1 El Salvador environmental concerns

El Salvador has one of the highest annual deforestation rates in the world, 1.37% (1990-2005), a high percentage of primary forests have disappeared throughout the years causing bad water quality due to soil erosion. According to the National Service of Territorial Studies (Spanish abbreviation, SNET), more than 90% of rivers are contaminated with fecal leas, toxic pesticides, spills and bad hygienist practices of the population and they have become unusable as sources of drinking water. Also, the high demographic density of the country, mainly in the cities contributes to increasing the environmental problems: air pollution by transport and factory gas emissions, and soil-water by the sanitary industry and solid waste, respectively

Although geothermal is regarded worldwide as a clean source of energy, in El Salvador, geothermal projects take place in a highly sensitive natural and social environment, which should be taken into account in the environmental assessment.

3. ENVIRONMENTAL ASSESSMENT PROCESS IN EL SALVADOR

3.1 Environmental issues

The environmental law in El Salvador was passed in 1998, while the national environment policy and benefits of natural resources (water, air, biodiversity, etc.) were passed in 2000. All of these became instruments for the public sector that defined a legal framework for environmental matters. All

projects must be submitted to the MARN for prior approval before construction begins. The request for approval must contain an environmental impact assessment (EIA), and the project is then submitted to a public hearing process if the MARN deems that the environmental impact will be significant. The concerns expressed in the public hearing are documented by the MARN, and they may require modifications in the project design before final approval. If the concerns expressed at the public hearing are not properly addressed by the developer, the project approval may be denied. In actual practice, several permits have been denied by the environmental authorities, but all clean energy projects have been approved. It must be observed, however, that most of the opposition to geothermal projects may not be channelled through official procedures, and may surface after the start of construction, even when the developer is in possession of all the necessary permits.

When a developer obtains a permit, he must submit an environmental bond guarantee to MARN that he will execute all the environmental mitigation/compensation measures that are stated in the permit. Failure to comply will result in MARN cashing the bond (Rodríguez and Arévalo, 2007).

At present, in El Salvador there are no specific regulations for all geothermal activities, works or projects but the Environmental Impact Study is requested for power electricity generation from nuclear energy, thermal, geothermal, hydro, wind and tidal (Art. 21, f, EL). However, trends on regulations in the world indicate that they are becoming even more stringent. New geothermal power plants have to be able not only to achieve these standards but also be compatible with other industries in the area, like tourism, and have the acceptance by the communities hosting the plants (Padilla, 2007).

Recently, the environmental regulation has been modified where the categorization for any project will be applied regarding the environmental potential impact and if the main criteria are accomplished. The main goal for project categorization is the administrative charge reduction of the Environmental Ministry staff with the result that their resolution should be more expedite. Three groups are used for activities or projects categorization:

- *Projects A:* No environmental management nor permits to protect the environment is required.
- *Projects B1:* Mitigation measures added in form as a preliminary assessment, the Ministry gives a resolution written but an environmental permit is not needed.
- *Projects B2:* The developer must have an EIS study and their Environmental Management Plan and Monitoring are indispensable.

4. ENVIRONMENTAL MANAGEMENT IN GEOTHERMAL PROJECTS

According to the Environmental Assessment System in El Salvador, the Environmental Impact Assessment is a tool that allows the selection of the alternative that best guarantees the protection of the environment when a project is designed and executed (Art.18 EL).

LaGeo, S.A de C.V in charge the geothermal resources exploration and exploitation in El Salvador according to the governmental institutions policies has created within his enterprise a philosophy that is a legal fulfillment and a transparent administration mechanism. Through the master social responsibility policy and the respect to the environment, safety and occupational health, commercialization and quality policies, creates an added value for their stakeholders in that it allows the company to grow based on sustainable development.

Re-injection is adopted as the primary disposal method for brine, rehabilitation on land disturbances through slopes is stabilized, terraces and roadsides. During the well test, barriers in the source such as silencers, rock mufflers and fresh water injected steam outlets are installed to mitigate the noise level for communities and for the safety of workers, and so on. An air, water and soil quality monitoring

programme is added to the risk analysis on geothermal activities that the environmental management operative tools guarantee for the fulfilment of LaGeo's enterprise policies.

Public involvement in the decision making for any project development is an inherent condition according to the environmental law. LaGeo is conscientious in its roll of a "responsible neighbour" and has created a Social Projection Area (Spanish abbreviation, APS) as a formal structure to promote and contribute to the local development with the local governments and other institutions (OGs, ONGs, civil society) within the influence zones such the existing Ahuachapan and Berlin geothermal power plants.

4.1 Findings, improvement opportunities

As mentioned above, LaGeo goes beyond what the Environmental Law (EL) seeks to accomplish, but 10 years after the EL was passed, the geothermal projects continue to be a threat for different groups. Some of the findings from the geothermal project experiences are as follows:

- The imminent social resistance to geothermal project development combined with the lack of clear information about the environmental regulations is the cause of special attention.
- The high environmental and social sensitivity in El Salvador makes an exhaustive environmental assessment process for projects' development necessary.
- All projects interact with the environment by emitting residues and consuming resources. This fact should be taken into account even though and Environmental Impact Study is not required by the regulator authority.
- The environmental policy of LaGeo is focused on environmental impact prevention and the fulfillment of the law, which would allow projects to be developed in harmony with the environment, even though it is highly sensitive.
- In geothermal project developments with the participation of other parties who possibly do not have an environmental and social responsibility policy similar to LaGeo's, how is it possible to get an agreement for a satisfactory environmental performance?

5. DASI – A NEW METHOD FOR ENVIRONMENTAL IMPACT ASSESSMENT OF GEOTHERMAL PROJECTS

5.1 Basis

The modern environmental management is organized around one simple concept which is also a fact, the environment is affected due to everything we take from it (consumption) and that which we throw on it (emissions). Every person, activity, project or production process interacts with its environment, consumes resources and emits waste. These emissions and consumption are the "environmental aspects" of the project.

The DASI method (dissociation of aspects /synthesis of impacts) is based on the systematic identification and evaluation of all environmental aspects related to the activities of a project with the objective of selecting measurements for preventing or controlling potential environmental impacts. The differentiation between "environmental aspects" and "environmental impacts" is the key to this method. These terms are defined as follows:

- *Environmental aspects*: are the elements of the activities which can interact with the environment (a significant environmental aspect produce or can produce a significant environmental impact).
- *Environmental impact*: is any change in the environment (biotic, abiotic or anthropic) as a result of the environmental aspects of an activity which the environment can not absorb.

The environmental aspects are not environmental impacts but they can be if they interact with the environment in a no-controlled way. This relation is shown in Figure 2

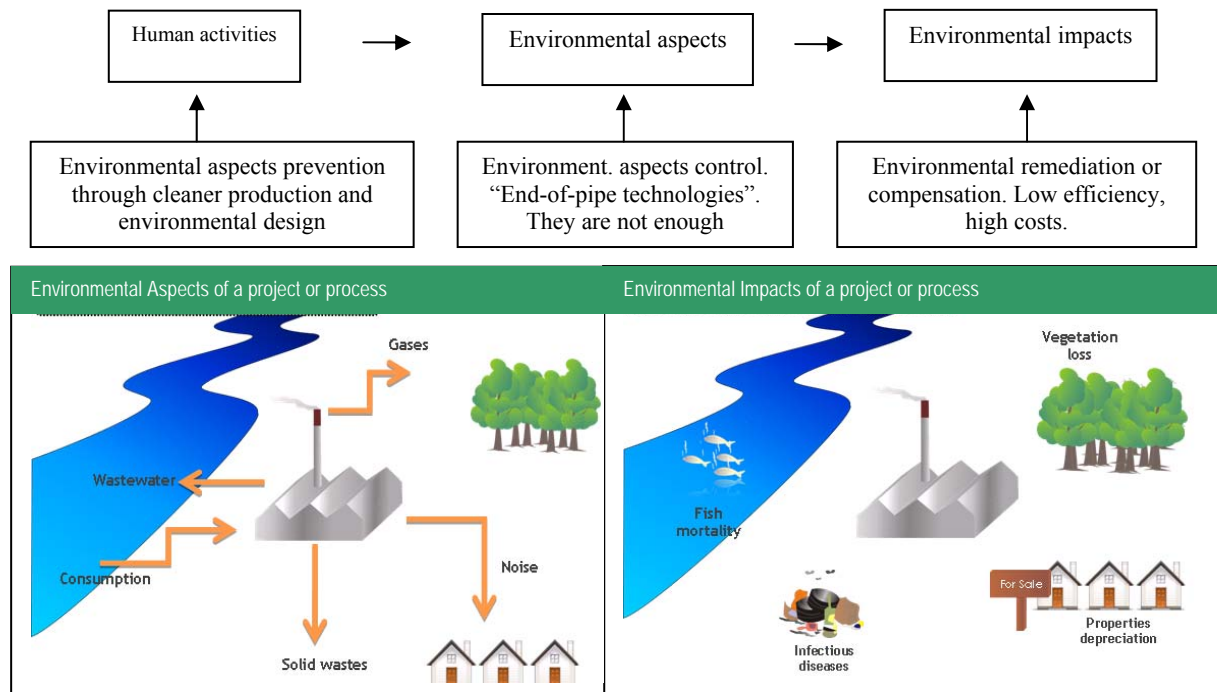


FIGURE 2: Environmental aspects and environmental impacts

The fact that the environmental impact assessment is based on the concept of “environmental impact” and the environmental management is based on the concept of “environmental aspects” makes it difficult to integrate both tools. The DASI method is oriented to generate the environmental management plan of a project as a direct result of the environmental evaluation process.

5.2 Advantages

The advantages of the DASI method are:

- It is exhaustive and well-organized;
- Focus is on the problem;
- It uses the legal framework as a criteria of the evaluation process;
- It uses the sensitivity of the environment as a criteria of the evaluation process;
- It is objective, as it is based on concepts accepted by the involved parts;
- It can be applied in the different stages of the project.

5.3 Methodology description

DASI is a method for the early environmental evaluation of projects, based on the concept of environmental aspects, which allows not only for the ability to focus on the prevention strategy but also the integration of the environmental evaluation process with the environmental management system and making it easier for the environmental controls in the operation stage of the project. The evaluation of the environmental aspects in different levels is based on this methodology (see Figure 3).

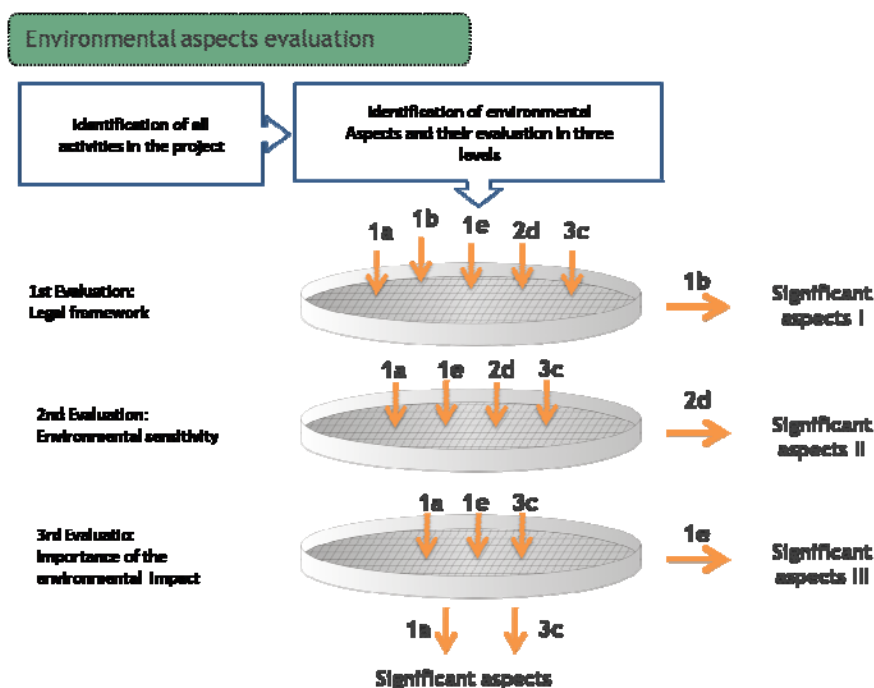


FIGURE 3: Environmental aspects evaluation process applying the DASI method

- *Identification of stages and activities.* The complete project should be dissociated in stages and activities in a chronological sequence and codified
- *Identification of environmental aspects.* Regarding all emissions and consumption of each activity and codifying them.
- *Environmental aspects evaluation.* Environmental aspects would be significant regarding:
 - Approach to standard limits;
 - Interaction with high sensitivity environmental elements;
 - Importance of the potential environmental impact.

These are the three levels of the evaluation of environmental aspects, applied as a kind of “sifters”. The environmental aspects with significant results at each level must be managed.

i) The first evaluation of environmental aspects includes two main tasks:

- Identification and interpretation of the environmental regulations applicable to each environmental aspect;
- Characterization and quantifying of each environmental aspect (quality and quantity).

Table 1 shows the quantitative criteria for the determination of significance of environmental aspects on the first level of evaluation.

TABLE 1: Quantitative criteria for the first evaluation of environmental aspects

Magnitude of the environmental aspect: Established based on estimation of emissions and consumption for the study project and/or similar projects	
≤ 75 % of the standard limit	Not-significant
> 75 % of the standard limit	Significant

ii) The second evaluation of environmental aspects (environmental sensitivity) includes:

- a. Identification and delimitation of elements of the receptor surroundings (biotic, abiotic, anthropic);
- b. Evaluation of the sensitivity of these elements (regarding regulations or some criteria such as: the presence of species in danger of extinction, highly populated areas, native forest, aquifer recharge areas, etc.);
- c. Environmental aspects and highly sensitive element interaction analysis.

The environmental aspects which interact with highly sensitive elements of the receptor surroundings will be regarded as significant.

iii) The third evaluation of the environmental aspects is used when there are no regulations applicable and there are no interactions between environmental aspects and highly sensitive elements of the receptor surroundings. This evaluation includes the interdisciplinary team analysis of the importance of the potential environmental impact caused by an environmental aspect, taking into account some criteria such as: intensity, extension, persistence (applied to the environmental aspect) and reversibility, and recuperability (applied to the receptor surroundings).

5.4 Environmental management plan and environmental monitoring

The EMP is created based on the environmental evaluation process. For each environmental aspect (specific for each activity) where the results are significant, environmental measures should be established and organized in four different intervention levels, in order of preference, from the modification of the activities producer of environmental aspects, to the elaboration of proposals for compensating affected communities. Table 2 shows the different intervention levels of the environmental measures. The measures are ordered as follows:

Prevention → *Control* → *Recuperation* → *Compensation*

TABLE 2: Intervention levels of environmental measures

	Type 1: Impacts prevention		Type 2: Impacts control	
Measure	Aspect prevention	Aspect control	Anthropic affectation prevention	Anthropic affectation control
Intervention	To the activity	To the aspect	To the natural environment	To the anthropic environment
Strategy	Eco-efficiency	End-of-pipe	Remediation	Compensation

5.5 Environmental monitoring

The environmental monitoring consists of controlling systematically some parameters representing the environmental aspect or the receptor surroundings. These parameters will be the “performance indicators” or the “state indicators”, respectively.

6. THE DASI METHOD APPLIED TO THE CHINAMECA DEEP EXPLORATION PROJECT

The Chinameca geothermal project started on April 2008 with the construction of the drilling platform (civil works) and the deep exploration is expected to start early September. The project was categorized as a B1 project by the Ministry of Environment of El Salvador (an environmental impact study was not required). However some social groups asked to be informed about the environmental impact assessment and specifically about the environmental impact study (EIS). The EIS had been developed by LaGeo and all this information was available and shown to the people concerned.

Apart from the traditional tools applicable, the environmental impact assessment of the Chinameca deep exploration project is being strengthened by applying the DASI method. As an example, tables 3 to 7 show the results of the environmental evaluation process of two activities of the Chinameca deep exploration project, selecting four environmental aspects for their evaluation, management and monitoring plan.

TABLE 3: General information of the project

Name:	Drilling of one geothermal well in the Chinameca field
Developer:	LaGeo
Contrator(s):	Santa Barbara Drilling Company
Location:	Platform CHI-3, Chinameca field, Chinameca, San Miguel
Description:	The project consist of the drilling of one exploratory geothermal well in order to verify the presence of the geothermal resource and the feasibility for its utilization
Starting date:	September, 1st. 2008

TABLE 4: Identification of activities and environmental aspects

Identification of activities		Identification of environmental aspects	
Activity		Environmental aspects	
C	Civil Works	C1	Placement of work. Machines at the worksite (traffic)
		C2	Placement of work. Elimination of vegetation
		C3	Noise emission by tracks
		C4	Dust generation by tracks movements
		C5	Emission of combustion gases by vehicles
P	Preparation and injection of drilling fluids	P1	Solid wastes. Packages with residues of chemical additives (no-hazardous)
		P2	Solid wastes. Packages with residues of chemical additives (hazardous)
		P3	Solid wastes. Paper bags with residues of bentonite
		P4	Solid wastes, with oil residues
		P5	Special liquid wastes (drilling muds from tanks cleaning)
		P6	Noise emission by pumping equipment
		P7	Placement of work fresh water pipe installation
		P8	Fresh water consumption for preparation of drilling muds

TABLE 5: First evaluation of environmental aspects

First evaluation of environmental aspects						
EA	Applicable legislation	Standard	Magnitude of the aspect	Limit (≥75%)	Significance	
C2	LCVS		Procedure		Significant	
C4				N/A	Not significant	
P6	NSO 13.11.02:01 ¹			102.5 dBA	Not significant ²	
P8	RGLMA	LANDA	Procedure	Qualitative	N/A	Significant

LCVS, NSO 13.11.02:01, RGLMA, LANDA: Salvadorian National Laws and Norms

¹ Not officialised

² Not officialised standard

TABLE 6: Second evaluation of environmental aspects

Second evaluation of environmental aspects				
EA	Sensitivity of:			Significance
	Physic environment	Biotic environment	Anthropic environment	
	Low	Low	High	
C2				Significant
C4			Interaction	Significant
P6			Interaction	Significant
P8				Significant

After the second evaluation, all the environmental aspects resulted in being significant; therefore, the third evaluation level is not necessary.

TABLE 7: Environmental management plan and monitoring

Environmental management plan and monitoring					
EA.	Prevention measures	Control measures	Recuperation measures	Compensation measures	Monitoring
C2	Alternative sites analysis. Designs which allows elimination of vegetation minimization. Elimination of vegetation strictly necessary	Identification of vegetation to be eliminated	Forestation (in affected area)	Forestation (in any area). Environmental projects development	No. of chopped trees, species and trunk; No. of planted trees
C4	Soil humidification				No. of soil humidification processes
P6	Preventive mechanic maintenance	Placement of noise sources far from inhabited sites. Barriers installation			Noise levels in platform and closest houses
P8		Water coming from existing and authorized sources		Compensation for water consumption	Amount of water coming from no-authorized sources

7. CONCLUSIONS AND RECOMMENDATIONS

The environmental aspects of geothermal projects must be considered as an integral part of the project design, in order to ensure that the facility can comply with the legislation and is accepted by the neighbouring communities. The DASI method uses the sensitivity of the environment as a criterium for the evaluation process and as an aid to reduce the risk to the project's execution if the environmental aspects are properly management.

The Environmental Management Plan and monitoring as result the environmental aspects evaluation helps the Company get both internal and external control of the legal audits.

In El Salvador, there are no special regulations for geothermal, however, there are several legal dispositions to its environmental aspects that it make easier for their application such as in the Chinameca Deep exploration project case.

REFERENCES

Arevalo, A.S., 1998: Environmental aspects of the Berlín geothermal power station in El Salvador. Report 2 in: *Geothermal Training in Iceland 1998*. UNU-GTP, Iceland, 25-50.

Arevalo, A.S., 2006: Environmental and social issues in geothermal in El Salvador. *Proceedings of the Workshop for Decision Makers on Geothermal Projects in Central America, San Salvador, UNU-GTP*, CD, 14 pp.

El Salvador Environmental Law, 2003.

Environmental Consultans GEA., 2007: *Assessment and environmental management in projects*. Training Course in El Salvador, 2007, Quality Training Group, El Salvador.

Padilla E.K., 2007: Preliminary study on emission abatement and use of gas from geothermal power plants in El Salvador. Report 18 in: *Geothermal Training in Iceland in 2007*. UNU-GTP, Iceland, 417-446.

Rodriguez, J.A., and Arevalo, A.S., 2007: Geothermal, the environment and neighbouring communities. In: Rodriguez, J.A.: *Lectures on geothermal in Central America*. UNU-GTP, Iceland, report 2-2007, 21-26.