Archaeoacoustics in Archaeology

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Abstract

Archaeoacoustics is an approach to analyze any archaeological sites that have interesting acoustic characteristics or natural physical phenomena affecting brain activity. It can be used to demonstrate for example sound occurrences incorporated into the design of the ancient structures by the architects. This is not the only application, following an anthropologic approach, archaeoacoustics can explain why during rituals an altered state of mind intensifies the experience. In fact natural phenomena, now scientifically measurable, influence the psychological state of the people by inducing mystical states. Over seven years of research in this field we have demonstrated ancient civilisations had some knowledge of this phenomena, through understanding the significance of why specific locations were chosen for buildings such as temples. Using digital recording equipment, it is now possible to record non-audible sound frequency bands. These bands have a direct effect on the human body and mind without a person being aware of the existence of their accompanying mechanical vibrations.

Keywords: archaeoacustics, ultrasounds, infrasounds, low sound frequency

1. Introduction

Archaeoacoustics is not a new science, but a complementary approach to archaeology, it is a new perspective to analyze archaeological sites which sometimes have interesting sound characteristics (Debertolis et al. 2012-2015). It can demonstrate sound occurrences planned by the builders of some structures. Natural sound phenomena were used in several civilizations to create impressive rites, with some ancient structures designed in a such a way as to directly influence the mind through the vibrations they produced towards a particular state of consciousness (Debertolis and Gullà 2015; Jahn et al. 1996; Cook et al. 2008). This point of view of ancient sites has had more expansion in the nineties and our research group has followed this road since 2010 investigating a large group of "sacred" sites in Europe and Asia (England, Bosnia, Serbia, Slovenia, Italy, Portugal, Malta, Greece and Turkey) publishing our conclusions. Using modern digital recording techniques it is now possible to record very clearly non audible sound frequency bands such as ultrasound or infrasound, which are able to modify the brain activity. We discovered that the most part of sites from Göbekli Tepe in Turkey to Tarxien Temples in Malta, from Alatri Acropolis in Italy to Delphi in Greece are all placed over sources of natural low frequencies or magnetic fields which affect human brain activity. We also reproduced the band of vibrations found by other authors in some sacred sites in UK and Ireland in the laboratory and in one sacred site in Italy, confirming that these vibration interfere with human mind in various ways (Debertolis et al 2014). Sometime these bands of sounds have a direct effect on the human body without a person being aware of the associated mechanical vibrations. So after the analysis of about forty ancient sites the hypothesis of our research group was confirmed and became a thesis. This is: in some archaeological sites considered sacred for thousands of years, there are measurable natural audio phenomena that make the place somewhat more mystical than others. How between 11,600 and 2,000 years ago the builders of the temples were able to find the right location for their temples without the use of the measuring devices we have today? We cannot know this for the most ancient civilizations without a written source, but we know that ancient Romans had this knowledge because we have historical records speaking about this. These techniques were used to find the optimal location for military camps, public buildings or spas, being careful to avoid any potential negative impact on health (Debertolis and Gullà 2015) It is believed that the empirical knowledge handed down to the Romans from the Etruscans, resulted in the Romans holding their soothsayers and in particular a category of priests, called the augurs in high esteem (Debertolis and Zivić 2015).

2. Infrasounds, audible low frequencies, Ultrasounds and magnetic fields

There are a lot of scientific papers that demonstrate mechanical vibrations have a positive or negative influence on our health and there are several predominant sources of naturally occurring ultrasounds, very low frequency and infrasound found in the environment. Depending on age and gender, humans can perceive sounds in the range of 20Hz to 20Khz, in some cases sounds above 14-18Khz are not audible to the human ear. Frequencies above 20Khz are considered ultrasound whilst frequencies below 20Hz are considered infrasound. Careful measurements have shown that hearing does not abruptly stop at 20Hz but the ear is capable of registering infrasound if the sound pressure is sufficient.

Low frequency sound has a relatively long wavelength and low material absorption rate, hence it has the ability to travel vast distances. These properties make it possible to achieve a profound effect on vast tracts of acoustic space with the production of high sound pressure level acoustic waves. Low frequency sound is non directional sound in it's propagation and therefore has the effect of enveloping the individual without any discernable localized source.

Any severe and artificial extreme imposed on the sonic environment has a profoundly destabilizing effect on the individual, indeed infrasound has been used in the context of wars and nowadays there are currently several organizations conducting research in the area of acoustic weapons. However, natural low vibrations with an absence of high pressure can have a positive influence on human health and some people can perceive very low-frequency sounds as a sensation rather than a sound. Infrasound may also cause feelings of awe or fear in humans. Given it is not consciously perceived, it may make people feel that odd or supernatural events are taking place (Debertolis and Bisconti 2013) So it is possible to hypothesise that where there are a lot of natural low vibrations present, ancient populations considered these sites to be "sacred" (Figure 1).

Figure 1 – A typical Neolithic sacred site placed on Apuan Alps in Italy. Our research showed strong infrasounds just in this location able to affect mind. These frequencies are not present also at short distance. These vibration have a geologic origin, probably because the frictions of geological faults close to this site.

The same argument could be applied to natural ultrasounds. The upper frequency limit in humans of approximately 20.000Hz is due to limitations of the middle ear, which acts as a low-pass filter. However, if ultrasound is fed directly into the human skull and reaches the cochlea through bone conduction, without passing through the middle ear, it is then possible to also hear these frequencies (Debertolis and Bisconti 2013). Because in humans the upper limit pitch of hearing tends to decrease with age, children are able to hear some high frequencies sounds that older adults cannot. Ultrasounds are well known and used in the medical field. Ultrasonography is a diagnostic medical imaging technique used to visualize many internal organs with real time tomographic images. Ultrasound is used for healing inflamed tissue and for therapeutic applications or in dentistry for cleaning tartar from teeth. Although the long term effects of exposure to ultrasound at strong intensity are still unknown, currently the medical profession considers the benefits to patients to outweigh the risks. In contrast to medical applications ultrasound has been studied as a basis for sonic weapons, due to its direct effect on the human body and nervous system. Applications have been developed that include riot control through the disorientation of attackers and lethal levels of ultrasound that can be used like a gun. In fact high frequencies can readily be absorbed by materials and as they are highly directional they have been incorporated in the design of acoustic weapons (Debertolis and Bisconti 2013). It is probable that natural emissions of ultrasounds were heard by very young people of ancient civilizations as a supernatural sound, but in the rest of the population these were felt only as a good or bad sensation relative to the perceptible frequencies in a particular location along with the mystic aspect of the site.

3. How to move into archaeoacoustics?

For recording sounds we use two types of dynamic high-end microphones extended in the ultrasound field together principally with a digital portable recorder with a maximum sampling rate of 192KHz (Tascam DR-680 of TEAC Group), but we controlled the result with other digital recorders (Tascam DR-100 and Marantz PMD661) with less technical characteristics. At the same time as recording in the air we used professional studio microphones with a wide dynamic range and a flat response at different frequencies (Sennheiser MKH 8020, response Frequency 10Hz - 60.000Hz) along with shielded cables (Mogami Gold Edition XLR) and gold-plated connectors (Figure 2).

Figure 2 – The set-up used for recording sounds: the recorder Tascam DR-680 and Sennheiser MKH 8020 microphones placed in the sacred Etruscan acropolis at Marzabotto (Italy).

For recording in water we used ultrasensitive omnidirectional microphones also used by sea biologists (Aquarian H2a-XLR Hydrophone, frequency response from 10Hz to 100Hz) with shielded water proof cable from factory (Figure 3). This type of microphone has a wide bandwidth typically used to hear whale song up to several kilometers away. In this case the sound is transmitted very quickly in water, with the body of water acting as a reflector capable of capturing every vibration many meters away (Figure 4).

Figure 3 – The Aquarian H2a-XLR Hydrophones together with the digital recorder Marantz PMD661.

Figure 4 – Two Hydrophones were placed in Ravne Hypogeum in Visoko (Bosnia-Herzegovina) for recording resonance in the ancient structure. There was almost 8-10cm of water on the bottom of the floor, so the Hydrophones were the most adapt device for recording vibrations in these conditions (Debertolis and Savolainen 2012).

For recording ultrasounds we use a Pettersson D1000X Bat detector and Bat sound software, Pettersson Elektronik, Uppsala University. It is the best source for recording ultrasounds from every source. Originally built for recording ultrasounds from bats, this device is very useful for recording natural ultrasounds up to 400.000Hz (Figure 5).

Figure 5 – We used the Pettersson D1000X Bat detector from Swedish firm Pettersson Elektronik a lot in Portugal during our research on stone circles. The study showed that the granite megaliths are able to produce some interesting ultrasounds if hit by the sun. These infrasounds are closely placed audible frequencies and perceptible by a sensitive ear.

Before recording we use a spectrum analyzer (Spectran NF-3010 from the German factory Aaronia AG) for searching electromagnetic phenomena present around us which could have had a negative influence on our results (Figure 6).

Figure 6 - Spectran NF-3010 from the German factory Aaronia AG.

We also use a geologic device for confirming what we find by microphones in infrasound range. It is GeoBox SR04S3 Datasheet from Italian firm SARA. The digital sensor SR04 GeoBox is a high-performance instrument especially suitable for acquiring signals for seismological and geophysical surveys such as the Horizontal/Vertical Spectral Ratio - HVSR. The SR04 GeoBox is designed especially for recording ambient seismic noise, but it can also record earthquakes and artificial vibrations. Compact, reliable and simple, it is fully functional within minutes after deployment (Figure 7).

Figure 7 – Left: GeoBox SR04S3. Right: the device connected with the computer at work.

Praat program version 4.2.1 from the University of Toronto and Audacity open-source program version 2.0.2, both for Windows were used to analyze the various recorded tracks.

4. Results of our methods

It's not possible to summarize all the results found during the seven years of research in this paper. However, the thesis by SBRG is that natural phenomena in the audible, infrasonic or ultrasonic sound bands may be closely connected to particular aspects of spirituality. These characteristics appear to have ultimately influenced the choice of construction of a particular temple in a certain location. It was observed that when a natural phenomenon was found, the archaeological site was ancient and important and had a church or temple present long before the arrival of medieval churches. Non significant data was also collected from chapels and medieval sites of religious importance, that also appeared to offer mystical properties, but without any such physical or mechanical. On the contrary, many locations built between the Neolithic Age to the Fall of Roman Empire have some interesting phenomena suggested by the archaeology without their being any significant archaeoacoustical features. Maybe this knowledge perhaps was lost during the Middle Ages (Debertolis and Zivić 2015).

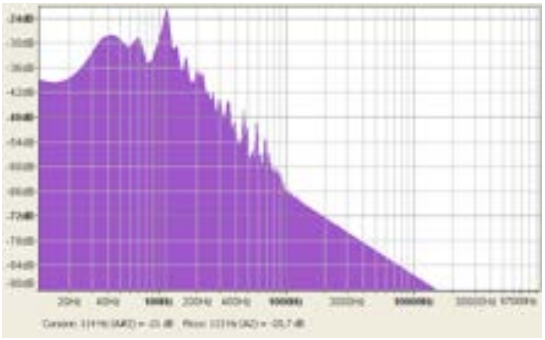

Figure 8 – The typical aspect of resonance at 114Hz found in Hal Saflieni Hypogeum in Malta. The resonance was stimulated by a sciamanic drum, but if the drum were drummed by soft hand instead of by a ram there were no resonance by the envirorment (Debertolis et al. 2015).

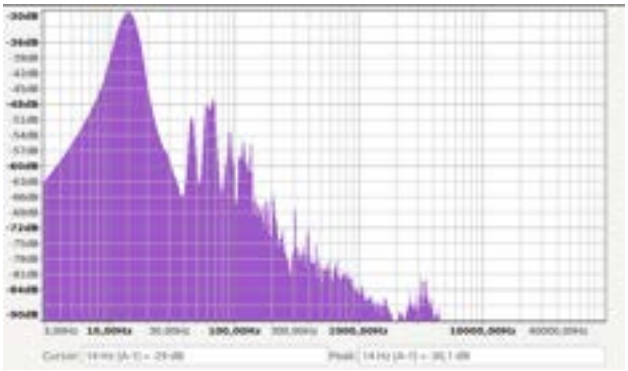

Figure 9 - The aspect of sound coming from subterranean water in an Etruscan sacred sites close the Bomarzo pyramid in Tuscany (Italy). It is possible to perceive an infrasound frequency at 14Hz in the silence at the volume of -30db.

5. Conclusion

The low frequencies, infrasounds, ultrasounds, magnetic field found in several ancient sacred sites explain very clearly the sensation of mysticism which some people perceive in these places and how it is very easy for those practising meditation at these sites to apply their techniques. We can suppose that these frequencies are probably comming from geological faults or from the movement of underground water. These sacred sites were where wisdom, culture and attention was common, helped by this good natural enviroment. Because infrasounds and low frequencies are not directional, for our protocol we needed to capture these sounds using professional microphones with a flat response on all frequencies and a deep response in all frequencies. In either case, researching ultrasounds or low frequencies, it is very important to use well shielded cables with gold-platted connectors to avoid picking up radio waves from other sources. Living our modern lives in urban towns and cities, we are exposed to a lot of bad mechanic vibrations with a high volume which in most cases is very detrimental for health. In contrast, in their absence ancient people would have been more attuned to natural vibrations. They understood the best locations to go to so they could make contact with God through their prayers,

leading them to build their temples in these locations. In conclusion as our experience demonstrates, archaeoacoustics appears to be an interesting new method for reanalysing ancient sites using different study parameters. This reaffirms the aura of legends that pervades these places, and modern technology is now able to give greater clarity to the origin of many interesting phenomena.

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