

## PROJECT ACUSAN (ACOUSTIC INVESTIGATIONS IN ANTARCTICA)

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**Abstract:** *The ACUSAN (ACoUSTic investigations in ANtarctica) Project was contracted to the Bulgarian Antarctic Institute in 2016. The project has two phases – field measurements and acoustic investigations of the collected acoustic signals and noises. The main purpose of the project was to measure and characterize the acoustic environment around the Bulgarian Antarctic Base (BAB). As the sounds in Antarctica are very particular and peculiar, the people living in such conditions feel rather different than in usual civil sound environment. The tasks of the project are developed in two main directions. First – to collect field data and information and second – to proceed the data and to investigate the frequency and dynamic range of the registered signals. Except the technical characteristics of the signals in Antarctica, the sounds registered during the travel trip are also investigated. So, the full acoustic picture influencing the polar people to be documented, investigated and determined in its full range.*

## ПРОЕКТ АКУСТИЧЕСКИ ИЗСЛЕДВАНИЯ НА АНТАРКТИДА (АКУСАН)

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**Ключови думи:** *Антарктида, акустически сигнали, шумове, анализ*

**Резюме:** *Проектът АКУСАН (АКУСТИЧЕСКИ изследвания в АНтарктида) е представен и одобрен през 2016 година от Българския Антарктически Институт (БАИ). Основната му цел е чрез измервания и документиране на различни акустични сигнали и шумове, да се охарактеризира акустичната среда в района на Българската Антарктическа База (БАБ). Проектът има както чисто физически, така и някои психологически и психосоматични задачи, за да определи как и по какъв начин влияят на българските изследователи пребиваващи на БАБ по време на антарктическото лято, звуците и шумовете от естествен и/или антропогенен произход. Като се има предвид абсолютната девственост на околната шумова среда в околностите на БАБ, да се определят основните честотни и динамични характеристики на звуците, регистрирани в естествена среда с различна апаратура. Попълно, друга основна задача решавана от изследователския екип е регистрацията на естествени и изкуствено създавани звуци и шумове по време на пътуването - до и от БАБ на остров Ливингстън. Като се има предвид богатото разнообразие на различните звукови източници по пътя на изследователите от естествени и изкуствени източници, да се проследят адаптационните възможности на хората. Проектът включваше два етапа. Първи – събиране, регистрация и архивиране на различните звукови и шумови сигнали. Втори – обработката данните и сигналите с цел, пълно охарактеризиране на спектралния и динамичен диапазон на акустичната среда – на БАБ и по дългия път към нея.*

### Introduction

The project called ACUSAN explore the possibilities about registration and documentation the acoustic environment in Antarctica and the way to reach it by all approaches – airplane, boat, bus, etc. The organization of the Project is constructed by two main groups of tasks – field measurements and data collection and laboratory data processing to investigate the registered acoustic signals. The first part – field data collection and registration has been done by Tatiana Assenova during the 25<sup>th</sup> national Antarctic expedition to the BAB on Livingstone Island (South Shetlands). The main part of the data processing – frequency and dynamic range of the sounds and noises has been processed by

Emil Oinakov – PhD in the field of signal processing. The overall supervision was due to the Prof. Boyko Ranguelov's initiative. It is important to mention that this work is rather innovative. Very few similar investigations have been performed by Australians [1], UK base located [2] and BBC [3] researchers, Germans [4] and Norwegians [5]. This is due to the hard weather conditions, difficulties to find and explore the respective equipment and hard working conditions in the base and on the way to and back Antarctica.

### Equipment and Measurements methodology

For the recording of the signals (noise and sounds), hard memory recorder Zoom H6 APHBundle together with Mid-Side and Stereo Microphones and LCD display has been used <http://www.lcd-module.com/products/oled.html>

To extend the dynamic range also microphone DBX DriveRack RTA-M wide angle and directed microphone Rode NTG-2 have been included into equipment.

The methodology focused on the sounds and noise in the very quiet environment, to the middle range volume of sounds and to the high level of noise. All records lasted between second and tens of minutes. The total length of the registered records of all sounds and noise is about 23 Giga bites. The analyzed duration was selected to the 73 minutes of the representative signals of all kinds of sounds.

### Data processing and Results

During the investigation process the table, the original notes and records in the operator's (Tatiana Asenova) notebook of the outdoor field measurements in Antarctica and on the way are preserved and have been used. As it is presented in the table, the original format is not presented due to the limitations of the text length, but in general two major groups of signals have been separated:

- signals generated by the natural phenomena and (about 40% of the total records)
- signals generated by man-made activity (about 50%)
- there are also some mixed signals – background noise and anthropogenic sounds (about 10%).

All these sounds have been processed in a systematic way (the steps of the methodology have been performed by us, following the main tasks of the project ACUSAN itself.

- first step – visualization of the signal in digital form
- second – selection of the representative lengths of the recorded signals
- third – spectral analysis and assessment of the selections and establishment of the predominant frequencies
- forth – dynamic range in dB, as a characteristic of the power of the sounds
- fifth – calculation of the autocorrelation function and assessment of the homogeneity of the sound sources

Most of these actions have been executed by Emil Oinakov.

### Discussion and Analysis

The analysis of the results obtained shows many specifics:

- The visual forms of the signals show numerous differences (as it can be expected) – just examples are presented – fig.1 to fig. 4.

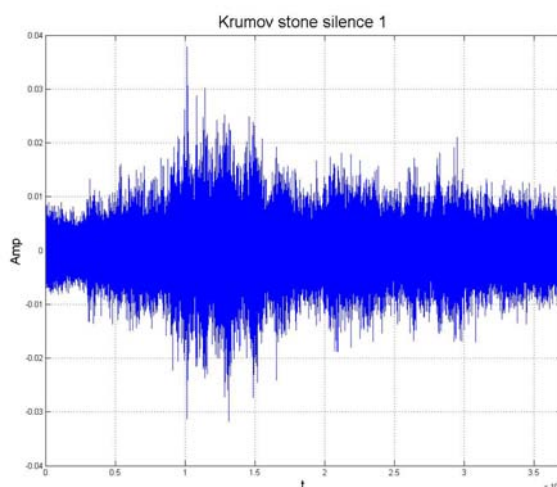


Fig. 1. The noise of silence on Krumov Kamak nunatak

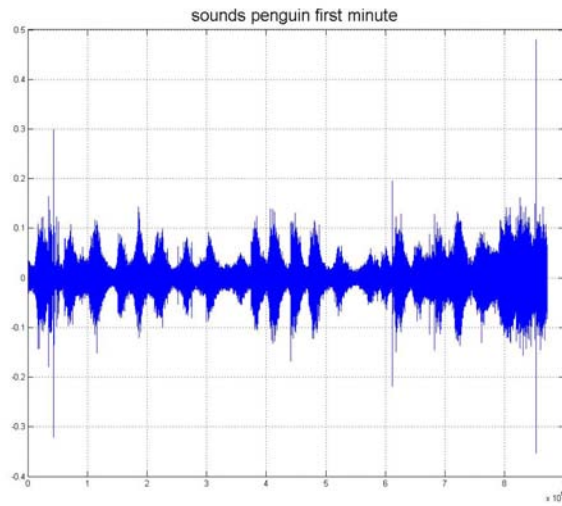


Fig. 2. Sounds of penguins on the beach

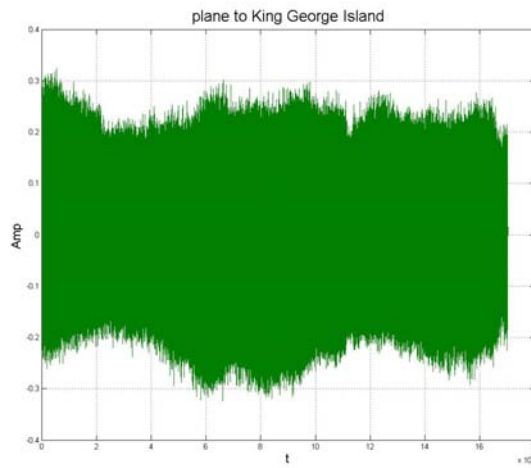


Fig. 3. Noise of the airplane landing

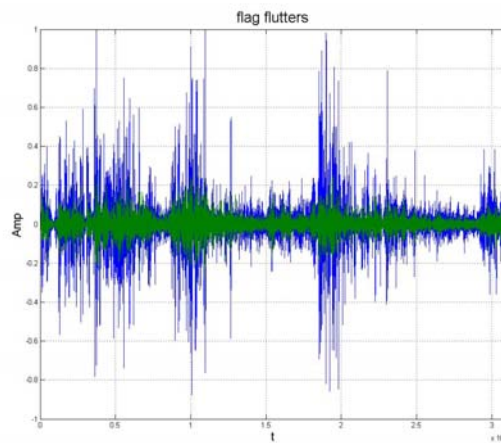


Fig. 4. Noise of the flag fluttering

- In general the frequency band covers frequencies between 0.1 to 400-600 Hz. Just for example – fig. 5, fig.6 and fig 7

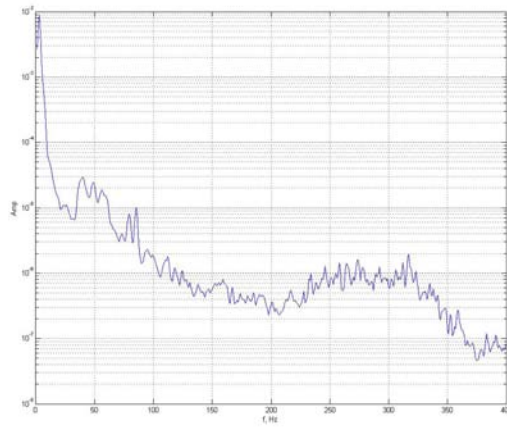


Fig. 5. Spectrum of the Krumov Kamak nunatak silence

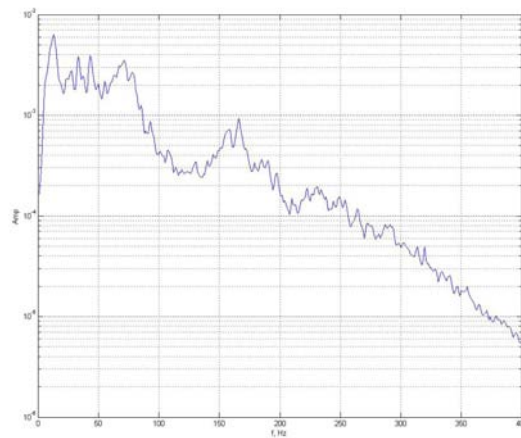


Fig. 6. Snow digging sounds – illustration of an anthropogenic and the natural noise

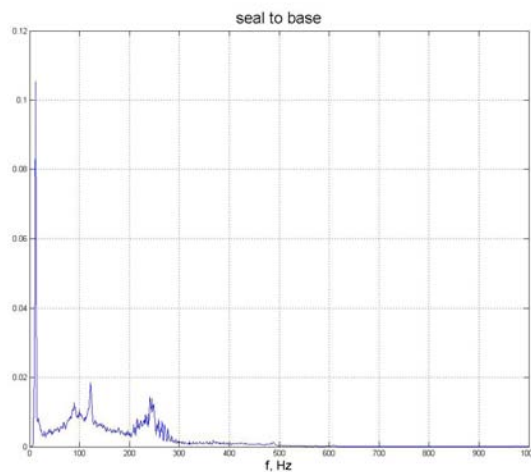


Fig. 7. Spectrum of the seal's sounds near the BAB, Livingstone Island

- The amplitudes variations have the larger interval of changes (as it can be expected) – from about 10dB to  $10^{-5}$ dB
- The autocorrelation functions are also typical with a central maximum, which respect the homogeneity of the sources of sounds – fig. 8 and fig.9..

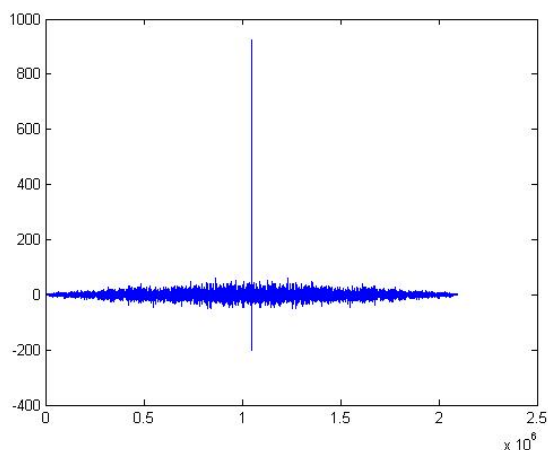


Fig. 8. Autocorrelation function of the natural noises in the South Bay

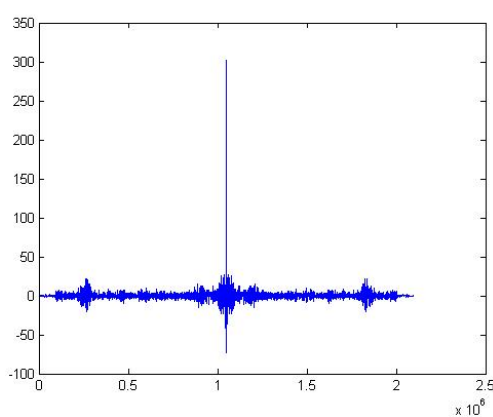


Fig. 9. Autocorrelation function of natural (rain) and human (people conversation) sounds

Of course, there are a lot of exceptions of the presented examples, but the trends established are sustainable.

### Conclusions

The new and original project called ACUSAN investigates the sounds and noises in Antarctica – mainly around the Bulgarian Antarctic Base (BAB) as well as to the way to and from the BAB, covering different sources of noises and sounds – anthropogenic and natural. A lot of data and information have been collected and processed.

The results of data processing show many specifics:

- The spectral content does not differ a lot from the usual acoustic environment, but the low frequency noise can influence the perception of the polar people.
- The dynamic range is lower than in the everyday life outside Antarctica.
- The sources of the noises and sounds are much more homogenous and coherent than in usual everyday acoustic environment in much more noisy cities and towns outside Antarctica.
- New and promising investigations are ahead to investigate the noise and sounds in Antarctica and their relationships with the psychology and psychosomatic response of the people working in the Antarctic environment.

The ACUSAN project gives promising results and could be extended in different directions – for example noise and colors relationships, natural and anthropogenic influence to the animal world in Antarctica, etc.

### References:

1. <http://press-files.anu.edu.au/downloads/press/p316261/pdf/book.pdf?referer=87>
2. <http://discoveringantarctica.org.uk/introducing-antarctica/imagining-antarctica/the-sound-of-silence/>
3. <http://www.bbc.co.uk/nature/16250444>
4. [http://www.gruenrekorder.de/?page\\_id=4733](http://www.gruenrekorder.de/?page_id=4733)
5. <http://www.antarctica.gov.au/about-antarctica/sounds-images/sounds>

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