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CURRENT OPERATION OF ANCIENT GREEK THEATRES: THE PROBLEM OF ENVIRONMENTAL NOISE

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Abstract

Distinctive principles of design were applied to ancient Greek theatres in every region and time period, and flexible solutions were found for each theatre's individual problems such as location and architectural composition, statics and drainage, visuals and acoustics, stage equipment and theatre machinery. The revival of ancient drama (from the early 20th century), the demand to bring performances back to their natural place (about eighty years ago) and the popular trend that has developed since then, have given priority to matters of mild and reversible interventions so as to ensure the proper conditions for the operation of theatres. Despite the serious distortions brought about by Roman interventions or lasting destructions, in most cases the reopening of the theatres is deemed feasible. Any disagreements as to the organisation of performances are usually centred on the manner and position in which modern infrastructures are to be installed. However, any attempts at consolidating and restoring prove to be incomplete without the corresponding acoustic interventions, since the contemporary sound environment is a destructive nuisance to outdoor acoustic comfort, while the various stage-design solutions normally fail to exploit the natural (passive) acoustic potential of the theatre space.

The purpose of the paper is to present the current situation of fourteen (14) ancient Greek theatres (Theatre of Dionysus Elefthereus, Thorikos, Amphiaraiion at Oropos, Eretria, Argos, Epidaurus, Megalopolis, Delphi, Larisa, Dion, Dodoni, Philippi, Thassos and Maroneia), the assessment of their contemporary sound environment and the acoustic evaluation for their current or potential reopening. Furthermore, the effect of traffic and other urban noises on the emergence of sound and speech intelligibility will be presented via specific examples.

Keywords

Background noise, effective signal rising.

1. Introduction

Contemporary reopening of the ancient Greek theatres requires a set of mild and reversible interventions, which would ensure the proper conditions of theatrical operation. As analyzed in an earlier publication, in the field of the protection of ancient Greek theatres, there are two critical and often contradictory goals: the emergence of the individual phases of construction of every theatre - monument and the functional restoration of the theatre space [1].

During restoration works, complex and contradictory choices come up, because every theatre, as a palimpsest of successive building phases, is a unique case where the timeless typological developments are intertwined with Roman interventions. While organizing performances in modern times (which exclusively concern the drama plays of classical period), the problems are basically focused on scenographic arrangements and the location of contemporary theatre infrastructure in the area of the orchestra and the ruins of the stage, which essentially date back to post classical period building phases. [2-3].

During a performance, the actors' and spectators' requirements coincide with the unhindered theatrical communication which, as demonstrated by long-lasting and numerous acoustic surveys, under certain circumstances is served by the unique acoustic behavior of outdoor theatrical places of antiquity:

- elimination of the external unwanted sounds (noise protection),
- harmonic deployment of the crowd around the action (architectural forms of open floor plan),
- appropriate sizes according to human vocal and acoustic scales (distribution of direct sound),
- activation of a passive loud speaker (for supporting positive, early sound reflections, as well as decreasing late, disturbing reflections and echo)[4-5].

In a previous publication, the critical acoustic conditions that define the modern reopening of ancient Greek theatres were negotiated:

- reduction of the human voice by 25 to 33 dB[A] due to the typical size of the surviving theatres (up to 37 dB in cases where the third diazoma of the koilon still exists),
- amplification of the direct sound by max 6,5 dB with positive contributions from the orchestra, the stage and their combination (the gains are limited by half due to incorrect application or installation of the scenery in performance conditions),
- acceptable to satisfactory speech intelligibility levels (effective signal rising of about 20 to 25dB), in circumstances of limited background noise within the limit of the criteria NC-20 / 25 [2-6].

2. Research

This paper is part of a broader research (ongoing since 2004), aiming at monitoring the current status of the ancient theatres in Greece (modifications, destruction, protection works) and evaluating their acoustic quality in modern operation conditions. The whole survey sample includes a sum of fourteen (14) ancient Greek theatres (Argos, Delphi, Dion, Theatre of Dionysus Elefthereus, Dodoni, Epidauros, Eretria, Thassos, Thorikos, Maroneia, Megalopolis, Larisa, Philippi, Amphiaraiion at Oropos) [7- 8].

Table 1 – Full survey sample and briefly recorded data.

Theatre	Use	Koilon	Orchestra	Skene	Environment
A1 Argos	B2	C1	D1	E2	F3
G :	G1 37	G3 43	G5 46		
A2 Delphoi	B2	C2	D2	E2	F2
G :	G1 33	G3 38	G5 47		
A3 Dion	B1	C6	D3	E2	F2
G :	G1 38	G2 43	G4 46		
A4 Dionysus El.	B4	C3	D2	E2	F3
G :	G1 44	G3 54	G5 65		
A5 Dodoni	B3	C3	D2	E3	F1
G :	G1 27	G2 36	G4 34		
A6 Epidaurus	B1	C2		E2	F1
G:	G1 29	G2 36	G3 46		
A7 Eretria	B3	C5	D4	E3	F2
G :	G1 37	G2 41	G5 47		
A8 Thassos	B2	C6	D2	E2	F1
G :	G1 33	G2 37			
A9 Thorikos	B2	C2	D5	E1	F2
G :	G1 34	G4 54	G5 37		
A10 Larisa	B3	C3	D2	E2	F3
G :	G1 43	G3 58 (70)	G5 51		
A11 Maroneia	B2	C4	D3	E2	F2
G :	G1 34	G2 37	G5 46		
A12 Megalopolis	B3	C5		E5	F2
G :	G1 33	G4 37			
A13 Philippi	B1	C3	D2	E2	F2
G :	G1 40	G2 44	G5 52		
A14 Oropos	B2	C5	D2	E4	F1
G :	G1 33	G4 37			

The survey data is briefly recorded in Table 1, which includes:

- in column A the location of each theatre,
- in column B the current use of the theatrical space, with typical entries: B1 for official festivals, B2 for occasional performances, B3 for temporary ban due to restoration works and B4 for permanent performance prohibition,
- in column C the status of the koilon, with typical entries: C1 for carved in rock, C2 for full restoration, C3 for full restoration including Roman interventions, C4 for partial restoration including Roman interventions, C5 for damage by illicit stone traders C6 for damage by illicit stone traders - partial intervention with wooden gradients.

- in column D the status of the orchestra, with the typical entries: D1 for Roman conversion into water tank, D2 for Roman coating, D3 for damaged, D4 for preserved charoneion passage, D5 for incomplete configuration,
- in column E the status of the scene, with typical entries: E1 without any kind of building, E2 for damaged building and foundation ruins, E3 for yposcenium ruins, E4 for colonnade of the proscenium, E5 for scenea ductilis (mobile stage),
- in column F the contemporary environment of the theatrical monument with entries: F1 for natural environment with minimum activity, F2 for semi-urban environment with agricultural activities and traffic, F3 for urban environment with urban activities and traffic,
- in column G the noise levels in dB[A], with entries: G1 for background noise, G2 for natural sounds, G3 for urban activity noise, G4 for rural activity noise, G5 for road traffic noise.

3. Typical examples

For the restricted size of this presentation, three (3) typical examples of the current status and noise pollution in the contemporary environment of the ancient Greek theatres will be analyzed.

3.1. The Argos theatre

The town of Argos in the Peloponnese is densely built at the foot of the ancient acropolis. In the theatre, performances take place only occasionally. The stone curved gradients of the koilon and the foundation ruins of the scene alongside Roman intervention traces in the orchestra (the foundation of a tank for naval battle representations) are preserved. In order to settle the aggravated traffic situation in the urban center in the late 90's, the road leading to the archaeological site (alongside the main axis of the theatre place and approximately 300m far from the orchestra) was converted into a ring road (2 major and 1 auxiliary lanes, with an hourly load of about 600 vehicles in normal traffic conditions).

Recent sound measurements showed that urban traffic noise aggravates the theatre's acoustic conditions with an hourly equivalent sound level of 46dB[A]. In addition, around the theatre, mixed uses (background noise 37 dB[A]) of residency and small industrial units and yards coexist (levels of 43 dB[A] because of E/M equipment). This burden of noise is on the increase due to the encirclement of the theatrical space from typical urban activities.

3.2. The Delphi theatre

The ancient oracle at Delphi is on the south slope of Mount Parnassus (in Fokida), in a semi-open valley opening west to the Corinthian gulf. The theatre overlooks the ancient temple complex (in a cavity sheltered from the homonymous modern village), above the main road from Delphi to Arachova. The theatre place hosted the first attempts of the ancient drama revival (early 20th century by A. Sikelianos and E. Palmer), which established its return to the natural environment and also influenced modern views on the performance in outdoor conditions (in contrast to hitherto indoor attempts, according to the German classicism form of stage direction).

The koilon is maintained in good condition (despite the partial prohibition due to the inevitable restoration works for a part of the gradients), while the characteristic interference of the scene construction (only surviving remnants of foundations) protects a large

number of seats from the activities of people visiting the shrine and traffic noise (downstream). Thanks to its location and despite the touristic development of the region, the environment of the theatre area at Delphi upholds acceptable levels (background noise 33 dB[A], nature's sounds 38 dB[A] and occasional traffic noises 47 dB[A]).

3.3. The Dodoni theatre

The ancient temple at Dodoni is located in Epirus (near Ioannina), in a closed valley. The theatre hosted theatre festivals about 50 years but in recent years (due to fixation problems in koilon) is under temporary ban of performances. The quite acoustic environment of Dodoni was temporarily endangered in the early 90's, during the design process of new Egnatia highway, which was originally designed to vertically cross the valley and the wider archaeological site. The accuracy of the acoustic environmental impact study was disputed, resulting in shifting the final design of the highway to the north after a vigorous local and European mobilization, and it was materialized through a long tunnel, without eye contact with the perimeter of theater [9].

As recorded in recent sound measurements in the wider area of the valley, under conditions of moderate road traffic (closed highway with 4 main, 2 auxiliary lanes and an hourly load of approximately 540 vehicles), the effect of traffic remains at low levels of nuisance 40 dB[A]. Simultaneously, the acoustic environment of the theatre (thanks to its location) is maintained under exceptional circumstances of silence (background noise 27 dB[A], nature's sounds 36 dB[A], occasional rural activities (34 dB[A]).

4. Data process

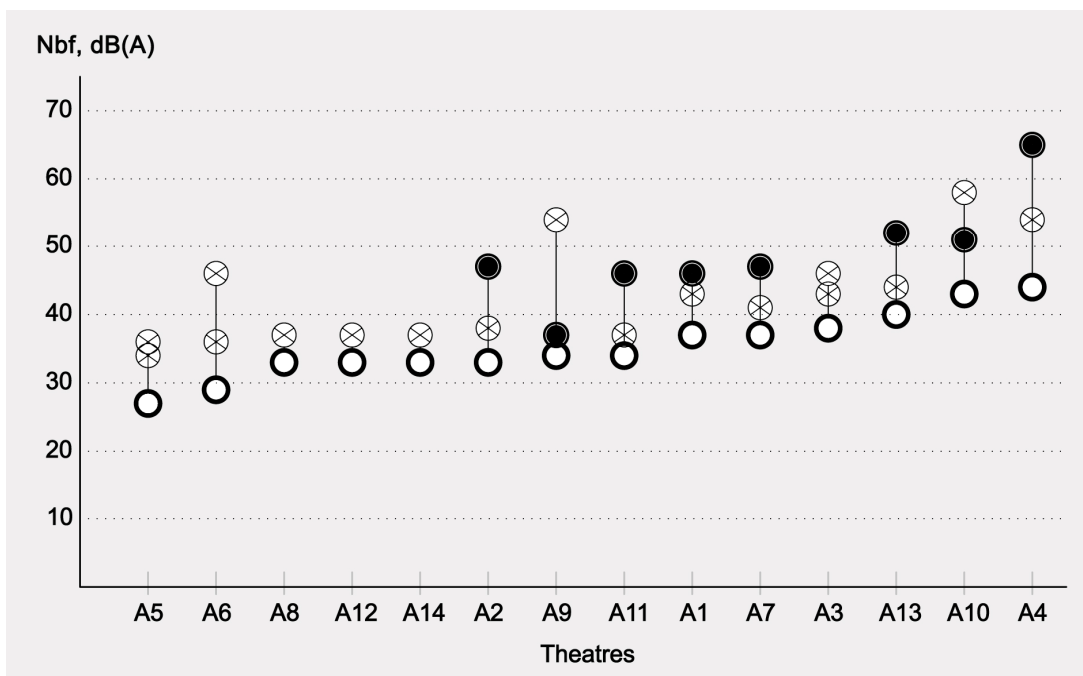
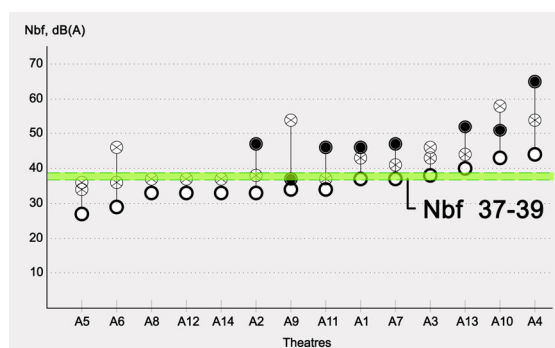
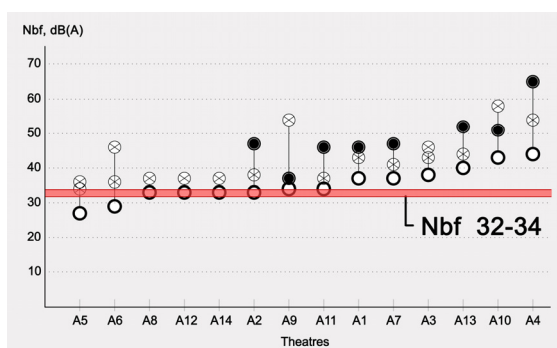


Figure 1 – Theatres in ascending order of background noise levels.

In Figure 1, the 14 theatres of the sample (points A1, A2, etc. on the horizontal axis) appear in ascending order of environmental noise levels (noise intensities in dB[A] on the vertical axis). A white circle shows the sign of the background noise, with an X in a circle to indicate the occasional noise (nature, outdoor activities, etc.) and a dark circle to indicate the permanent sound nuisance (traffic, urban noise). At a first glance, it can be easily distinguished that the last places (most degraded in terms of noise) are occupied by the theatres that were incorporated with an urban area or for those that are contemporary located near busy highways and expressways (A1, A3, A4, A7, A10, A13). For acoustic evaluation of ancient Greek theatres, in circumstances of potential re-opening (when in fact the background noise gets rid of the casual or occasional annoyance), we have laid out a numerical model to calculate the effective signal rising (Ra), which is defined as the sound level difference between the intensity levels of the effective signal and the noise. This is a qualitative value - criterion that corresponds to the perceptible portion of the sound energy (which is related to the intelligibility of speech) in contrast to the cancellation, masking of the remaining energy of the effective signal from the negative sound nuisance. During our calculations of the simulation model, the following assumptions were made:

- the actor is at the back of the orchestra (at the crossing point of possible scenery with the central axis of the koilon, 1, 7 m above the level of the orchestra)
- the initial intensity of the human voice L_0 is 87 dB[A] (at 1m) with spherical wave conditions (without any electrical gains)
- the viewer is at a maximum distance of 36 to 45m from the actor (i.e., lateral or central positions for 90 - 95% of the seats of the koilon, except for the third diazoma cases, 1,1 m above the level of position)
- the decrease of the direct sound because of the distance, L_d , is 31 to 33 dB[A],
- the orchestra as a perfect reflector (gain of +3 dB, without sound absorption)
- any background noise N_{bf} is amplified (+5 dB) due to the presence of the crowd during the performance,
- the rising R_a of the effective signal is min 20dB,
- the final rising signal values are given in rounded decibel values according to the formula;

$$R_a = L_0 - L_d + 3 - (N_{bf} + 5) \geq 20dB$$



Figures 2, 3 – Alternative application of the calculation model for limited acoustic conditions.

As shown in Figure 2, the theatres of the sample are classified as follows:

- two (2) in very satisfying acoustic condition ($R_a > 20\text{dB}$): Dodoni, Epidaurus (natural environment with limited and occasional activities),
- six (6) in marginally good condition ($R_a \approx 20\text{dB}$): Delphi, Thassos, Thorikos, Maronia, Megalopolis, Amphiaraion at Oropos (natural or semi-urban environment with occasional rural or tourism activity) and
- six (6) in unacceptable condition ($R_a < 20\text{dB}$): Argos, Dion, Theatre of Dionysus Elefthereus, Eretria, Larissa, Philippi (urban or semi-urban environment, traffic).

Alternatively, for limited acoustic comfort conditions, the calculation model of the rising signal was converted in accordance with the following assumptions:

- for the purposes of a performance, a mobile scenery structure is placed behind the orchestra (overall gain min +5 dB, due to the orchestra, the scenery and their combination),
- the rising of the effective signal is min 17dB.

As expected, the classification of the theatres of the sample is improved, according to Figure 3, as follows:

- two (2) in excellent acoustic condition ($R_a \gg 17\text{dB}$): Dodoni, Epidaurus,
- six (6) in satisfying condition ($R_a > 17\text{dB}$): Delphi, Thassos, Thorikos, Maronia, Megalopolis, Amphiaraion at Oropos,
- four (4) in acceptable or marginally acceptable condition ($R_a \approx 17\text{dB}$): Argos, Dion, Eretria, Philippi (urban or semi-urban environment in moderate or heavy traffic condition in a distance) and
- two (2) in unacceptable condition ($R_a < 17\text{dB}$): Theatre of Dionysus Elefthereus, Larissa (urban environment and traffic).

5. Conclusions

In the process of the research, we identified major urban pressures and recorded intense traffic noises which cause serious nuisance in the acoustic environment of the theatrical monuments of antiquity. Their inherent potential for passive amplification, combined with normal, vocal and acoustic standards of a theatrical performance do not allow proper operation in distinctive nuisance conditions ($> 35\text{ dB [A]}$). The survey results confirm the international sound limits in order to preserve the required silence within cultural sites (NC-25 curve) and specify the responsibility of the Greek State, which should finally establish a silence criterion, for imposing mandatory sound protection measures (against urban or any other activity) and adopt temporary or occasional measures in a wide archaeological zone (until the final elimination of noise sources).

An equally important problem is the common destruction of the skene of the ancient Greek theatres. To deal with this lack, an aesthetically neutral and constructively revocable background during the performances in the right place and development, could contribute not only as a beneficial reflector (with gains from +2 to +3,5 dB), but also as a sound barrier (with even a limited effectiveness from -1 to -3 dB). This critical increase in the effective signal rising would improve the acoustic comfort in an extensive part of the seats, especially in the second diazoma of the koilon.

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