

Sound Pressure Level Measurements at and around the Las Pailas Geothermal Project and in Rincón de la Vieja National Park, Guanacaste, Costa Rica

Edward C. Hakanson

Casa #3, La Colonia del ICE, La Fortuna de Bagaces, Guanacaste, Costa Rica

edward_hakanson@yahoo.com

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ABSTRACT

Sound Pressure Level Measurements have been made in the area under development for the Las Pailas Geothermal Project, expected to come on line with a 35 MW powerhouse in 2011, as well as within the north-bordering Rincón de la Vieja National Park and a region of open grasslands to the northwest. Each noise level measurement was taken at 120 cm above the soil level at points located one kilometer apart from one another. Throughout the field area there are important differences in elevation, topographic gradient, and land use, all of which may influence the measured sound pressure levels. The sources of environmental background noise in the field area perceived during the study were also recorded. All of these data have been compiled in an Access database and integrated so that they may be visualized in ArcView.

This report presents the findings of this investigation and conclusions on the factors that may influence environmental background noise in and around the Las Pailas Geothermal Project as well as within the Rincón de la Vieja National Park. The current and future results of this investigation may be utilized in the decision making process for future development of the Las Pailas Geothermal Project.

1. INTRODUCTION

As part of a field investigation for a Master's Thesis in Natural Resource Management, sound pressure levels are being collected in a field area with an extension of approximately 3200 Hectares (32 km²) located within the Costa Rica Lambert North coordinates 300-311 N, 382-391 E (Curubandé topographic base map, 1:50000) on the Pacific slope of Rincón de la Vieja Volcano in Guanacaste, Costa Rica (Figure 1), sound pressure levels are being recorded at 57 observation points to obtain the environmental noise data collected on a one kilometer grid in order to determine a baseline for environmental noise and evaluate how land use and topographic gradient may affect the environmental noise level. The field area is concentrated at and around the currently under development Las Pailas Geothermal Project (Instituto Costarricense de Electricidad, 2005) with a total area of 1312 Ha, the southwestern corner of Rincón de la Vieja National Park (1189 Ha) and extends towards the northwest covering an additional 788 Ha. Sources of environmental noise are reported as continuous, intermittent, and impact during a 3 minute and 45 second data collection session at each observation point.

To aid in the quantification different land use practices, ArcView was used to create an unsupervised reclassified map of a true color multispectral image of the field area, acquired with the MASTER sensor in the CARTA 2005 Mission (Figures 2 and 3).

In this figure, three general land use practices can be interpreted in the area under study: Open field with ravines and creeks (northwest); Primary Forest (east); and agriculture / anthropologic intervention (south).

2. FIELDWORK AND SITE DESCRIPTION

At fifty-seven previously located observation points distributed between 422 and 1291 m s.n.m., sound level pressure data were taken from 20/09/2008 to 19/01/2009 utilizing a Quest Type 2 model 2800 integrated sound level meter and on 21/05/2009 utilizing a Quest SoudPro DL Datalogging sound level meter. Each was configured for a slow response, A-weighted measurement with an upper limit of 80 dB. The Costa Rican Decree No. 32692-S was consulted for the minimum duration of the sampling session. Following the recommendation in this document, at each observation point, sixteen sound pressure level measurements were taken, one every fifteen seconds, during a three minute forty-five second sampling session. Also, field data on land use, topographic gradient and environmental noise sources were recorded. The topographic gradient is reported as inclined slightly (0-10%), moderately (10-30%) or highly (> 30%). Site description data is presented according to fourteen previously determined field areas (Figure 4). Preferential wind direction was considered in this field study.

2.1 Sector Guachipelín (I)

Three environmental noise measurements were made in open grassland (TS-001, TS-002) and riparian forest (TS-003) with a slightly to highly inclined topographic gradient towards the southwest (TS-001) and south-southeast (TS-002 and TS-003).

2.2 Sitio Varillales (II)

Three environmental noise measurements were made in open grassland (TS-004) and secondary forest (TS-005, TS-006) with a slightly to moderately inclined topographic gradient towards the southeast.

2.3 Las Parcelas de Santa María (III)

Three environmental noise measurements were made in intervened forest (TS-007), secondary forest (TS-008) and open grassland (TS-016) with a moderately to highly inclined topographic gradient towards the southeast (TS-007), south (TS-016) and southwest (TS-008).

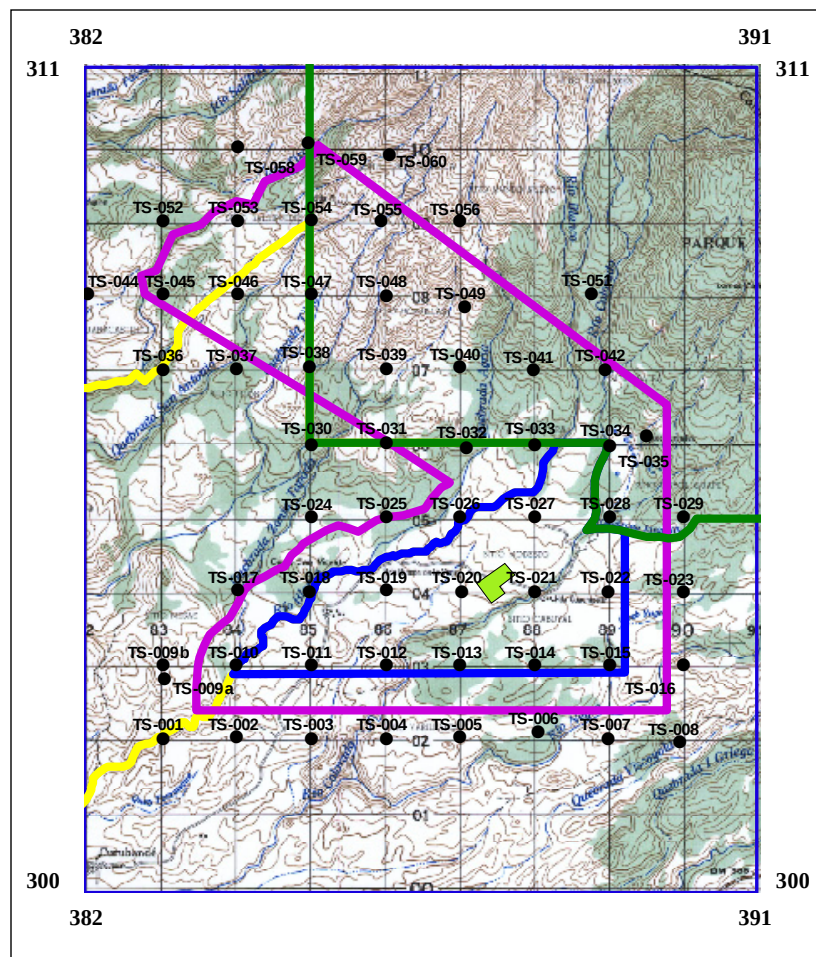


Figure 1: Field Area. The purple line encloses the area under study; the blue line is the area currently under development at the Las Pailas Geothermal Project; the green line is the border of Rincón de la Vieja National Park and the yellow line is the border of Mundo Nuevo, a private property owned by Guanacaste Dry Forest (a non governmental organization) and administered by the Costa Rican Park Service. Observation points are marked with a black dot and the green polygon represents the location of the future 35 Mw power plant of the Las Pailas Geothermal Project.

2.4 Sitio Cabuyal (IV)

Six environmental noise measurements were made in open grassland (TS-013), secondary forest (TS-014, TS-021, TS-022, TS-023) and riparian forest (TS-015) with a slightly to highly inclined topographic towards the north (TS-013), south (TS-022, TS-023) and southwest (TS-014) and west (TS-015, TS-021).

2.5 Hacienda Guachipelín (V)

Three environmental noise measurements were made in open grassland (TS-011), secondary forest (TS-012) and a bombacosis quintata tree plantation (TS-019) with a slightly to moderately inclined topographic gradient towards the northeast (TS-011), southeast (TS-019) and northwest (TS-012).

2.6 Mundo Nuevo (VI)

Ten environmental noise measurements were made in secondary forest (TS-10, TS-017, TS-018, TS-025, TS-037), undisturbed low land forest (TS-009), regenerating forest (TS-024, TS-026), riparian forest (TS-036) and open grassland (TS-046) with a slightly to highly inclined topographic gradient towards the southeast (TS-009, TS-010, TS-017, TS-018, TS-025, TS-026), southwest (TS-024, TS-036, TS-046) and northwest (TS-037).

2.7 Sitio Modesto (VII)

Two environmental noise measurements were made in intervened secondary forest (TS-020) and open grassland (TS-027) with a slightly inclined topographic gradient towards the south (TS-020) and southwest (TS-027).

2.8 Sitio Coyo Guape (VIII)

Five environmental noise measurements were made in primary forest (TS-28, TS-029, TS-34, TS-35, TS-4) with a slightly to highly inclined topographic gradient towards the south (TS-028, TS-041), southwest (TS-029, TS-035) and northwest (TS-034).

2.9 Sitio Pará (IX)

One environmental noise measurement was made in a secondary forest (TS-033) with a moderately inclined topographic gradient towards the south.

2.10 Sitio Balsa (X)

Two environmental noise measurements were made in primary forest (TS-042, TS-051) with a slightly to highly inclined topographic gradient to the northwest (TS-042) and west (TS-051).

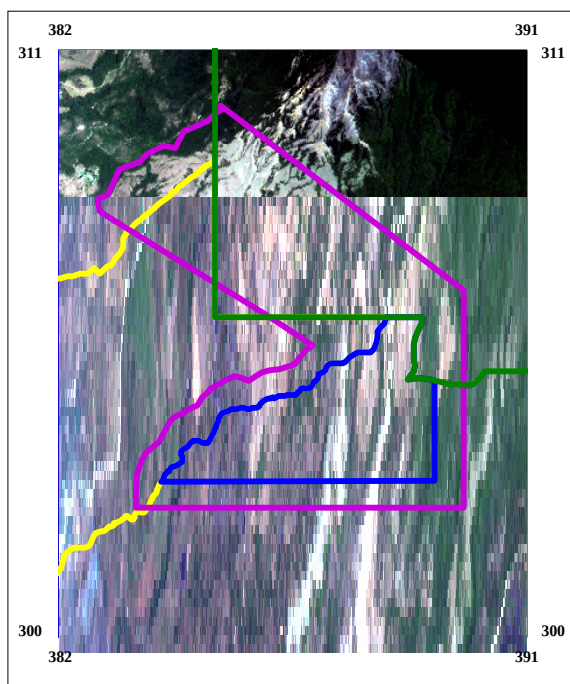


Figure 2: Natural color multispectral image of the field area (Mission CARTA 2005).

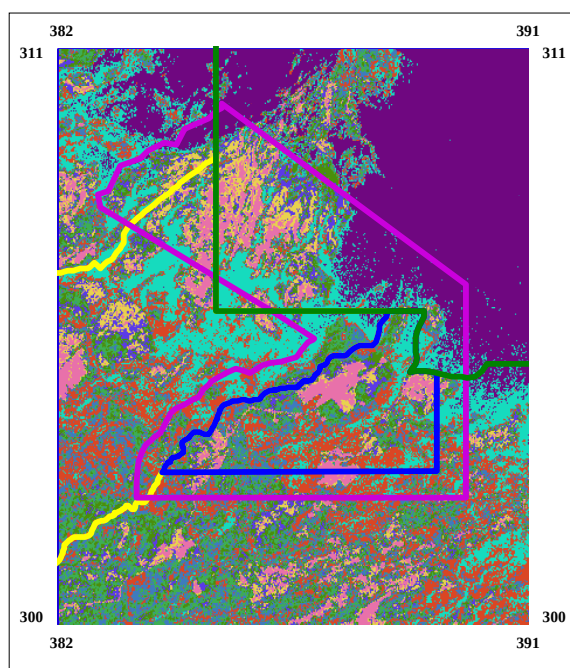


Figure 3: Reclassified multispectral image of the field area (Mission CARTA 2005) utilizing ArcView. Purple: Primary Forest; Cyan: Secondary and Riparian Forest; Green Tones: Intervened Secondary Forest, Forest Regeneration and Tree Plantations; Blue: Transición from Forest Regeneration to clear-cut land / open grass land; Pink and Peach: Open grass land/clear-cut land; Red: Undisturbed low-land forest.

2.11 Sitio Las Hornillas (XI)

Nine environmental noise measurements were made in secondary forest (TS-030, TS-032, TS-038, TS-039, TS-040), riparian forest (TS-031, TS-049) and open grassland

(TS-047, TS-048) with a slightly to highly inclined topographic gradient to the southeast (TS-031, TS-038, TS-039, TS-049), south (TS-032), west (TS-040, TS-047, TS-048) and northwest (TS-030).

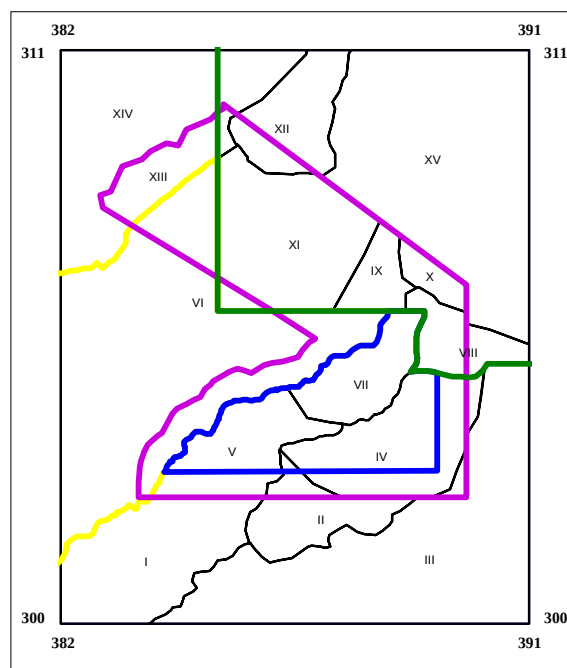


Figure 4: Field Sectors. I (Sector Guachipelín); II (Sitio Varialles); III (Las Parcelas de Santa María); IV (Sitio Cabuyal); V (Hacienda Guachipelín); VI (Mundo Nuevo); VII (Sitio Modesto); VIII (Sitio Coyo Guape); IX (Sitio Pará); X (Sitio Balsa); XI (Sitio Las Hornillas); XII (Sitio Ojos de Agua); XIII (Sitio Salsipuedes); XIV (Borinquen); XV (Parque Nacional Rincón de la Vieja).

2.12 Sitio Ojos de Agua (XII)

Three environmental noise measurements were made in regenerating forest (TS-056, TS-060) and open grassland (TS-055) with a topographic gradient moderately to highly inclined towards the south (TS-055, TS-056) and southwest (TS-060).

2.13 Sitio Salsipuedes (XIII)

Three environmental noise measurements were made in open grassland (TS-045, TS-053, TS-054) with a topographic gradient slightly to highly inclined towards the south.

2.14 Borinquen (XIV)

Four environmental noise measurements were made in open grassland (TS-044) and secondary forest (TS-052, TS-058, TS-059) with a topographic gradient moderately to highly inclined towards the south (TS-044, TS-058, TS-059) and west (TS-052).

3. SOUND PRESSURE LEVEL RESULTS

In the field area, average sound pressure levels ranged from 33.3 to 72.4 dB-A during the sampling season with the most frequent sound pressure level in the 40-45 dB-A range, followed by the 50-55 dB-A range and 60-65 dB-A range (Figures 5 and 6).

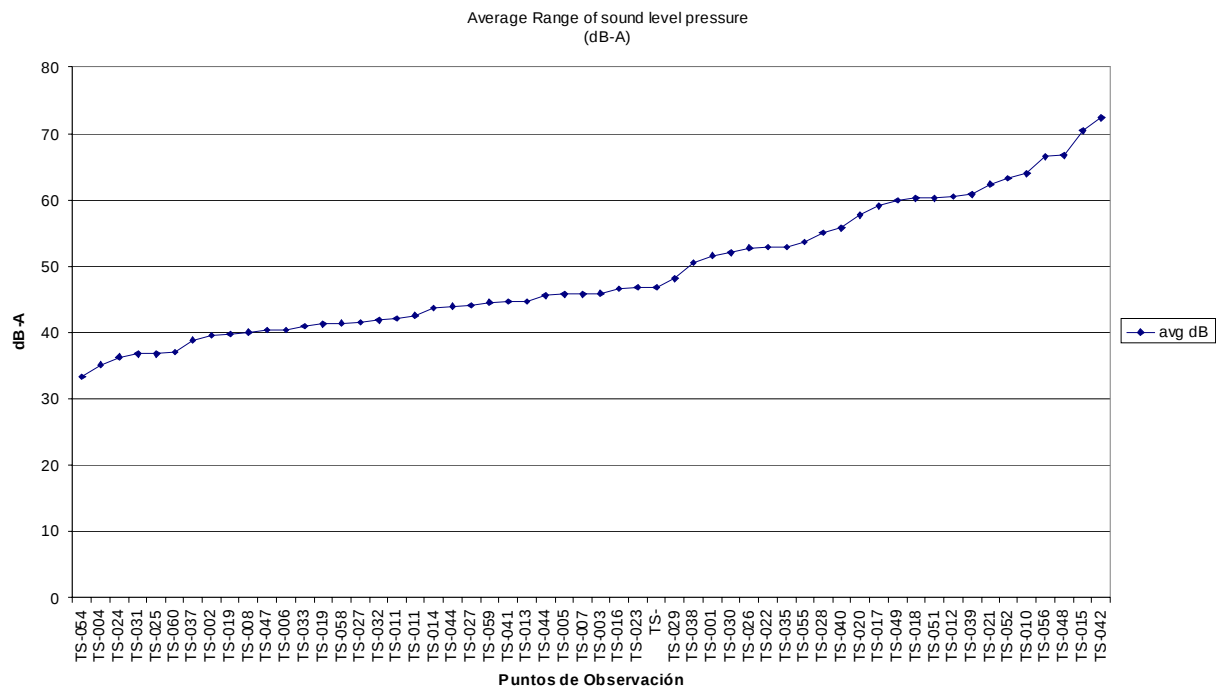


Figure 5: Average sound pressure levels (33.3-72.4 dB-A) recorded at 50 observation points in the area under investigation from 09/21/2008 to 21/05/2009.

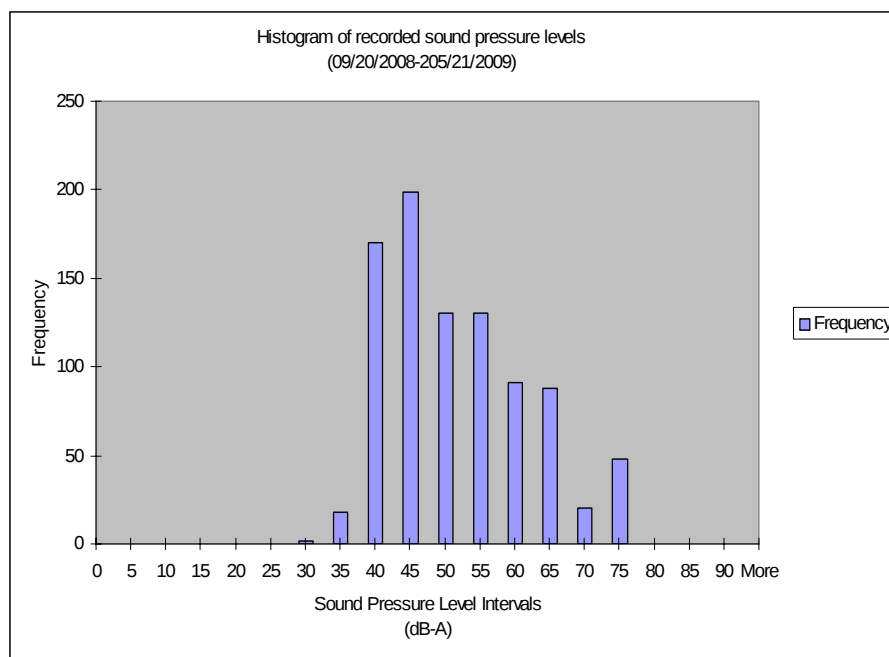


Figure 6: Frequency histogram of sound pressure levels recorded at 50 observation points in the area under investigation from 09/21/2008 to 21/05/2009.

3.1 Environmental Noise Sources

Environmental noise sources can be considered as continuous, intermittent or impact. In this field study an attempt was made to identify and classify the sources of environmental sound in the area under study. In general the most common sounds were produced by natural sources such as wind, rivers, birds of various species, cattle, mosquitos, crickets and ciqueda bugs, each of which have varying intensities throughout the field. Other types of naturally occurring sounds perceived during the field

survey were waterfalls, thunder, rain, monkeys, frogs, and humming birds. Sources of non-naturally occurring sounds perceived during the field survey were heavy machinery (dump trucks and steam rollers), vehicles, over flying airplanes and drilling operations and well production tests at the nearby Las Pailas Geothermal Project (Table 1).

The average sound pressure levels at each observation point are contoured to show how environmental noise is distributed in the area (Figure 7) in order to compare the spatial distribution of environmental noise with different

Table 1. Classification of the sources of naturally and non-naturally occurring sounds at and around the Las Pailas Geothermal Project.

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4. CONCLUSIONS

The majority environmental noise sources of at and around the Las Pailas Geothermal Project are naturally occurring and in general are within the 40-45 dB-A range although some such as occasional howler and white-faced monkey calls, some particular bird species, wind, rivers and ravines generate high sound pressure levels (up to 75 dB-A). Places where the topographic gradient is inclined towards the Las Pailas Geothermal Project (TS-020, TS-027, TS-012, TS-011, TS-013, TS-015, TS-021, TS-025, TS-026, TS-027 TS-031, TS-032 and TS-033) may be more affected by the noise that will produce the first 35 Mw power plant to be installed at Las Pailas Geothermal Project, as well as the open grasslands and intervened secondary forest in the north central and southwestern sectors of the area currently under development. The secondary forest to the north and northwest of the Las Pailas Geothermal Project may serve as a noise buffer to the powerplant. Although preferential wind direction patterns were not considered in this field

investigation, they might also impact noise propagation from power plant and therefore should be studied and evaluated. Once the power plant is constructed and operating, it is suggested that noise monitoring area with a minimum of a two kilometer radius around the power plant be established to determine the effects of the power plant on the environmental noise baseline established in this report.

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