Implementation of Noise Barriers in Attiki Odos Motorway based on the relevant Strategic Noise Mapping and Noise Action Plan

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Summary

Attiki Odos Motorway (the "Athens ring road") constitutes one of the most important co-financed road projects in Europe, laying the foundations for the execution of a series of successful road concession projects in Greece. As per the Environmental Noise Protection and Monitoring, Attiki Odos has already implemented in 2009-2010 a Strategic Noise Map (SNM) and Noise Action Plan, followed by a full update in 2014 according to the directive 2002/49/EC (END). The updated Noise Action Plan (NAP), foreseen as main actions against road traffic noise, the implementation of reflective transparent noise barriers, partial motorway covers and also urban design tools. In order to validate the results, a comparison of the calculated noise indices Lden & Lnight results with the measured noise levels in more than 150 locations along the motorway - from the annual environmental noise monitoring program - was implemented proving exceptional correlation. According to the most recent results of the noise monitoring program of Attiki Odos during 2017, in the Geographical Section A13 (from K.P.32+600 to K.P.32+980 in both directions), a significant exceedance of levels of the above noise indicators, was documented as well as important residents' complaints. The Ministry of the Environment and Energy in view of the protection of sensitive receivers has mandated the execution of a Special Environmental Noise Evaluation Study including the implementation of anti-noise barriers limits based on a detailed DTM (Digital Terrain Model) using the CadnaA software. The calculations of both noise indicators levels with and without barrier incorporating of the traffic data and the acoustic measurements were executed and both horizontal and vertical noise maps were performed based on the original SNM & NAP for the scenarios with and without barriers in order to ensure the elimination of noise level exceedances and meet the noise criteria of the Greek legal framework.

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1. Introduction

Attica Tollway, a pioneering co-financed road project in Europe constructed on a concession basis, is a modern urban motorway extending along 70 km of length, constituting the ring road of the greater metropolitan area of Athens and the backbone of the road network of the whole Attica Prefecture. It consists of two directionally separated roadways, each consisting of 3 lanes and an emergency lane (hard shoulder). The suburban railway of Athens has been constructed in the central reservation of the motorway. Attica Tollway is part of the PATHE road axis (Patra - Athens - Thessaloniki - Evzoni) and connects the Athens - Lamia National Road with the Athens - Korinthos National Road, by-passing the centre of Athens.

The Strategic Noise Mapping (SNM) and Noise Action Plans (NAP), as per the European Directive 2002/49/EC [1], aims at the determination of a common approach for the prevention or decrease of the harmful effects, including annoyance of residents due to exposure to environmental noise originating from a linear source such as Attica Tollway [2],[3]. In some cases, there is a significant number of residents' complaints being exposed to high environmental noise owing to the operation of Attica Tollway. For this reason, every year an annual Noise Monitoring Program [4], [5], [6] is performed in order to calculate the indices L_{den} and L_{night}. In case that the above indices have been exceeded, the statutory limits for three continuously years the necessary noise mitigation measures will have to be taken, such as implementation of anti-noise barriers, in order to protect the sensitive receptors.

Figure 1. Attiki Odos motorway [7]

2. The Attica Tollway SNM & NAP 2017

In the section of Attica Tollway in Gerakas region (geographical unit A13), some adverse complaints of residents were noticed owing to the environmental noise stemming from the motorway. For this reason, a series of noise measurements were performed so as to verify if the statutory limits were exceeded. After analyzing the results of measurements the exceedances of statutory limits were verified according to the Greek legal framework and the need of taking the necessary mitigation measures was recommended, such as the construction of anti-noise barriers for the protection of citizens living near the motorway in Gerakas. Initially, for the calibration of the noise model, the noise measurements were executed in a distance of 2 meters from the facades of the buildings so as the measurements would not be affected by reflections. Four positions were chosen, in front of the façade of dwellings where adverse complaints of citizens were. The results of the measurements were used for the calibration of the model (use of *CadnaA* software). Figures 1, 2 and 3 hereafter show the very good correlation between the results of the noise model and the ones of the measurements for the three noise indices (a) L_{den}, (b) L_n and (c) L_{de}. As it is demonstrated, the correlation coefficient for

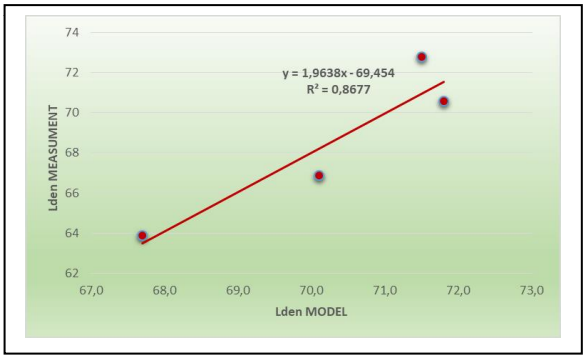

Figure 2. Correlation between noise model and measurements – Noise Index: L_{den}

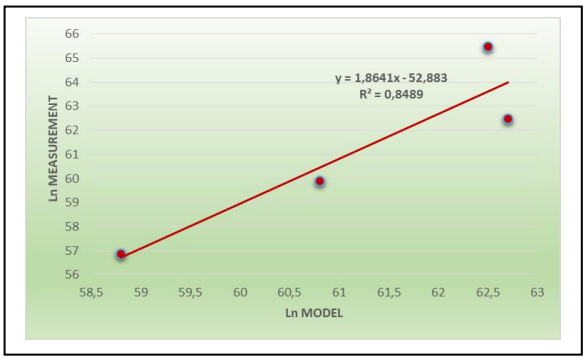

Figure 3. Correlation between noise model and measurements – Noise Index: L_n

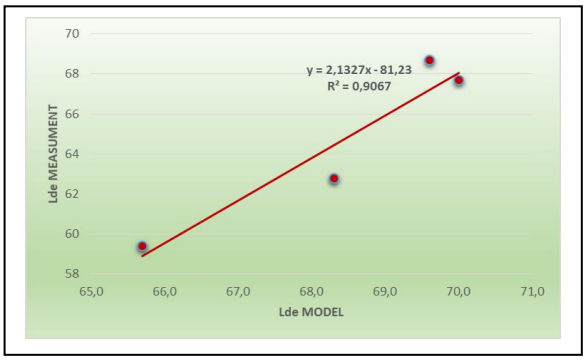

Figure 4. Correlation between noise model and measurements – Noise Index: L_{de}

In order to build the most appropriate noise model (using *CadnaA* software [8]) of the immediate urban areas, a Digital Terrain Model (DTM) of the total road axes and the surrounding areas (at a distance bigger than 200m. from the road) was executed in order to build the SNM 2017 geographical unit A13 [9]. For the solution of the noise model, three scenarios were used. A do

nothing scenario with no mitigation measures, a scenario including anti-noise barriers in two sensitive receivers and another scenario with an additional barrier, opposing to the previous barrier. For the calculation of the noise indices L_{den}, L_{night} and L_{de} the method of NMPB-Routes-96 was used. Annual traffic data were provided by Attica. In figure 5 hereafter the noise model in three scenarios is indicated, as described above.

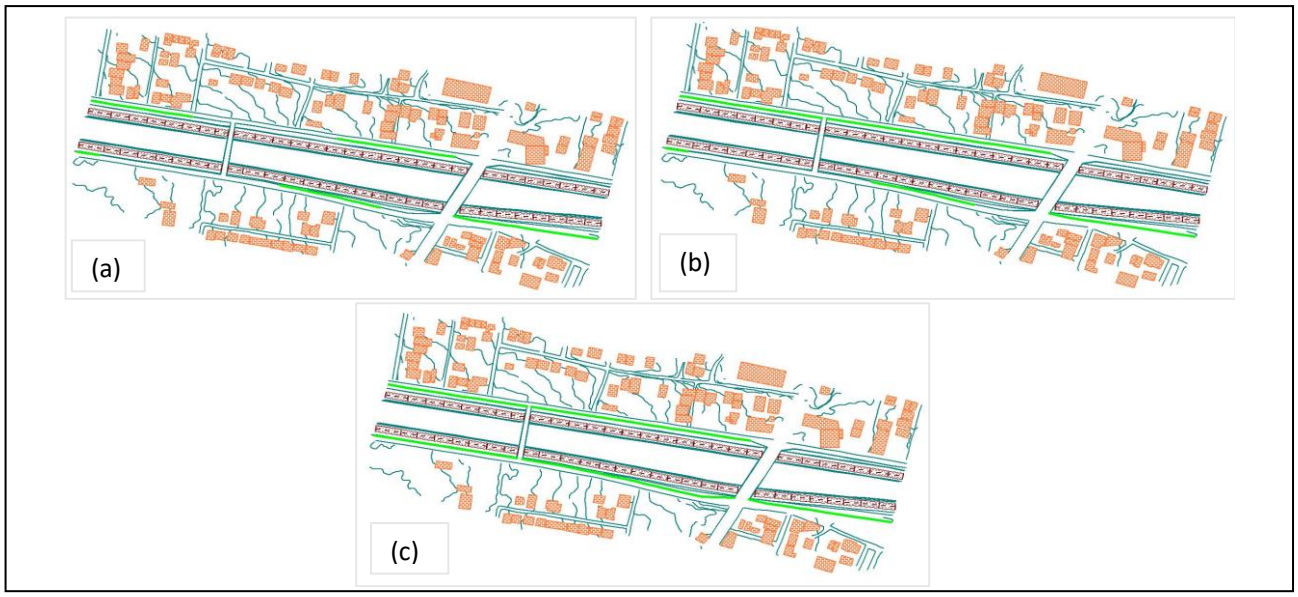

Figure 5. Noise model scenarios: (a) Do nothing, (b) Barriers for two sensitive receivers and (c) Additional. Barrier.

After having built the noise model, the horizontal and the vertical grids of the study area were calculated (Geographical unit A13). In Figures 6, 7 and 8 hereafter, an indicative part of SNM 2017 is presented for the three environmental noise indices L_{den}, L_n and L_{de} of the 2002/49/EC Directive for the three scenarios described above.

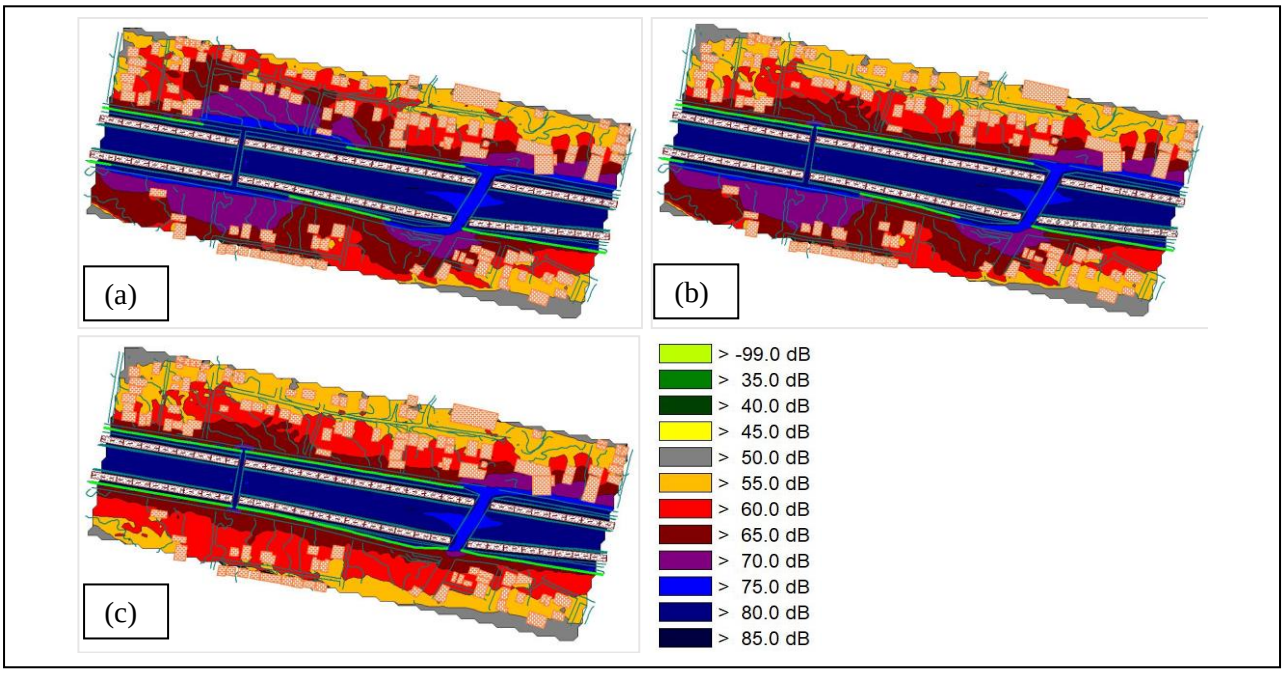

Figure 6. Attica Tollway (Geographical Unit A13) SNM 2017 – Horizontal Grid - Noise Index: L_{den} (a) 1^{rst} scenario with no mitigation measures, (b) 2nd scenario with barriers in two receptors and (c) 3rd scenario with barriers in three receptors (full covered area).

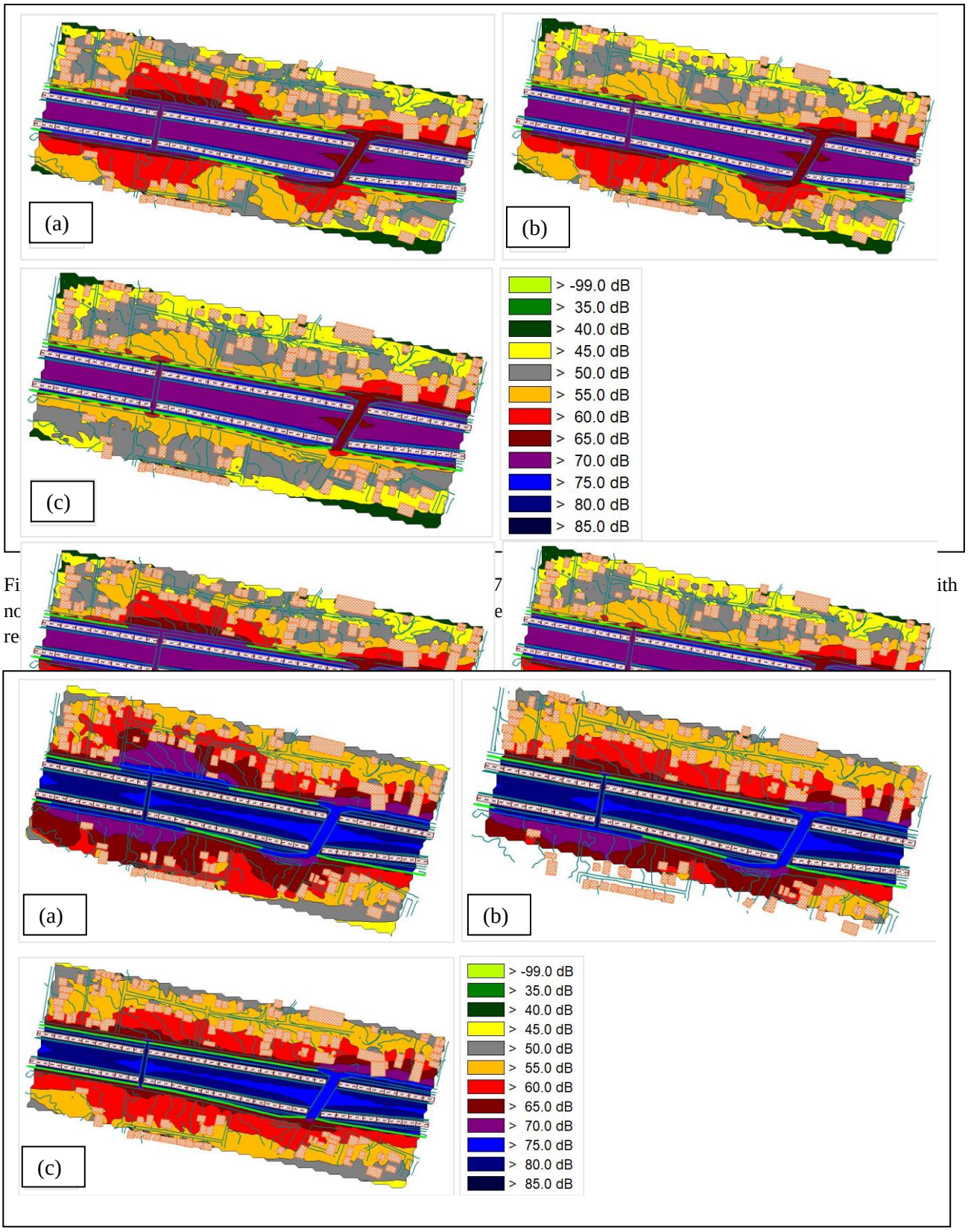

Figure 8. Attica Tollway (Geographical Unit A13) SNM 2017 – Horizontal Grid - Noise Index: L_{de} (a) 1^{rst} scenario with no mitigation measures, (b) 2nd scenario with barriers in two receptors and (c) 3rd scenario with barriers in three receptors (full covered area).

The Horizontal Grids carried out in a height of 4 m. from the ground according to the European Directive. After having calculated the horizontal grids, the SNM 2017 of Attica Tollway was completed with the calculation of vertical grids. In figures 9 and 10 hereafter, the vertical noise fluctuation for the indices L_{den} and L_n respectively is demonstrated, in one of the three sensitive receptors, for the condition with no mitigation measures and the state with the mounting of noise barrier 4,5 m. of height.

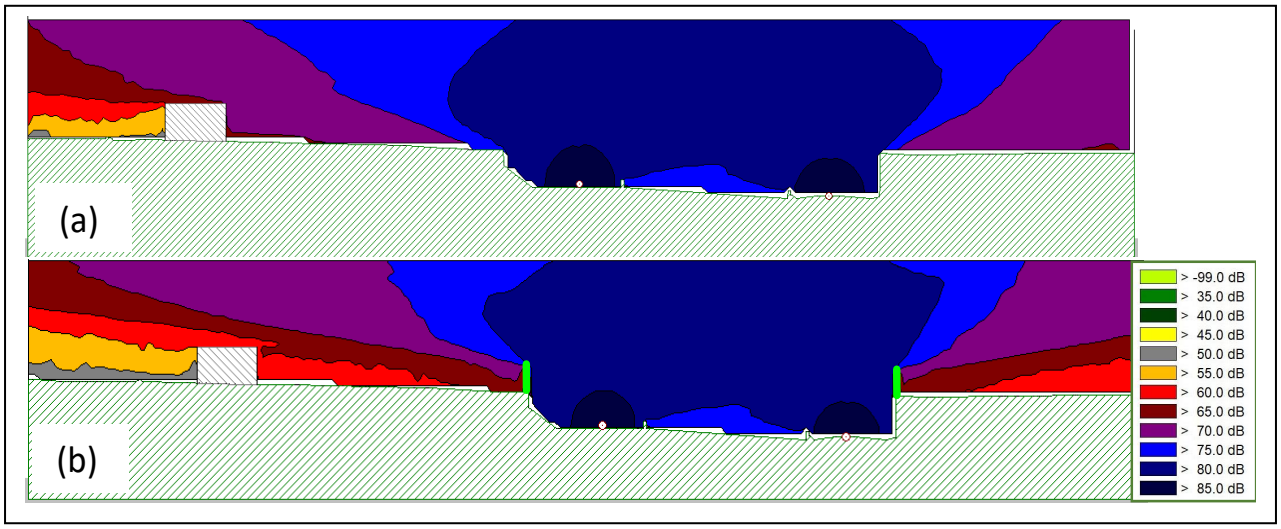

Figure 9. Attica Tollway (Geographical Unit A13) SNM 2017 – Vertical Grid - Noise Index: L_{den} (a) condition with no mitigation measures, (b) condition with the mounting of noise barrier.

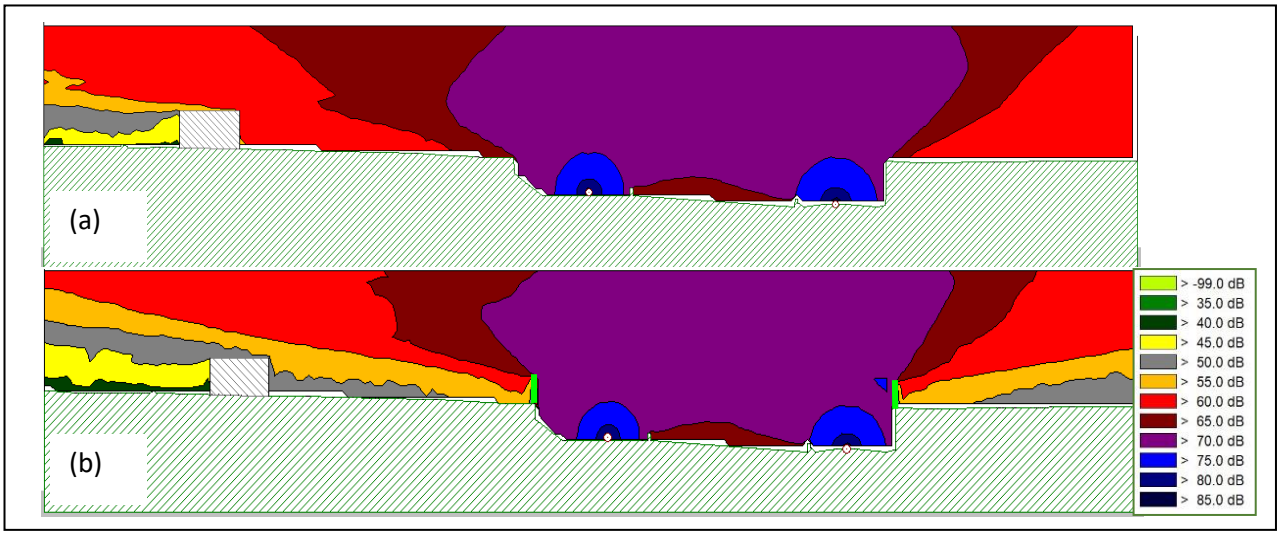

Figure 10. Attica Tollway (Geographical Unit A13) SNM 2017 – Vertical Grid - Noise Index: L_n (a) condition with no mitigation measures, (b) condition with the mounting of noise barrier.

According to the European Directive 2002/49, the thresholds for the L_{den}, L_n and L_{de} are 70 dB(A), 60 dB(A) and 67 dB(A) respectively. Based on the above results, the statutory limits of the noise indices were exceeded and the implementation of immediate mitigation measures was suggested (i.e. noise barriers). So, the construction of aesthetic noise barriers with effective heights of 4,5m was proven essential.

In order to resolve the issue of the environmental noise exposure on the population exceeding the existing criterion and limit, a full analysis of the implementation of adequate noise barriers was executed within the Noise Action Plan 2017 (NAP 2017) for Attica Tollway. This led to the implementation of some 1900 m^2 of PMMA transparent noise barriers in the geographical unit A13 in Gerakas along the road network.

3. Conclusions

It is known that the environmental noise is harmful for the health of inhabitants of an urban area. Residents living near a highway such as Attica Tollway are exposed in traffic noise and they encounter problems on sleep (sleep disturbance). For this reason, it is considered important that the residents must be protected from the negative effects of traffic noise. Every year, annual monitoring programs are carried out in order to calculate the levels of noise in a distance of 2 m. from the façade of the sensitive receptors. According to the results of measurements the need of implementation of mitigation measures becomes necessary.

To conclude, we have to mention that humans' health must be safeguarded from environmental noise and owing to this, suitable noise mitigation measures must be taken. Therefore, it is essential that the projects described above must be performed so as to decrease the adverse complaints and shelter the sensitive receivers.

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